Pacific Northwest Region
Invasive Plant Program
Preventing and Managing Invasive Plants
Final Environmental Impact Statement

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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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 standardize invasive plant prevention, and expand the set of invasive plant treatment tools available for use on National Forests in Region Six.

The FEIS considers four alternatives in detail (including No Action). Adoption of the standards in any of the action alternatives would likely reduce the extent and rate of spread of invasive plants across the region, and help prevent new infestations. All of the action alternatives include standards to protect human health and the environment. The Forest Service preferred alternative is the Proposed Action.

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SUMMARY

This Final Environmental Impact Statement (FEIS) 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[1]. Existing direction would be replaced with updated and more comprehensive direction (Chapter 1.1).

This FEIS 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 (FS) Handbook 1909.15. The document describes the purpose and need for action, the alternatives including the Proposed Action, the affected environment, and the effects of the alternatives. Chapter references are provided in this summary to help readers access these topics in the four chapters.

Purpose and Need

Invasive plants are currently damaging biological diversity and ecosystem integrity of lands within and outside the National Forests of the Pacific Northwest. Invasive plants create a host of adverse environmental effects, including: 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. Invasive plants spread between Nation Forest system lands to neighboring areas, affecting all land ownerships.

An estimated 420,000 acres of National Forest System lands in the Region are currently infested with invasive plants (Chapter 3.1)[2]. Invasive plants continue to increase and occupy previously uninfested areas. Collectively, the current National Forest System land and Resource Management Plans (Forest Plans) in the Region do not provide adequate management direction and tools to effectively address this problem. Current direction, based on a Region Six-wide 1988 Record of Decision and 1989 Mediated Agreement related to unwanted vegetation, limits the treatment tools allowed on the National Forests within the Region.

1 In this FEIS, invasive plants are defined as “non-native plant whose introduction does or is likely to cause economic or environmental harm or harm to human health” [Executive Order 13122].
2 This total does not include invasive plants floating or submerged in water. Floating or submerged invasive plants are not included in this action (Chapter 1.5).

There exists an underlying need on National Forests for: (1) Forest Plan direction that will reduce the extent and rate of spread of invasive plants and help prevent new infestations; (2) Release from the Forest Plan direction established by the 1988 Record of Decision (ROD) and 1989 Mediated Agreement so that new practices, technologies, and formulations of herbicides are available for use in invasive plant management[3]; (3) An, updated list of herbicides available for use by the Forests (Chapter 1.2).

Not meeting this underlying need would mean the adverse effects from invasive plants would continue to increase on National Forests and Grasslands within the Region, compromising our ability to manage for healthy native ecosystems. Invasive plants would continue to spread to neighboring lands, creating adverse effects on and off National Forest System land. (See Figure S-1)

The Proposed Action

The Proposed Action amends all Forest Plans within Region Six[4] to improve and increase consistency of invasive plant prevention, and allows the use of an expanded set of invasive plant treatment tools. The Proposed Action also includes restoration requirements and an inventory and monitoring plan framework.

Key features of the Proposed Action include:

- Expanded invasive plant prevention that focuses on reducing ground disturbances and limiting the introduction and spread of invasive plants;
- Increased emphasis on early detection and treatment of new invasive plant sites;
- An expanded and modernized invasive plant treatment toolbox;
- Increase emphasis on protecting and restoring healthy native plant communities;
- A monitoring plan framework that provides a consistent blueprint for more detailed future monitoring plans;
- Long-term site goals that provide the mechanism to link treatment to prevention, revegetation/restoration and monitoring in an integrated and adaptive process;

3 Parts of the 1988 ROD and 1989 Mediated Agreement that apply to unwanted vegetation that are not considered invasive plants are not affected by this FEIS.
4 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.

The selected alternative would amend all Forest Plans in Region Six and provide management direction for projects, but it would not approve any site-specific projects. Site-specific treatment decisions would be based on location, biology and size of the target invasive plant species, site conditions, and integrated resource objectives. Invasive plant treatment projects would be subject to future NEPA analysis before being implemented.

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 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).

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Figure S-1 USDA Forest Service Pacific Northwest Region

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Public Involvement and Issues

Members of the public have provided the Forest Service extensive help 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. Significant issues include both key issues that are sensitive to the differences in alternatives, and other issues that have effects that do not vary between alternatives. The key issues were used to help formulate the alternatives.

DEIS Comment Period

The DEIS was circulated for public review and comment in August 2004. The Forest Service received approximately 300 pieces of correspondence during the comment period. The Forest Service responded to the comments in a variety of ways: modifying alternatives (changing language in the DFC, goals, objectives or standards), supplementing the analysis, or making correction to the analysis. A detailed summary of all public comments to the DEIS is provided in Appendix A.

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. Each action alternative adds a unique set of invasive plant management standards to Forest Plans in Region Six.

Chapter 4.2 focuses on characteristics of the standards and how they influence the introduction, establishment and spread of invasive plants.

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. Certain herbicides and the methods by which they are applied could also harm plant pollinators.

Chapter 4.3 focuses on the potential for herbicides to harm non-target plants and plant pollinators.

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, vegetation-eating or insect-eating birds, mammals, and/or amphibians.

Chapter 4.4 focuses on the risks to wildlife associated with the use of herbicides.

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. 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.

Chapter 4.5 focuses on the health and safety of forestry workers and the public.

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 System lands. Also, invasive plant management may compete with other important land management needs, resulting in opportunity-cost tradeoffs.

Chapter 4.6 focuses on the cost of invasive plant management, both in terms of monetary costs and the opportunity cost tradeoffs.

The No Action Alternative

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 Six, the FSM, and letters of Regional policy (Chapter 2.3).

The Other Action Alternatives

In addition to the Proposed Action, two other "action alternatives" (Alternatives B and D) were developed to meet the underlying need for action and address the identified issues. All three 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.

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 and road maintenance. Under Alternative B, the use of herbicides for treatment of invasive plants is a "tool of last resort[5]."

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 potentially more risky herbicides (2,4-D and Dicamba).

5 "Tool of last resort" means that tool will be used only if all other methods for managing invasive plants are ineffective or too expensive.

Table S-1 Key Features of the Alternatives Considered in Detail.				
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 additional, more prescriptive 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.

Inventory and Monitoring

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 will guide future development of detailed monitoring plans at the Forest or site-specific project level (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 herbicides available to land managers would remain limited. 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 the high priority goal of controlling invasive plants.

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.

Table S-2 provides a summary/comparison of the effects of implementing each alternative found in Chapter 4.

Despite careful design of the management direction for the action alternatives, a risk of adverse effects remains (Chapter 4.8.1). Some potential effects cannot be fully mitigated. An accidental herbicide spill, for instance, may kill non-target species even though a spill plan is in place. Mitigation measures will be applied at the project scale to avoid these effects to the extent possible. No additional mitigation would be reasonable to apply at this programmatic scale.

The Forest Service Preferred Alternative is the Proposed Action

Table S-2 compares the key features of the four alternatives considered in detail in Chapter 2 of this FEIS.

Table S-2 Alternative Comparison/Decision Factors

Factor for Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
How Well the Alternative Meets the Underlying Need for Action				
Reduce the Extent and Rate of Invasive Plant Spread	Does not include new prevention standards. Control may never be reached.	Moderate to high potential for reducing rate of spread from adherence to new prevention standards. Control may be reached within 32 years assuming effective annual treatment of 30,000 acres and spread reduced by half.	Highest potential for reducing rate of spread from adherence to new prevention standards. Control may be reached within 47 years if 20,000 acres are effectively treated annually and spread is reduced to 4 percent.	Moderate potential for reducing rate of spread from adherence to new prevention standards. Control may be reached within 21 years if 40,000 acres are effectively treated annually and spread is reduced to 7 percent.
Release from Forest Plan Direction so that new practices/ technologies/ and herbicides are available; provides an updated list of herbicides	Maintains current Forest Plan management direction, no new tools available.	High potential to result in effective treatments because it provides for a suite of tools (including herbicides) that are adequate to effectively treat all known infestations.	Alternative B lacks sufficient variety of tools for adapting to different environmental circumstances. For example, Alternative B provides only one tool, sethoxydim, for invasive grass control. Success using sethoxydim on different grasses varies from good when treating reed canarygrass to no effectiveness on quackgrass (Tu et al, 2001). Alternative B may not be effective in remote, difficult to access terrain due to restrictions on aerial spray. Herbicide resistance may increase under Alternative B because there are fewer herbicide choices.	Same as Proposed Action. The additional two herbicides in Alternative D belong to the same family as herbicides in the Proposed Action, so there is no additional advantage in Alternative D for managing herbicide resistance.
Potential Effects to Human Health and The Environment				

Table S-2 Alternative Comparison/Decision Factors

Factor for Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Potential to harm non-target plants	Herbicide use on an estimated 13,000 acres annually includes four herbicides with potential to harm non-target plants: picloram, glyphosate, triclopyr, dicamba	Herbicide use on an estimated 8,500 acres annually includes three herbicides that have potential to harm non-target plants: picloram, glyphosate, imazapyr. Less risk to non-target plants than No Action, more than Alternative B. Implementing Standard #16 would mitigate potential effects of chlorsulfuron, metsulfuron methyl, sulfometuron methyl, and triclopyr.	Herbicide use on an estimated 2,000 acres annually includes one herbicides with greater potential to harm non-target plants: glyphosate Least risk to non-target plants. Implementing Standard #16 would mitigate potential effect of triclopyr.	Herbicide use on an estimated 15,500 acres includes five herbicides with most potential to harm non-target plants: chlorsulfuron, metsulfuron methyl, sulfometuron methyl, picloram, glyphosate, triclopyr, dicamba. Most risk to non-target plants
Number of herbicides included in each alternative that have known potential to cause toxic effects to honey bees	Current herbicide list includes three herbicides with potential to harm pollinators (honeybees): 2,4-D, glyphosate and triclopyr.	Herbicide list includes two herbicides with potential to harm pollinators (honeybees): glyphosate and triclopyr. Less risk to pollinators than No Action, more than Alternative B	Herbicide list includes one herbicide with potential to harm pollinators (honeybees): glyphosate. Least risk to pollinators	Same as No Action
Effects on birds and mammals ***Please note that the number of exposure scenarios is not influenced by the estimated acres treated annually.***	There are 25 plausible scenarios where herbicide exposure could harm individual animals. Use of herbicides associated with these harmful exposure scenarios occurs on approximately 13,646 acres annually	There are 21 plausible scenarios where herbicide exposure could harm individual animals. Reduced risk to birds and mammals as compared to No Action. Use of herbicides associated with these scenarios is predicted to occur on about 9,000 acres annually	There are 12 plausible scenarios where herbicide exposure could harm individual animals. Reduced risk to birds and mammals as compared to Proposed Action. Use of herbicides associated with these scenarios is predicted to occur on about 2,500 acres annually.	There are 45 plausible scenarios where herbicide exposure could harm individual animals. Increased risk to birds and mammals as compared to No Action. Use of herbicides associated with these scenarios is predicted to occur on about 27,500 acres annually.

Table S-2 Alternative Comparison/Decision Factors

Factor for Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Number of herbicides included that may harm amphibians	Three herbicides approved for use currently are known to potentially harm amphibians.	Reduces herbicides from 3 to 1 known to potentially harm amphibians.	Reduces herbicides from 3 to 1 known to potentially harm amphibians	Same as No Action.
Worker exposure to manual treatment hazards	Approximately 36,500 worker days of exposure annually from manual treatments.	Approximately 30,500 worker days of exposure annually from manual treatments. Reduces potential for exposure as compared to No Action.	Approximately 45,000 worker days of exposure annually from manual treatments. Increases potential for exposure as compared to No Action.	Approximately 8,500 worker days of exposure annually from manual treatments. Reduces potential for exposure as compared to Proposed Action.
Worker exposure to harmful doses of herbicide and/or NPE	No plausible scenarios for harm to workers applying herbicides at typical application rates. Current Herbicide use is associated with an estimated 13 plausible scenarios that could harm workers at maximum label rates. These scenarios are associated with herbicide use that occurs annually on about 12,281 acres.	No plausible scenarios for harm to workers applying any approved herbicides at typical application rates. Projected herbicide use is associated with an estimated 11 plausible scenarios that could harm workers at maximum label rates (less than No Action). These scenarios are associated with herbicide use that is projected to occur annually on about 4,960 acres under this alternative.	No plausible scenarios for harm to workers applying any approved herbicides at typical application rates. Projected herbicide use is associated with an estimated 7 plausible scenarios that could harm workers at maximum label rates (less than Proposed Action and No Action). These scenarios are associated with herbicide use projected to occur annually on about 508 acres under this alternative.	One plausible scenario for harm to workers applying 2,4-D at typical application rates. Projected herbicide use is associated with an estimated 20 plausible scenarios that could harm workers at maximum label rates (more than No Action). These scenarios are associated with herbicide use project to occur annually on about 24,317 acres under this alternative.

Table S-2 Alternative Comparison/Decision Factors

Factor for Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Public Exposure to Harmful Doses of Herbicides and/or NPE (other than through drinking water contamination)	No plausible scenarios for harm to the public from herbicides applied at typical application rates. Current herbicide use is associated with an estimated 9 plausible scenarios that could harm people when applied at maximum label rates. These scenarios are associated with herbicide use that occurs annually on about 591 acres.	No plausible scenarios for harm to the public from herbicides applied at typical application rates. Herbicides allowed are associated with an estimated 4 plausible scenarios that could harm people when applied at maximum label rates (less than No Action). These scenarios are associated with herbicide use that is projected to occur on about 1,000 acres each year.	No plausible scenarios for harm to the public from herbicides applied at typical application rates. Herbicides allowed are associated with an estimated 4 plausible scenarios that could harm people when applied at maximum label rates (same as Proposed Action). These scenarios are associated with herbicide use that is projected to occur on about 500 acres each year.	Three plausible scenarios for harm to the public from 2,4-D applied at typical application rates. In addition, 2,4-D and other herbicides allowed are associated with an estimated 15 plausible scenarios that could harm people when applied at maximum label rates (more than No Action). These scenarios are associated with herbicide use projected to occur annually on about 15,000 acres under this alternative.
Potential for Drinking Water Contamination	No scenarios known for herbicide to reach harmful concentrations in drinking water from drift.	No scenarios known for herbicide to reach harmful concentrations in drinking water from drift.	No scenarios known for herbicide to reach harmful concentrations in drinking water from drift.	One worst-case scenario known for herbicide to reach harmful concentrations in drinking water from drift. This scenario would have the potential to occur over about 14,000 acres annually.
Potential for drinking water contaminated by tanker spill into pond	A tanker spill into a pond could reach harmful concentration; four plausible scenarios.	A tanker spill into a pond could reach harmful concentration; seven plausible scenarios, more than No Action.	A tanker spill into a pond could reach harmful concentration; three plausible scenarios.	A tanker spill into a pond could reach harmful concentration; nine plausible scenarios, more than any alternative.
Effects on Existing uses/management activities on National Forest				
Estimated percentage increase in cost of heavy equipment work	No increase.	2% increase in cost of heavy equipment work from adoption of prevention standards.	11% increase in cost of heavy equipment work from adoption of prevention standards.	Same as Proposed Action

Table S-2 Alternative Comparison/Decision Factors

Factor for Comparison	Current Direction/ 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.	No new road closures expected from invasive plant prevention standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft National Policy.	Tendency for more roads to be closed or decommissioned due to wording of standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft National Policy.	No Direct Effect. 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	Reduces grazing levels, due to rangeland grazing capacities being diminished by invasive plants.	Reduces grazing levels, due to more consistent applications of prevention measures.	Highest tendency to reduce grazing levels, due to more rigid and consistent applications of prevention measures.	Same as Proposed Action.
Acres of National Forest where weed free feed would be required	2.5 million	4.6 million (Wilderness Areas only) Increases costs of obtaining feed for pack stock, increases recreation administration costs accordingly.	24.9 million (all National Forests in the Region) Increases costs of obtaining feed for pack stock, increases recreation administration costs more than the Proposed Action.	2.5 million (same as No Action)
Associated Costs				
Average Cost of Treatment	Approximately 25,000 acres per year can be treated given the current $4.1 million annual budget.	Reduces average costs of treatment compared to No Action, so 5,000 more acres can be effectively treated each year.	Increases average cost of treatment compared to No Action, so 5,000 fewer acres can be effectively treated each year.	Reduces average cost of treatment compared to No Action so 15,000 more acres can be effectively treated each year.

* Off-Highway Vehicle Recreation – In this document, the term off-highway vehicle (OHV) refers to vehicles used for off-highway pursuits and may include 3 and 4 wheelers, motorcycles, dune buggies, 4x4 vehicles, and other motorized vehicles.

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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[6] to improve the ability of the National Forests to prevent and manage invasive plants[7]. Updated and more comprehensive direction would replace existing direction for the prevention and management of invasive plants.

Invasive plants are currently damaging biological diversity and ecosystem integrity of lands within and outside the National Forest system in the Pacific Northwest. Invasive plants create a host of adverse environmental effects, including: 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; and reduced soil productivity. Invasive plants spread between National Forest system lands to neighboring areas, affecting all land ownerships.

The economic impact of invasive plants 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).

An estimated 420,000 acres of National Forest System lands in the Region are currently infested with invasive plants[8]. Despite current management efforts, invasive plants continue to increase and occupy previously uninfested areas, such as Wilderness areas, Research Natural Areas, and Hell's Canyon National Recreation Area.

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 unique and valuable 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

6Region 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.
7 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].
8 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.

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.

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.

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[9]. These documents require consideration of invasive plant prevention, but specific direction on how to actually prevent the spread of invasive plants is not provided.[10] 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.

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9 These documents have been incorporated into the Forest Plans within the Region.

10 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 adequate tools for effectively responding to the invasive plant threat.

This EIS responds to an underlying need that currently exist on all National Forest System land in Region Six for:

1. Forest Plan direction that will reduce the extent and rate of spread of invasive plants and help prevent new infestations.
2. Release from 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 the new management direction is to facilitate subsequent actions to eliminate or control invasive plants so that: (1) the Desired Future Condition (DFC) of National Forest System lands can be attained [11]; (2) federal land managers' ability to provide goods and services from the National Forest System lands is maintained; and (3) the Forest Service's ability to cooperate with similar efforts across other ownerships is improved.

Not meeting this underlying need would mean the adverse effects from invasive plants would continue to increase on National Forests and Grasslands within the Region, compromising our ability to manage for healthy native ecosystems. Invasive plants would continue to spread to neighboring lands, creating adverse effects on and off National Forest System land. (See Figure S-1)

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 her make a reasoned decision, whether to:

1. Select No Action 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

11 Refer to Chapter 2.4 for more information on Desired Future Condition

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. Portions of the 1988 ROD and Mediated Agreement that involve management of other unwanted native vegetation would remain in place. The Record of Decision will address transition between existing management direction and any new direction selected.

Management direction provided by the selected alternative would apply to future projects and activities. The selected alternative will not by itself change any permitted or authorized activity on National Forest System land. Project-level analysis (NEPA) will still be required. The final decision for this EIS will influence the design and development of these projects.

The selected alternative will not be retained as a Regional-scale decision; rather it will become part of the individual Forest Plans. Over time, decision makers for individual National Forests may modify the decisions that result from this EIS in accordance with planning laws, policies and regulations.

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 treatment of invasive plants, along with associated 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 Pacific Northwest Region National Forests

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1.6 Public Participation, Scoping and Issues

Ongoing public involvement occurred throughout the NEPA process. Initial scoping 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, and organizations, governments, and tribes. Public meetings were held in Oregon and Washington.

Public issues[12] were identified based on the scoping input. Where possible, the Proposed Action was refined to resolve issues. Some issues could not be resolved without substantial change to the Proposed Action. Alternatives were developed to address these 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.

Some issues raised by the public are inherent to invasive plant management and do not vary between alternatives. These "other issues" are:

- Effects on Soil Productivity
- Effects on Aquatic Organisms
- Effects on Federally Listed and Forest Service Sensitive Species
- Effects on Tribal /Treaty Rights and Environmental Justice

Chapter 4 presents detailed analysis related to these issues.

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12 Issues are points of discussion, debate, or dispute about the environmental effects of an action.

1.6.1 Key Issues

Key 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 treatment methods also factors into the effectiveness of the alternatives.

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 are controlled

Key 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 those herbicides that have a relatively higher potential to harm non-target plants

Key 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

Key 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.

Factors for Comparison of Alternatives

- Number of worker days of exposure to manual treatment hazards
- Number of herbicide and NPE[13] worker scenarios exceeding reference dose (RfD)[14]
- 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
- 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

Key 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.

Prevention 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

13 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).
14 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.

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

1.6.2 Other Issues

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. 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. 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 is an important responsibility of the Federal Government.

Within Region Six, many Native American tribes have treaty reserved or Executive Order rights outside the bounds of their respective Indian reservations. Additionally, there are tribes without specific off-reservation reserved rights who continue to gather natural resources for traditional or cultural purposes. These lands, often called “ceded lands” include much of the National Forest System lands in Washington and Oregon. 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.

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.

1.6.3 DEIS Comment Period

The DEIS was circulated for public review and comment in August 2004[15]. The Forest Service received approximately 300 pieces of correspondence during the comment period. Most of the correspondence originated in Oregon and Washington. The comments were

15 The 90-day public review period began on August 22, 2004, and ended on November 24, 2004.

considered individually and collectively. Comments extracts were categorized based on their subject matter. The Forest Service responded to the comments by:

1. Modifying alternatives – The wording of standards was changed in response to comments. One new standard was added to all alternatives.
2. Supplementing analysis – Several sections of the FEIS include supplemental analysis or clarifying discussions in response to comments.
3. Corrections – Some comments resulted in corrections to the existing analysis.

Appendix A provides a summary of all public comments to the DEIS. The analysis files contain a database linking these comments to the correspondence received. Lists of commenters and detailed demographic information are in the files.

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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, the Proposed Action, Alternative B and Alternative D, (hereafter referred to as the "alternatives").[16] All the alternatives follow the Integrated Weed Management (IWM)[17] 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: a Desired Future Condition statement (DFC), 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

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16 In the early stages of alternative development the No Action alternative was labeled as Alt. A, and the Proposed Action was Alt. C. The switch was made mid-process to help reduce confusion for future readers regarding which is No Action, (current direction) and which is the Forest Service's Proposed Action.
17 Integrated Weed Management (IWM) - An interdisciplinary weed management approach for selecting methods for preventing, containing, and controlling noxious weeds in coordination with other resource management activities to achieve optimum management goals and objectives (FSM 2080.5).

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 System 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 2.9 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 emphasis on reducing conditions that contribute to invasive plant introduction, establishment and spread. The standards included in Alternative B tend to be stricter and less flexible than in the other alternatives, and tend to apply to more acreage in the Region. 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 [18]." Treatment projects would be prioritized to favor those projects with the highest likelihood of restoring native plant communities.

Some standards in Alternative B include additional or alternate language when compared to the other alternatives. This additional or alternate language does not necessarily or in all cases change the intent of the standard. In some cases, the language was kept to maintain the flavor of the "Restore Native Ecosystems Alternative." The differences in potential effects of the standards as worded in each alternative are disclosed in Chapter 4 and the numerous summary tables throughout the document. In many cases, these differences cannot be quantified at a Regional scale.

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.

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18 "Tool of last resort" means that tool will be used only if all other methods for managing invasive plants are ineffective or too expensive.

Alternative D includes the use of two, less expensive and potentially 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 additional, more prescriptive 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.

2.3 Current Direction and the No Action Alternative

Forest Service Manual 2080.2 directs the Forest Service to use an integrated weed management (IWM) approach to control and contain the spread of noxious weeds on National Forest System lands and from National Forest System lands to adjacent lands.

Forest Service Manual 2080.5 defines IWM as: "An interdisciplinary pest management approach for selecting methods for preventing, containing, and controlling noxious weeds in coordination with other resource management activities to achieve optimum management goals and objectives. Methods include: education, preventive measures, herbicides, cultural, physical or mechanical methods, biological control agents, and general land management practices, such as manipulation of livestock or wildlife grazing strategies, that accomplish vegetation management objectives."

Specific objectives to be achieved through integrated weed management include:

- Prevention of the introduction and establishment of noxious weed infestations.
- Containment and suppression of existing noxious weed infestations.
- Formal and informal cooperation with State agencies, local landowners, weed control districts and boards, Native American tribes and other Federal agencies in the management and control of noxious weeds.
- Education and awareness of employees, users of National Forest System lands, adjacent landowners, and State agencies about noxious weed threats to native plant communities and ecosystems.

Additional direction for the management of invasive plants on the National Forests in Region Six 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. A listing of current Forest Plan standards and guidelines is included in Appendix F.

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.[19] 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. 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

Best management practices related to roads management and invasive plants are outlined in the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E) and the USDA Forest Service Backcountry Road Maintenance and Weed Management publication (7100 Engineering July 2003 0371-2811-MTDC).

The Mt. Baker-Snoqualmie National Forest has amended their Forest Plan to require the use of invasive plant prevention practices related to road management. Other Forests are implementing invasive plant prevention and treatment/restoration practices related to roads management to varying degrees.

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, consistent coordination to schedule activities to prevent the spread of invasive plants is not occurring.

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. Road related erosion control projects currently specify the use of seed mixes that include native type grasses.

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19 “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.

Livestock Grazing

Though not directly required, numerous annual operating instructions and grazing allotment management plans across the Region already include some consideration 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 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 to livestock grazing within 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. Several Forests within the Region requires 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 Forest Service considers invasive plants when developing the terms and conditions or mitigation measures, associated with 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. A process for determining priorities based on a Forest Service guide for how to prioritize sites and select treatment methods is shown in Chapter 3.3.

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 topics of consideration, including: the potential human health risks; potential environment effects; 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[20].

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

20 Blue Mountain Biodiversity Project v. U.S. Forest Service – CV 01-703-HA, 2002.

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

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 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

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 Five Step Approach for Managing Competing and Unwanted Vegetation

2.4 Management Direction Common to All Action Alternatives

The proposed management direction included in the action alternatives follows the IWM approach described in Chapter 2.3. The action alternatives build on the 1988 ROD and 1989 Mediated Agreement emphasis on protecting ecosystem and human health. None of the alternatives release the Forest Service from the requirement to protect the health of people and the environment when implementing invasive plant treatment projects. The management direction common to all action alternatives is intended to increase the likelihood that invasive plant projects are safe and effective. All alternatives would still require site-specific analysis that addresses: the potential human health risks, potential environmental effects; and knowledge of the physical and biological characteristics of the site. All of the alternatives (except Alternative D) maintain the objective to reduce herbicide use over time.

Four kinds of new management direction would be added to Forest Plans in Region Six under the action alternatives: A Desired Future Condition statement, goals and objectives, prevention and treatment/restoration standards, along with an inventory and monitoring plan framework. This will meet the need for Forest Plan direction that will prevent or reduce the spread of invasive plants (see Chapter 1.2).

Desired Future Condition (DFC) statement 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 (with the exception of Objective 3.2) are common to all action alternatives. Not all objectives are associated with specific proposed standards. In these cases, objectives would be met through adherence to existing standards, policies and laws.

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.

2.4.1 Desired Future Conditions, Goals and Objectives

The following Desired Future Condition (DFC), 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, and damaged ecosystems are being restored. High quality habitat is provided for native organisms throughout the region. Invasive plants do not jeopardize the ability of the National Forests to provide goods and services communities expect. 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 - 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 – Retain native vegetation consistent with site capability and integrated resource management objectives 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 Region Six (Proposed Action and Alternative B only).

Goal 4 – Implement invasive plant treatment strategies that protect sensitive ecosystem components, and maintain biological diversity and function within ecosystems. Reduce loss or degradation of native habitat from invasive plants while minimizing adverse effects from treatment projects.

Objective 4.1 – Maintain water quality while implementing invasive plant treatments.

Objective 4.2 - Protect non-target 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 tribal, other 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 detailed monitoring plans at the sub-regional or site-specific project level. A measure included within the monitoring framework that will improve the Forest's ability to detect, respond rapidly to new infestations is the requirement to maintaining an invasive plant inventory consistent with nationally accepted (e.g., NRIS/Terra) protocols.

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.

Protection Measure Effects Monitoring – Were the standards and protection measures effective at reducing potential effects to ESA-listed species and/or designated critical habitat? It is important to evaluate the effectiveness of protection measures so the Forest Service can accurately report and predict the effects of our projects.

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 IWM approaches described in Chapter 2.3. The action alternatives represent different approaches to two of the key components of IWM: (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 IWM 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, 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 2-2 displays and compares the alternative Forest Plan standards and the objectives each standard would address.[21]

21 The action alternatives do not always include distinct standards for implementing the objectives. In these situations, achievement of the goals and objectives rely on existing laws, policies and manual direction.

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
Prevention Standards			
1 (Objectives 1.1, 1.2, 2.3, 2.4, 2.5)	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; wildland fire implementation plans; grazing allotment management plans, recreation management plans, vegetation 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 (Objectives 1.1, 1.2, 2.3)	Actions conducted or authorized by written permit by the Forest Service that will operate outside the limits of the road prism (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 wildland fires, and other emergency situations where cleaning would delay response time.	Actions conducted or authorized by written permit by the Forest Service that will operate outside the limits of the road prism (including public works and service contracts), require the cleaning of **all equipment and vehicles** prior to entering National Forest System land for all projects, **and before leaving the project site**, when operating in areas where invasive plants have been identified as present at a level where transport of invasive plant seed or vegetation propagules (root fragments) is likely and a concern. This standard would not apply to initial attack of wildland fires, and other emergency situations where cleaning would delay response time.	Same as Proposed Action.

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
3 (Objectives 1.1, 2.3)	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/or mulch is not available, individual Forests should require sources certified to be weed free using the North American Weed Free Forage Program standards (see Appendix O) or a similar certification process. This standard may need to be phased in as a certification process is established.	Same as Proposed Action.	Same as Proposed Action.
4 (Objectives 1.1, 2.5)	Use only pelletized or certified weed free feed in **wilderness and wilderness trailheads**. If state certified weed free feed is not available, individual Forests should require feed certified to be weed free using North American Weed Free Forage Program standards or a similar certification process. This standard may need to be phased in as a certification process is established.	Use only pelletized or certified weed free feed on **all National Forest System lands.** If state certified weed free feed is not available, individual Forests should require feed certified to be weed free using North American Weed Free Forage Program standards or a similar certification process. This standard may need to be phased in as a certification process is established. Choose weed-free project staging areas, livestock and packhorse corrals, and trailheads.	No corollary standard. (Same as current direction)
5 (Objective 2.2)	No corollary standard. (Addressed as Objective 2.2 and in the USDA Forest Service Guide to Noxious Weed Prevention Practices)	Consistent with project objectives, retain native vegetation in an around project locations and minimize creating soil conditions that promote the establishment and spread of invasive plants.	Same a Proposed Action
6 (Objectives 1.1, 5.1, 5.3)	Through annual operating instructions, and the revision of grazing allotment management plans, incorporate invasive plant prevention practices that reduce the spread of invasive plants. Plan and implement practices in cooperation with the grazing permit holder.	Same as Proposed Action, **plus**: Document consideration of the prevention practices included in the grazing management section of the USDA Forest Service Guide to Noxious Weed Prevention Practices, (Appendix E).	Same as Proposed Action.

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
7 (Objectives 1.1, 1.2, 1.3)	Inspect active gravel, fill, sand stockpiles, quarry sites, and borrow material for invasive plants before use and transport. Treat or require treatment of infested sources before any use of pit material. Use only gravel, fill, sand, and rock that is judged to be weed free by District or Forest weed specialists.	Same as Proposed Action, **plus**: Strip and stockpile and treat infested sources before any use of material. Inspect active gravel, fill, sand stockpiles, quarries, and borrow material **annually** for invasive plants.	Same as Proposed Action.
8 (Objectives 1.1, 1.2, 5.1)	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 practices 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 road blading, brushing and ditch cleaning equipment after operating in infested areas to remove plant seed and propagules.	Same as Proposed Action.
9 (Objectives 1.1, 2.4)	No corollary standard.	Close or decommission non-essential[1] roads where roads analysis indicates that the presence, type, use and location of roads may increase the introduction and spread of invasive plants; and such introduction adversely affect native plant and animal species and ecosystem function. Retain administrative access as needed for invasive plant treatment and site restoration.	No corollary standard.
10 (Objectives 1.1, 2.4, 2.5)	Require the establishment of a system of roads, trails, and areas designated for motor vehicle use; and prohibit the use of motor vehicles off the designated system that is not consistent with the classes of motor vehicles and if applicable, the time of year, designated for use.[2]	Same as Proposed Action.	No corollary standard.
Treatment and Restoration Standards			

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
11 (Objectives 1.5, 5.1)	Prioritize infestations of invasive plants for treatment at the landscape, watershed or larger multiple forest/multiple owner scale.	Same as Proposed Action.	Same as Proposed Action.
12 (Objectives 1.1, 5.1)	Develop a long-term site strategy for restoring/revegetating invasive plant sites prior to treatment.	Same as Proposed Action.	Same as Proposed Action.
13 (Objectives 1.1, 1.4)	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. Use persistent non-natives, such as crested wheatgrass, clover and range alfalfa, if necessary, on degraded sites, where less persistent species have been shown to be unsuccessful in competing with invasive plants.
14 (Objectives 1.4, 4.1, 4.2)	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 (Objectives 1.4, 3.1, 4.1, 4.2)	Application of any herbicides to treat invasive plants will be performed or directly supervised by a State or Federally licensed applicator. All treatment projects that involve the use of herbicides will develop and implement an herbicide transportation and handling safety plan.	Same as Proposed Action.	Same as Proposed Action.
16 (Objectives	Select from herbicide formulations containing one or more of the following **10 active ingredients**: chlorsulfuron, clopyralid, glyphosate, imazapic,	Select from herbicide formulations containing one or more of the following **4 active ingredients**: clopyralid, glyphosate, sethoxydim, and triclopyr. No	Select from herbicide formulations containing one or more of the following **12 active ingredients**:

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
1.4, 3.1, 4.1, 4.2)	imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. Mixtures of herbicide formulations containing 3 or less of these active ingredients may be applied where the sum of all individual Hazard Quotients for the relevant application scenarios is less than 1.0. [3] 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 and herbicide mixtures may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.	mixtures of these herbicide formulations is permitted. All herbicide application methods are allowed including wicking, wiping, injection, spot, broadcast and aerial, as permitted by the product label. 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.	2,4-D, chlorsulfuron, clopyralid, dicamba, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. Mixtures of herbicides formulations containing these active ingredients may be applied where the sum of all individual Hazard Quotients for the relevant application scenarios is less than 1.0. [3] All herbicide application methods are allowed including wicking, wiping, injection, spot, broadcast and aerial, as permitted by the product label. Additional herbicides and herbicide mixtures may be added in the future at either the Forest Plan or project level through appropriate risk analysis and NEPA/ESA procedures.
17 (Objective 3.4)	When herbicide treatments are chosen over other treatment methods, document the rationale for choosing herbicides.	Choose non-herbicide treatment methods over herbicides, unless non-herbicide methods are known to be ineffective or unfeasible. Use herbicides as a tool of last resort. Reduce herbicide use over time at both the regional and local scale.	No corollary standard.

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
18 (Objectives 3.1, 4.1, 4.2)	Use only adjuvants (e.g. surfactants, dyes) and inert ingredients reviewed in Forest Service hazard and risk assessment documents such as SERA, 1997a, 1997b; Bakke, 2002.	Use only adjuvants and herbicide formulations for which all ingredients have been publicly identified.	Same as Proposed Action.
19 (Objective 4.1)	To reduce or eliminate direct or indirect negative effects to non-target plants, terrestrial animals, water quality and aquatic biota (including amphibians) from the application of herbicide, use site-specific soil characteristics, proximity to surface water and local water table depth to determine herbicide formulation, size of buffers needed, if any, and application method and timing. Only consider those herbicides and herbicide mixtures registered for aquatic use when evaluating herbicide use near streams or surface water.	Same as Proposed Action, **plus**: Minimize application of herbicides and prohibit broadcast spraying in the riparian reserve land allocation 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 (Objectives 4.1, 4.2, 4.3)	Design invasive plant treatments to reduce or eliminate adverse effects to species and critical habitats proposed and/or listed under the Endangered Species Act. 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 (Objectives 3.1, 4.2)	Provide a minimum buffer of 300 feet for aerial application of herbicides near developed campgrounds, recreation residences and private land (unless otherwise authorized by adjacent private landowners).	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.

Table 2-2 Action Alternative Standards

Standard (Objective Addressed)	Proposed Action	Alternative B	Alternative D
22 (Objectives 4.1)	Prohibit aerial application of herbicides within legally designated municipal watersheds.	Same as Proposed Action.	Same as Proposed Action.
23 (Objective 3.1)	Prior to implementation of treatment projects, each Forest will develop a public information plan. The plan will ensure (at a minimum) that timely (normally 15 days) public notification will occur. Warning and information signs will be placed at appropriate locations (defined in the public information plan) to inform the public, and forest workers of herbicide application dates and herbicide used. If requested, individuals may be notified in advance of spray dates and times.	Same as Proposed Action.	Same as Proposed Action.

1. "Non-essential" is defined as not needed for future management.
2. Details, conditions, terms, definitions, etc. of this standard parallel those contained in Proposed Rule 36 CFR Parts 212, 251, 261, and 295 Travel Management; Designated Routes and Areas for Motor Vehicle Use, Federal Register Vol. 69, No. 135, July 15, 2004 (See Appendix R).
3. ATSDR, 2004. Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures. U.S. Department Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

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2.6 Comparison of Alternatives

This section provides a comparison of the treatment methods/tools available under each alternative (Table 2-3), and a summary/comparison of the effects of implementing each alternative found in Chapter 4 (Table 2-4). Information in Table 2-4 is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Herbicide risk assessments were used to evaluate the potential for harm to non-target plants, wildlife, human health, soils and aquatic organisms. Worst-case scenarios were considered (accidental exposures, application at maximum label rates) and evaluated. The comparison table displays the relative risks associated with each alternative based on the suite of herbicides and application methods allowed. The number of acres of annual herbicide use is based on current herbicide use on and off National Forest, applied to each alternative assuming a static budget. Under all alternatives, site-specific choices would be made to reduce potential for harm to non-target plants, wildlife, human health, soils and aquatic organisms.

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Table 2-3 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, plus: foaming, streaming, infrared, and other techniques using heat.	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 that may be determined to be effective (e.g. spraying water/salt/sugar mixtures).	Same as Proposed Action.	Same as Proposed Action.
Herbicides			

Table 2-3 Treatment Methods Under the Alternatives

No Action (Current Direction)	Proposed Action	Alternative B	Alternative D
Herbicide formulations containing only the following **5 active active ingredients** are permitted (except on the Malheur NF): glyphosate, picloram, triclopyr, dicamba, and 2,4-D (a "tool of last resort"). All application methods consistent with label requirements are permitted.	Herbicide formulations and mixtures 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, 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).	Herbicide formulations containing one or more of the following **4 active ingredients**: clopyralid, glyphosate, sethoxydim, and triclopyr. No mixtures of these herbicide formulations is permitted. All herbicide application methods are allowed including wicking, wiping, injection, spot, ground level broadcast and aerial, as permitted by product label. The use of triclopyr will be limited to selective application techniques only (e.g. spot spray, wiping, basal bark, cut stump, injection). Herbicides are considered a tool of last resort.	Herbicide formulations and mixtures 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 of herbicide application methods are allowed including wicking, wiping, injection, spot, ground level broadcast and aerial, as permitted by product label.
Prescribed Fire			
Broadcast and pile burning.	Broadcast and pile burning, and flaming.	Same as Proposed Action.	Same as Proposed Action.

Table 2-4 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				
Relative rate of invasive plant spread based on predicted effectiveness of prevention standards	8-12%	Moderate to high potential for reducing rate of spread from adherence to new prevention standards.	Highest potential for reducing rater of spread from adherence to new prevention standards.	Moderate potential for reducing rate of spread from adherence to new prevention standards.
Estimated acreage of invasive plants treated annually based on current herbicide use on and off National Forests applied to each alternative under a static budget	25,000 Acres	30,000 Acres	20,000 Acres	40,000 Acres
Number of years until invasive plants may be controlled assuming above areas are effectively treated and prevention standards reduce rate of spread	Never	32 years if spread is reduced to 6%	47+ years even if spread is reduced to 4%. This is because fewer treatments would be expected to occur annually, because the expense of treating each acre is highest under this alternative.	21 years if spread is reduced to 7%
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 Implementing Standard #16 would mitigate potential effects of chlorsulfuron, metsulfuron methyl, sulfometuron methyl, and triclopyr.	1 – glyphosate Implementing Standard #16 would mitigate potential effects of triclopyr.	5 –chlorsulfuron, metsulfuron methyl, sulfometuron methyl, picloram, glyphosate, triclopyr, dicamba

Table 2-4 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
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
Acres of annual herbicide treatment as an indicator of relative harm to 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.	25	21	12	45
Acres of annual herbicide treatment as an indicator of relative harm to wildlife	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				
Number of worker days of exposure to manual treatment hazards	36,593	30,719	44,948	8,602
Number of herbicide and NPE worker scenarios exceeding reference dose (RfD)	Typical 0 Worst-Case 13	0 11	0 7	1 20

Table 2-4 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Total acreage where worker scenarios exceeding RfD may occur treatment as an indicator of relative potential harm to workers	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 9	0 4	0 4	3 15
Total acreage where these public exposure scenarios exceeding RfD may occur as an indicator of relative harm to the public	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 runoff / leaching	Typical 0 Worst-Case 0	0 0	0 0	0 1
Total acreage where risk of public drinking water contaminated by herbicide runoff / leaching exceeds RfD as an indicator of relative harm to the public	Typical 0 Worst-Case 0	0 0	0 0	0 13,765

Table 2-4 Summary of Environmental Effects of Implementing the Alternatives

Factor For Comparison	Current Direction/ No Action	Proposed Action	Alternative B	Alternative D
Number of herbicide and NPE public scenarios exceed RfD for drinking water contaminated by tanker spill into pond	Typical 1 Worst-Case 4	1 6	1 3	2 9
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.	No new road closures expected from invasive plant prevention standards. OHV use allowed only on specifically designated roads, trails, and areas based on implementation of draft national policy.	Tendency for more roads to be closed or decommissioned due to wording of standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft national policy.	No Direct Effect. 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	Reduces grazing levels due to rangeland grazing capacities being diminished by invasive plants.	Reduces grazing levels, due to more consistent applications of prevention measures.	Highest tendency to reduce grazing levels due to more rigid and consistent application of prevention measures.	Same as Proposed Action.
Acres of National Forest where weed free feed would be required	2.5 million	4.6 million (Wilderness Areas only). Increases costs of obtaining feed for pack stock, increases recreation administration costs accordingly.	24.9 million (all National Forests in the Region). Increases costs of obtaining feed for pack stock, increases recreation administration costs more than the Proposed Action.	2.5 million (same as No Action)

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.

2.7.1 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.

2.7.2 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 considered, 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 IWM would not address the purpose and need for this action, and would likely cause unnecessary environmental harm.

2.7.3 No Use of Herbicides

Additional public comments suggested that the Forest Service consider an exclusively non-herbicide alternative. An alternative of this nature was considered, but eliminated from detailed analysis because a non-herbicide alternative would 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.

The issue of scale needs to be considered when planning treatments of invasive species. 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 (Seiger, 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.

2.7.4 Additional Use of 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. Additional herbicides were not studied in detail 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. Additional herbicides could be approved in subsequent NEPA decisions with appropriate analysis.

2.7.5 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 considered but eliminated from detailed analysis for the following reasons:

Biological control 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 control is self-perpetuating, selective, energy self-sufficient, economical, and well suited to integration in an overall invasive plant management program (Wilson and McCaffrey, 1999). Successful biological control is based on the idea that one of the reasons introduced plants become invasive is their natural enemies were left behind (Schooler 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. 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 limits 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 IWM. Eliminating the consideration of bio-controls would not address the purpose and need for this action, and would likely cause unnecessary environmental harm.

2.7.6 Prohibit Aerial Application Of Herbicides

Some public comments suggested that the Forest Service prohibit the aerial application of herbicides (spray application from planes, or helicopter). An alternative of this nature was considered but eliminated from detailed analysis for the following reasons:

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.

2.7.7 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 2-5 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 2-5 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.
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.

Table 2-5 Components of the RNEA Dismissed From Detailed Consideration

Component	Reasons for Dismissal
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.
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.

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CHAPTER 3 AFFECTED ENVIRONMENT

Chapter 3 focuses on the invasive plant problem and the elements of the human environment that have been adversely affected by invasive plants. This chapter is organized into three parts: Chapter 3.1 discusses the current situation including the extent of invasive plants found in Region Six and the mechanisms by which these plants are spreading. Chapter 3.2 discusses the influence of invasive plants on ecosystem components. Chapter 3.3 describes current invasive plant management techniques.

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 non-native plants 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.

Naturalized species are non-native plants that reproduce consistently and sustain populations over many live cycles without direct intervention by humans (or in spite of human intervention); they often recruit offspring freely, usually close to adult plants, and do not necessarily invade natural, semi-natural or human-made ecosystems (Richardson et al 2000).

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 Forest System land in Region Six totals 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 different land ownerships, and land uses that occur within and around National Forests.

An estimated 420,000 acres[22] of National Forests and Grasslands in Region Six are infested with invasive plants (See Figure 3-1). At least 107 species have been inventoried by Forest Service botanists and weed specialists using inventory and mapping protocols established by the Forest Service under the NRIS Terra Invasive Plant database (USDA Forest Service, 2002-6161) (Appendix B). It is highly likely additional species are present on the National Forests in this Region, but have yet to be discovered.

Invasive plant populations increase in acreage at an estimated rate of 8-12 percent per year on Forest Service System land (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. At the world-wide scale, 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, 1998; Westbrooks, 1998). Distributions of invasive plants within the Region are increasing most rapidly in National Forests east of the Cascade crest (USDA Forest Service, 2000-Montoring).

22 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

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3.1.2 Invasive Plant Species in Region Six

There are 107 species of invasive plants reported in Region Six Forests (Appendix B). These species were added to the inventory in cooperation with local weed experts such as county or state weed coordinators[23].

The list of invasive plant species is not complete. Species known to be invasive may not be included on the list yet (such as Kentucky bluegrass or dandelion) because weed coordinators have not determined a strategy to treat them or may consider tolerating them due to the extent of their populations. The list of species provided is not meant to be static; it will evolve as inventories continue and species of high threat are discovered[24].

Species that cover the majority of known sites 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 ragwort, Scotch thistle, houndstongue, whitetop and medusahead. This list reflects the species found most often on Forests in Region Six, not necessarily the species of most concern throughout the Region and under different ownership.

These nineteen species will have varying treatment objectives and priorities for treatment (see Chapter 3.3.2 for more details) throughout Region Six. Depending on their location, species such as St. Johnswort tend to be tolerated more readily because they may be considered naturalized. These species may be of higher concern where native grasslands are invaded or where populations threaten adjacent uninfested lands of other ownerships.

Riparian species such as Japanese and giant knotweed or purple loosestrife, while not reported in the top nineteen, 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 National Forest System lands. An invasive grass such as cheatgrass, also not reported,

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23 The determination of invasiveness (see definitions) was made through assessment at the Forest level; examples of factors leading to such a determination include if the species was invading native plant communities or had been known to be an aggressive invader in similar habitat. Some species on this list may be considered naturalized and in lesser need of control efforts. They were added to the inventory because of their location; i.e., a small population of a naturalized species in a special area, for example, would be considered invasive for that particular project, but the control of the species throughout a Forest would not be considered.

24 The list is updated annually when NRIS/Terra annual updates are completed. Prioritization for treatment of such species will vary by Forest and will be done under site specific projects at the Forest level (see Chapter 3.3.2 for prioritization strategy).

is most likely underestimated because its ubiquitous nature on the eastside of the Cascades may make the species overlooked for treatment or considered untreatable in some situations.

Other species that are starting to spread within the Region 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, reed canarygrass, and numerous other invasive knapweed species[25]. Any species on state noxious weed lists in Washington and Oregon, while perhaps not on National Forest System land yet, would be considered of high threat if found.

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 the Region. 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. They provide a picture of the variety of biological traits (see Table 3.1) that can be found in the invasive plants of Region Six.

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 native 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.

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25 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. Also, any species on state noxious weed lists in Washington and Oregon, while perhaps not on Forest Service land yet, would be considered of high threat if found.

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. While only Japanese knotweed is discussed here, other species in the Region are also of great threat including giant knotweed and Himalayan knotweed.

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 (Seiger, 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 (Seiger, 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 (Seiger, 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 (Seiger, 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."

3.1.3 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).

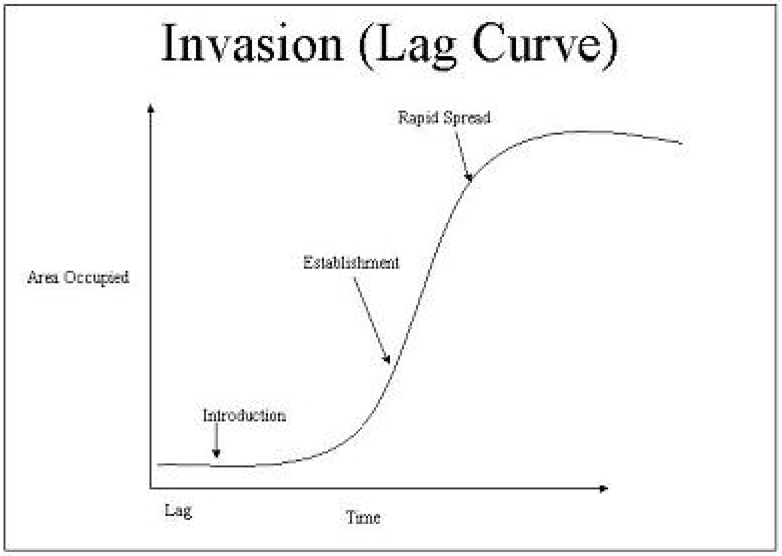

Figure 3-2 Three Phases of Invasion

This model provides guidance for making timely and appropriate decisions for managing invasive plants. Preventing species in the lag phase from spreading should be a priority for managers. Controlling infestations during periods of establishment when enough residual desired vegetation remains in the understory is another crucial time. Once the majority of the area becomes 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. These biological traits are exemplified by invasive plant species described in Chapter 3.1.2.

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; allowing for development of a long term viable seedbank.
• 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 plants (e.g., persisting for several years) annual or biennial species with the capacity to become perennial under the right conditions.
• Ability to delay flowering until environmental conditions improve.
• Able to reproduce vegetatively (i.e., without having to produce seed).
• Hybrids of vegetatively reproducing species can develop viable seed (e.g. knotweeds).
• 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.

Natural Vectors

Once introduced, natural vectors[26] such as birds, insects, or wildlife, natural forces such as wind, and water assist in the distribution of invasive. 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).

26 For the purposes of this document, the term “natural vectors” will be used interchangeably with “natural forces” or simply “vectors.

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 Wonsavage, 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 - cited in Gill and Beardall 2001).

The Role of Disturbance in Invasion

Invasion and dominance by invasive plants is 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 invasive plant establishment, and in areas where desirable species are not available to occupy these sites, invasive species can 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 plant species. 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 invasive plant 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 invasive plant invasions. Fires have been implicated as a major natural disturbance, creating conditions favorable for invasive plants. 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 invasive plant invasions, especially if the disturbances that result from the activity are small and minimize soil 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 invasive plant 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. For example, soil disturbance can stimulate the germination of invasive plant seeds in the seed bank. (Myers and Bazely, 2003).

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	**Unknown**	**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
Total	23,974		
High Clearance Surfaced	25,160	27.1	46
High Clearance Unsurfaced	29,103	31.0	54
Total	54,263		
Highway Safety Act Surfaced	14,128	15.2	96
Highway Safety Act Unsurfaced	532	0.6	4
Total	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 6,300 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 (2002 Maintenance Needs Summary). It is 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 or the germination of invasive plant seed though scarification.

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 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 (Sheley et al., 1996). Healthy plant communities can provide resistance to invasion (Sheley et al., 1996; Pokorny et al., 2004.) The influence of grazing on plant invasion is complex, 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).

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 3.3.2.

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

Forest	Allot ments	Permit tees	Cattle		Horses		Sheep & Goats		Total	
			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

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

Region 6
Authorized to Graze

Forest	Allot ments	Permit tees	Cattle		Horses		Sheep & Goats		Total	
			HM	AUMs	HM	AUMs	HM	AUMs	HM	AUMs
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 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.

The use of straw or mulch is common during wildland fire rehabilitation, when bare soil is covered to protect it from erosion or when re-seeded areas need protection from the elements. The use of non-native straw has led to the spread of non-native species, which has been documented through personal observation on the Biscuit Fire in Siskiyou National Forest (Hutchinson personal communication, 2004).

Fuels management such as thinning, slash-busting/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 National Fire Plan has resulted in significant increases in fuel reduction projects, greatly increasing the potential for introduction, establishment and spread of invasive plants within the Region.

Fire can also be a tool in invasive plant management. It has been used in combination with other methods, serving to reduce biomass or weaken plants for subsequent herbicide treatments. Its effectiveness is usually limited to the above ground portions of plants. Although, its use has been limited in Region Six, it is considered as a treatment under the various alternatives in the EIS.

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. National Forest System land 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 Forest System land (Burchfield et al., date unknown). Nineteen percent (4.6 million acres in 59 separate Wilderness areas) of the Region’s 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.

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 System lands, and the provision of high-quality motorized opportunities and balanced environmental impacts are among the agencies current goals (USDA Forest Service, 2000-Recreation). 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.

One way for users of domestic animals to avoid spreading seeds is though the use of pelletized (processed) feed or feed that is certified to be weed and weed seed free by the State or organizations such as the North American Weed Management Association (NAWMA). Region Six is bordered in the United States by Idaho, Nevada, and California. Regional Forest Service direction in Idaho and Nevada requires that only certified weed free seed by used on all National Forest System lands in these States. [27] California is currently working on a certification program and similar requirements for National Forest System lands. Wallowa County Oregon has a working NAWMA certification program[28] and the nearby Eagle Cap Ranger District and Hells Canyon National Recreation Area prohibit use of uncertified weed free feed. NAWMA certification is currently available in the three states that share borders with Region Six, as well as 9 other western states. Unfortunately, Oregon and Washington do not currently have state-wide certification programs in place. However, certified weed-free or pelletized feed is currently required on about 2.5 million acres of Nation Forest System land in Region Six (mostly in wilderness and other specially designated areas; see discussion of Congressionally Designated Area in this Chapter for Specific closures).

While OHVs and pack animal feed are clear modes of 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

27 Intermountain Region's Closure Order Number 04-00-097, states that "Possessing, storing, or transporting, non-pelletized hay, straw or mulch on National Forest System Lands without having each individual bale or container tagged or marked as weed free, or having original and current evidence of weed free certification documentation present. All markings must meet the State and/or County standards for certification as weed free."

28 Wallowa County Haygrowers Association has more information on details of a certification program working in Oregon (www.certifiedwallowacountyhay.com).

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.

3.2 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 (National Academy of Sciences, 2002). Invasive plants have already caused permanent damage to public lands across the western United States (Asher and Surrier, 1998).

Human activities during the last 100 years have resulted in 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

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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 National Forest System 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 System lands within the project area: those occurring in the coast range mountains, Cascade Mountains, eastside range lands (National Grasslands), and east side mountains (Blue Mountains and Entiat Area). (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 spp.*), 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 Mountain 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 more detritus based at higher elevations, with increasing contributions from primary production within the stream occurring at lower elevations.

Stream systems occurring on rangelands east of the Cascade Mountains 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 these stream systems.

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 Cascade Mountains, but may have 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 (Chapter 3.2.3). 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.

The function of 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

Table 3-6 Potential Vegetation Groups

Potential Vegetation Group (PVG)	Description	Percentage of PVG on National Forests	Susceptibility to Invasion Rating
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
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.

Figure 3-4 Potential Vegetation Groups

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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 variety *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.[29] 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) (USDI FWS, 2002). Within these regions, National Forests may provide significant habitat for twenty or more species listed by the United States Department of Interior Fish and Wildlife Service (FWS) as "birds of conservation concern" (USDI FWS, 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 food, shelter, or breeding, is or can be adversely affected by invasive plants. Species

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29 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.

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., 1989), 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 et al. (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, 1995); 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, 1998; 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, 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 these 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; Olson, 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, Proposed 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 or adverse modification of critical habitat. Region Six provides habitat for species that are proposed, and 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 (See Threatened, Endangered, and Sensitive Plant and Animal List Locator, Appendix C).

The Region also maintains a list of sensitive species[30]. The primary objectives of the program is to ensure that Forest Service actions do not contribute to a loss of viability, or cause a trend

30 The Sensitive Species Program and the Regional Forester’s Sensitive Species List (RFSS) are proactive approaches for meeting the Agencies obligations under the Endangered Species Act (ESA) and the National Forest Management Act (NFMA), and National Policy direction as stated in the 2670 section of the Forest Service Manual and the U.S. Department of Agriculture Regulation 9500-4.

toward listing under ESA. Species identified by the FWS as "candidates" for listing under the ESA, and meeting the Forest Service criteria for protection, are included on the Regional Forester's Sensitive Species Lists (RFSS) (See Threatened, Endangered, and Sensitive Plant and Animal List Locator, Appendix C).

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 additional are suspected on the National Forests in Region Six[31]. 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,

31 The Regional list of Threatened and Endangered Species (July 21, 2004 Memo) shows *Thelypodium howellii spp. Spectabilis* as "suspected" on the Wallowa Whitman . Recent correspondence from the U.S. Fish and Wildlife Service concludes that they no longer suspect it on National Forest System land in the Region.

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	Seasonal wetlands
*Lilium occidentale** G1/S1 Oregon	Endangered	Coastal wetlands
*Lomatium cookie** G1/S1 Oregon	Endangered	Moist, alluvial floodplains, grasslands
*Plagiobothyrus hirtus** G1/S1 Oregon	Endangered	Low elevations in highly specialized alluvial soils.
*Sidalcea nelsoniana** G2/S1 Washington),S2 Oregon	Threatened	Remnant native grasslands
*Spiranthes diluvalis*** G2/S1 Washington	Threatened	Wet meadows

Table 3-8 Federally Listed Plant Species Documented or Suspected in Region Six		
Species Global/State Ranking	**Federal Protection Status**	**Habitat**

G= Global ranking, S=State ranking.
X=presumed extirpated or extinct.
H=historical occurrence.
*=only suspected on National Forest lands.
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

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Over 400 sensitive species (including vascular, non-vascular plant and fungi species) are on the Regional Forester's Sensitive Species List (Appendix C). This list is developed from a common set of criteria and species occurrence is listed as either documented or suspected for each Forest.

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 (*Sidalcea 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 (*Silene 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 in the 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.

Threatened, Endangered, 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*) and the Columbian white-tailed deer (*Odocoileus virginianus leucurus*). The Fender's blue butterfly (*Icaricia icarioides fenderi*) is suspected to occur on the Umpqua National Forest, but has not been confirmed. 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, and Oregon silverspot butterfly. Previously designated critical habitat was vacated, and new critical habitat is currently proposed for the western snowy plover. Candidate species currently included on the Sensitive Animal List are the Mardon skipper, Oregon spotted frog, Columbia spotted frog (Great Basin Distinct Population Segment (DPS)), Pacific fisher and western (Mazama) pocket gopher, and western sage grouse (Columbia Basin DPS). 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. (Connelly et al., 2000)

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 Wildlife Species Occurrence

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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 (USDI FWS, 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) or Distinct Population Segment (DPA) (NOAA, 2000). There are six "endangered" and two "proposed" fish ESUs in Region Six. Fifteen 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*	Proposed
Southwest Washington/Lower Columbia River Coho	*Oncorhynchus kisutch*	Proposed
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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Both "critical habitat" and species have protection under the ESA. Critical Habitat is defined 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.

Reduction of trees along streams, resulting from increased invasive plants, 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 that result from invasive plants 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.

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. (Grout et al., 1997).

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 (1997) 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." 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 and Machlis (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. 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
Hoh Indian Tribe	Burns **Paiute**
Confederated Tribes of the **Colville** Reservation	Confederated Tribes of the **Chehalis** Reservation
Jamestown S'Klallam Tribe of Indians	Confederated Tribes of **the Coos, Lower Umpqua and Siuslaw** Indians of Oregon
The Klamath Tribes	**Coquille** Indian Tribes
Lower Elwha Tribal Community	**Cow Creek** Band of Umpqua Tribe of Indians
Lummi Tribe of the Lummi Reservation, Washington	**Cowlitz** Indian Tribe
Makah Indian Tribe of the Makah Indian Reservation	Confederated Tribes of the **Grand Ronde** Community of Oregon
Muckleshoot Indian Tribe	**Kalispel** Indian Community of the Kalispel Reservation
Nez Perce Tribe (reservation in Idaho)	**Samish** Indian Tribe
Nisqually Indian Community	**Shoalwater Bay** Indian Tribe of the Shoalwater Bay Indian Reservation
Nooksack Indian Tribe	Confederated Tribes of **Siletz** Indians of Oregon
Port Gamble Band of S'Klallam Indians	**Snoqualmie** Tribal Organization
Puyallup Tribe of the Puyallup Reservation of the State of Washington	The **Spokane** Tribe
Quileute Tribe of the Quileute Reservation	
Quinault Indian Nation	
Sauk-Suiattle Indian Tribe	
Skokomish Indian Tribe	
Squaxin Island Tribe	

Table 3-11 Tribes and Treaty Rights	
Tribes with Off-Reservation Rights	**Tribes without Off Reservation Rights**
Stillaguamish Tribe of Indians **Suquamis**h Tribe of the Port Madison Reservation, Washington **Swinomish** Indian Tribal Community The Tulalip Tribes Confederated Tribes of the **Umatilla** Indian Reservation **Upper Skagit** Indian Tribe Confederated Tribes of the **Warm Springs** Reservation of Oregon Confederated Tribes and Bands of the **Yakama** Nation	

3.2.9 Congressionally Designated Areas

Congress has designated numerous areas as 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.

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.

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.

In Wilderness Areas motorized travel is prohibited and the ground disturbances and vectors of invasive plant seed spread associated with motorized vehicle use are greatly diminished.

However, both natural and human caused ground disturbances and vectors of invasive plant seed spread still exist. Invasive plant inventories show that Wilderness Areas in Region Six have not yet been highly infiltrated by invasive plants. Unfortunately, invasive plants are gradually finding there way into Wilderness Areas, and have been identified mostly along trails, and more heavily used zones such as riparian zones. Prevention measures are especially important in areas where invasive plants are not yet well established and where once established, treatment can be particularly difficult and in conflict with the values the area was originally designated for.

One invasive plant prevention strategy, currently in use on some National Forests, is to encourage or require the use of certified weed free hay or pelletized feed when using horses or other livestock in certain areas. Certified weed free hay or pelletized feed is currently required on about 2.5 million acres of Wilderness in Region Six. The following list shows National Forests in Region 6 that have weed-free feed requirements and where the requirements apply:

- Mt. Baker-Snoqualmie: Wilderness Regulation: Possessing unprocessed hay, straw, or raw grain livestock feed is prohibited. Use processed feed to reduce the chance of introducing weeds into native ecosystems.
- Rogue River-Siskiyou and Winema: For the Wild Rogue (35,818 acres, which includes a portion of BLM land administered by the FS), Grassy Knob (17,200 acres) and Kalmiopsis Wilderness (179,755 acres): Order No. SIF002 Prohibits: Possessing or storing hay or unprocessed (vialbe) grain. 36 CFR 261.58(cc). For the Sky Lakes (116,300 acres) and Red Buttes (19,940 acres): Order No. RRF-016 Prohibits: Possessing or storing hay or unprocessed (viable) grain. 36 CFR 261.58(cc).
- Gifford Pinchot: Wilderness Regulation: Unprocessed hay, grain or other forms of livestock feed are prohibited. Processed feed includes pelletized feeds and irradiated grains in their original container. Any livestock feed that may serve as a seed source for non-native plants is considered unprocessed.
- Olympic: 36CFR261.58(a and b) Prohibits the following acts in Wilderness Areas: Possessing and/or transporting unprocessed vegetative matter, such as hay, straw, grass or grain.
- Wallowa-Whitman: Hells Canyon National Recreation Area (Rec-S7 of the Hells Canyon CMP applies to all acres in the NRA) Rec-S7: All users of pack and saddle stock must carry and use pelletized, or other certified weed-free feed.

- Eagle Cap Ranger District: 36CFR261.58(t): Possessing, storing or transporting any supplemental livestock feed that is not free of all noxious weed seeds [is prohibited].

Other National Forests, including the Umatilla and the Wallowa-Whitman, encourage the use of weed-free or pelletized feed when using domestic animals in Wilderness Areas.

Figure 3-8 Congressionally Designated Areas

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3.3 Invasive Plant Management

Invasive plant management is 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 Forest Service, 2004) (Appendix S) 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 in accordance with Integrated Weed Management principles. 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. For more detailed information on control of specific species, see "Common Control Measures for Invasive Plants of the Pacific Northwest Region" (Appendix N). This document provides guidance through literature review to the botanists and weed coordinators in Region Six. It is a constantly expanding document.

Prioritizing Sites and Selecting Treatment Methods

The following discussion summarizes methods for prioritizing invasive plant treatments. Invasive plant species listed in Appendix B should be considered the "first cut" for Forest weed coordinators when developing site-specific treatment projects. The relative priority for treating each species or situation varies substantially between sites in the Region depending on site-specific risks and values.

In general, herbicides selected for use are those with the highest potential for success with the least amount of impact to non-target resources. Potency, selectivity and persistence of an herbicide are factors that influence its effectiveness and potential for adverse effects The choice of herbicide is based on characteristics of the invasive species; how is reproduces, its seed viability, the size of its population, site conditions, known effectiveness under similar site conditions and the ability to mitigate effects on non-target species.

Often herbicides are used in combination with other methods. Treatment effectiveness may increase when herbicide formulations are mixed or herbicide use is integrated with manual or mechanical treatments.

For example, initial treatment on an invasive species may be done by an herbicide, but then manual or mechanical methods would be implemented as maintenance treatments over the long-term.

Application methods used are often based on site accessibility. Aerial spraying, for example, would only be used in areas where access is remote and difficult and populations are of the size that non-herbicide methods or selective herbicide application is not feasible.

Prioritizing 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).

Other tools exist for assessing the invasiveness of a species to assist in prioritizing. One recommended tool is the Invasive Species Assessment Protocol (Morse et al, 2004). The protocol uses both screening and assessment questions to understand ecological impact, trends in distribution and abundance and management difficulties. Questions have a varying point system to develop an invasive ranking for a species. Such a protocol may be useful for developing an invasiveness rank would be helpful when working with cooperators at the regional scale. Rankings developed by other agencies could be useful for Forest staff when invasiveness is of question.

Prioritizing Treatments

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.

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 source 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. Another important point for consideration of treatments is control costs. A maintenance strategy focused on control may be more economically feasible than attempting to eradicate large populations.

Another 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.

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 3-12 is based on a Forest Service guide for how to prioritize sites and select treatment methods (USDA Forest Service 2001).

Table 3-12 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 on 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) Riparian corridors where high threat species such as knotweeds occur.	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

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. Thermal techniques such as steaming, super heated water and hot foam are also considered as viable treatments.

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[32] 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

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

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.

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. A new mulch made from wood products is currently being tested by the Forest Service and shows promise as having equivalent or higher erosion control potential than regular straw mulch (Forest Concepts, 2004)

Thermal techniques are being tested or used with some success throughout Region Six by such agencies as Oregon Department of Transportation (ODOT), the Nature Conservancy and the Bureau of Land Management (BLM). ODOT has converted a mowing unit to a thermal heat unit for treating roadsides (Prull personal communication, 2004). It has been most successful when used for maintenance treatments instead of initial treatments. The Nature Conservancy (Tu et al., 2002) tested the Eco-Weeder, an infrared technology device that uses the combustion of liquid gas to reach extremely high temperatures that place intense radiation directly on weeds to explode plant cells. The tool could be useful for small area treatments, especially on sidewalks, but the effectiveness on deep-rooted plants, sedges or rhizomatous grasses may not be as high. The Nature Conservancy also tested hot water pressure washers. The brand tested could apply hot water through a pressure nozzle with a wide spray or intense stream which would act as an injection device for below ground portions of plants. They found it effective on seedlings and annual plants within reach of the washer, but the effectiveness on plants with extensive underground roots or rhizomes would be less.

Hot foam has been tested by the Nature Conservancy and used by the BLM effectively on puncturevine and slender false brome. Again, this technique is limited to the reach of the foam generator, but is an excellent non-chemical method. It is effective on seedlings and annuals and can be applied under weather conditions including wind and light rain. It has shown some success with perennials and an injection tool has shown some success with knotweeds (Fairchild personal communication, 2004).

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.

See Appendix J for effects of these non-herbicide methods on non-target species.

Cultural Methods

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 and Petroff, 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 for more discussion).

Fertilization has had limited use in invasive plant management. It has been used on hawkweed species experimentally. Soluble nitrogen fertilizer applied after herbicide treatment could increase the competitiveness of perennial grasses and beneficial forbs. This method is most effective in pastures or rangelands where nitrogen levels are not high enough for optimum grass performance (Rinella and Sheley, 2002).

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). Sheep have been shown to provide control for cheatgrass if grazed twice after winter rosettes have greened up (Mosley, 1996). Goats have been used to successfully control Himalayan blackberry using high stocking levels in small fenced areas (Peters personal communication, 2004). Other species including gorse, bull and Canada thistle, scotch broom, yellow starthistle and perennial pepperweed are being grazed mostly by goats under different grazing strategies. Efforts for these species were combine with sheep grazing, herbicide treatment, biocontrols and planting competitive vegetation. The breed, sex, age of the animal and timing of grazing as it related to weed development and desired vegetation development were important factors in the design of an effective grazing prescription for these species (Peters personal communication, 2004).

Appropriate grazing by animals preferring invasive species can shift the plant community toward more desired grasses (Lacey et al., 1989). Olson (1999) described three grazing strategies for managing weeds: (1) moderate grazing levels to minimize the physiological impact on native plants and to reduce soil disturbance; (2) intensive grazing to counteract inherent dietary preferences of cattle, resulting in equal impacts on forage species including weeds; and (3) multi-species grazing that distributes the impact on livestock grazing more uniformly among desirable and undesirable species.

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). Research has been occurring through the collaborative program BEHAVE (Behavioral Education for Human, Animal, Vegetation and Ecosystem Management) which includes partners from the Universities of Idaho, Utah, Arizona and Montana State University, and the National Wildlife Research Center. Studies on the relationships between animal condition and circumstance and their propensity to graze weedy plants is one focus as well as how age and body condition can affect consumption (Utah State University, 2004). Specific research tied to this program also includes focus on providing incentives such as molasses to get animals to eat weeds and supplying anti-toxins to conteract the negative effects of weeds on animals.

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).

Most often, though, a single method is not effective to achieve substantial control of a range weed. A Successful long-term management program should be designed to include combinations of mechanical, cultural, biological, and chemical control techniques (DiTomaso, 2000).

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

See Appendix J for effects of these non-herbicide methods on non-target species.

Prescribed Fire Methods

Use of prescribed burning for treatment of invasive plants has had limited application in Region Six. While fire is sometimes necessary to prompt the germination of some plant seeds, such as knobcone pine, 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 sharply reduce the abundance of some species by preventing flower or seed set, destroying seeds, stimulating germination (for future seedling treatments), depleting carbohydrate reserves or killing perennating tissue (such as rhizomes, bulbs, or buds) (Rice, 2004). Fire can also be used to facilitate revegetation, increase herbicide efficacy, and remove litter to assist in emergence of desirable species (Rice, 2004) The weather, topography, and available fuel will determine the temperature and intensity of the prescribed burn this along with the timing of the treatment, largely determine how the burn impacts the vegetation and the abundance of particular species. Studies cited in a literature review concerning the use of fire as a tool for controlling non-native invasive plants provides insight on such factors (Rice, 2004).

The effectiveness of fire as a tool is variable. Numerous research was cited in Rice (2004) regarding this effectiveness. Most studies focused on grassland habitats primarily in the Mid west, but some valuable information for western states was included. For example, fire was used as a means to stimulate germination from a persistent seedbank of French and scotch broom species. This allows for follow-up treatments of seedlings over the two to three years needed for the new plants to develop seeds. Burning killed some seed and stimulated germination through scarification of other seeds in lab and field experiments (Bossard 1993, 2000). This was more successful in drier conditions than wetter conditions (Parker, 2001).

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 other invasives, such as when their seeds are specially adapted to fire, or when they resprout vigorously which emphasizes the need for repeated burning (studies cited in Rice, 2004). Burning in the fall did show some success in reducing cover scotch broom in western Washington, but frequent burning would still be required (Tveten and Fonda, 1999).

Many prescribed burn programs are 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. 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 develop 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.

Flaming is a tool of use for controlling invasive plants. Flaming is done with the use of propane torches. Such torching tools have been available for agricultural and roofing use. They can be purchased as portable backpack units. Flaming destroys cell structure in the plant, therefore reducing its energy towards growth. It will kill most small weeds and will at least stunt or kill larger weeds, depending on their root system (Flame Engineering, no date). Flaming is limited to conditions that would be too moist to carry a fire. They are useful for spot burning single plants or a small population of plants with little disturbance to the surrounding vegetation (Tu et al., 2001)

Total acres of invasive plants treated in the Region with prescribed fire were 1,149 in 2000 and 174 in 2001.

See Appendix J for effects of these non-herbicide methods on non-target species.

Biological Control

For the purposes of this document, biological control is the deliberate use of natural enemies (parasites, predators, or pathogens) to reduce weed densities. 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. Introduced plants without desirable close relatives in the United States are generally chosen for biological control. 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 (see Appendix J "Effects of non-herbicidal methods of invasive plant treatments" for a thorough discussion of testing). 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, interstate movement of plant pests requires a USDA Plant Protection and Quarantine (PPQ) permit. Permits are only approved for states that have been covered by an Environmental Assessment and Endangered Species Act consultation. In addition, 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 limits the introduction of organisms that will not survive or be ineffective on the target invasive plant. During testing non-target plants likely to be hosts are identified and tested for impacts. The host-specificity of organisms closely related to the proposed agent is examined to provide insight on the variability of life history traits and the possible breadth of host ranges. For more information, see Appendix H and Test Plant Lists at www.aphis.usda.gov/ppq/permits/tag. In addition to federal and state regulations, the International Code of Best Practices for biological control of weeds (Balciunas and Coombs, 2004) provides guidelines for all practitioners involved in redistributing agents.

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-APHIS, 2003).

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., 1989). 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.

See Appendix J for effects of these non-herbicide methods on non-target species.

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.

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: An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered as adverse, or as precursors to adverse effects. In an experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effects.

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

Persistent herbicide = a herbicide that, when applied at the recommended rate, will interfere with regrowth of native vegetation for an extended period of time.

Potency = the measure of the relative strength of a chemical.

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.

Selected herbicide = a chemical that is more toxic to some plant species than to others.

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 be selective or non-selective. This means they control all types of vegetation (non-selective), or they selectively control either some broadleaf plants or grasses while not affecting others (selective). 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.

Herbicides vary in selectivity of control for various plant groups. Those 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 infestations.

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 via ground vehicles with hose sprayers or 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.

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 3-13 lists the herbicides included in this EIS. 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). A document developed for this analysis, *Common Control Measure for Invasive Plants of the Pacific Northwest Region* (Mazzu, 2004) (see link in Appendix N) summarizes 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.

Table 3-13 Herbicides included in this EIS and analyzed in Chapter 4.

Chemical/Selected Brand Names/Action	Properties	General Uses/Known to be Effective on:
Chlorsulfuron (Telar,Glean,Corsair)/ Sulfonylurea-Interferes with enzyme acetolactate synthase w/ rapid cessation of cell division and plant growth in shoots and roots.	Glean -Selective pre-emergent or early post-emergent Telar – Selective pre- and post-emergent. Both are for many annual, biennial and perennial broadleaf species. Safe for most perennial grasses, conifers. Some soil residue.	Use at very low rates on annual, biennial and perennial species; especially dalmation toadflax, and houndstongue and perennial pepperweed.
Clopyralid (Transline)/ Synthetic auxin -Mimics natural plant hormones.	A highly translocated, selective herbicide active primarily through foliage of broadleaf species. Little effect on grasses.	Particularly effective on Asteraceae, Fabaceae, Polygonaceae, Solanaceae. Some species include knapweeds, yellow starthistle, Canada thistle, hawkweeds. Provides control of new germinants for one to two growing seasons.
Dicamba (Banvel , Vanquish) Synthetic auxin -Mimics natural plant hormones.	Used for the control of a variety of broadleaf and woody vegetation. Banvel is more likely to generate dicamba vapor than Vanquish.	Selective against many annual and perennial broadleaf species including woody and vine species (e.g. gorse, hawkweeds, tansy ragwort).
Glyphosate (RoundUp, Rodeo etc.)/ Inhibits three amino acids and protein synthesis.	A broad spectrum, non-selective translocated herbicide with no apparent soil activity. Adheres to soil which lessens or retards leaching or uptake by non-targets.	Low volume applications are most effective. Translocates to roots and rhizomes of perennials. While considered non-selective, sensitivities do vary depending on species. Main control for purple loosestrife, herb Robert, English ivy and reed canarygrass. Aquatic labeled formulations can be used near water.
Imazapic (Plateau)/Inhibits the plant enzyme acetolactate, which prevents protein synthesis.	Used for the control of some broadleaf plants and some grasses.	Use at low rates can control leafy spurge, cheatgrass, medusa head rye, toadflaxes and houndstongue
Imazapyr (Arsenal, Chopper, Stalker Habitat)/ Inhibits the plant enzyme acetolactate, which prevents protein synthesis.	Broad spectrum, non-selective pre- and post-emergent for annual and perennial grasses and broadleaved species.	Most effective as a post-emergent. Has been used on cheatgrass, whitetop, perennial pepperweed, dyers woad, tamarisk, woody species, and spartina. Aquatic labeled formulations can be used near water.

Table 3-13 Herbicides included in this EIS and analyzed in Chapter 4.

Chemical/Selected Brand Names/Action	Properties	General Uses/Known to be Effective on:
Metsulfuron methyl (Escort)/ Sulfonylurea - Inhibits acetolactate synthesis, protein synthesis inhibitor, block formation of amino acids.	Used for the control of many broadleaf and woody species. Most susceptible crop species in the Lily family (i.e. onions, Allium). Safest sulfonylurea around non-target grasses.	Use at low rates to control such species as houndstongue, sulfur cinquefoil perennial pepperweed.
Picloram (Tordon) Restricted Use Herbicide Synthetic auxin - Mimics natural plant hormones.	Selective, systemic for many annual and perennial broadleaf herbs and woody plants.	Use at low rates to control such species as knapweeds, Canada thistle, yellow starthistle, houndstongue, toadflaxs, sulfur cinquefoil, and hawkweeds. Provides control of new germinants for two to three growing seasons.
Sethoxydim (Poast)/ Inhibits acetyl co-enzyme, a key step for synthesis of fatty acids.	A selective, post-emergent grass herbicide.	Will control many annual and perennial grasses such as cheatgrass.
Sulfometuron methyl (Oust)/ Sulfonylurea -Inhibits acetolactase synthase, a key step in branch chain amino acid synthesis.	Broad spectrum pre- and post-emergent herbicide for both broadleaf species and grasses.	Used at low rates as a pre-emergent along roadsides. Known to be effective on canary reedgrass. (but not labeled for aquatic use) cheatgrass, medusahead.
Triclopyr (Garlon, Pathfinder, Remedy)/ Synthetic auxin - Mimics natural plant hormones.	A growth regulating selective, systemic herbicide for control of woody and broadleaf perennial weeds. Little or no impact on grasses.	Not for broadcast application under proposed action. Effective for many woody species such as scotch broom and blackberry. Also effective on English ivy, Japanese knotweed. Amine formulation may be used near water
2,4-D (Weedone, Weedar, many more) Synthetic auxin - Mimics natural plant hormones.	Readily absorbed and metabolized. Used for the control of many broadleaf species.	Effective for many broadleaf species (such as Canada thistle, Russian knapweed, sulfur cinquefoil, hoary cress). Aquatic labeled formulations can be used near water.

Risk information found in SERA documents (2,4-D 1998, Triclopyr 2003, Picloram 2003, Sethoxydim 2001, Glyphosate 2003, all others 2004) for each active ingredient. Information on species effectiveness in Tu et al. (2001) or from product labels.

The Decision to Use Herbicides

The choice of whether an herbicide is used over other control methods would be based on integrated weed management principles. Decisions would be made based on whether other methods or combination of methods are known to be effective on the species in similar habitat. The choice of herbicide would be based on the invasive species; how it reproduces, its seed viability, the size of its population, site conditions, known effectiveness under similar site conditions and the ability to mitigate effects on non-target species.

In most cases, if an herbicide is selected, it would be used in combination with other methods. For example, initial treatment on an invasive species may be done by an herbicide, but then manual or mechanical methods would be implemented as maintenance treatments over the long term. Large established populations would be less apt to undergo herbicide treatment. Such populations may be controlled at their perimeters to maintain "weed-free" zones or may be candidates for biological control. The focus of any herbicide treatment would be on the species of highest concern (see Chapter 3.1) where the negative effects can be mitigated.

Application methods used would be based on site accessibility. Aerial spraying, for example, would only be used in areas where access is remote and difficult and populations are of the size that non-herbicide methods or selective herbicide application are not feasible.

Herbicide Resistance

Herbicide resistance is the heritable (genetic) ability of an individual plant to survive a herbicide application to which the wild-type population is otherwise susceptible. Resistant individuals remain reproductively compatible with the wild-type, and may confer genetic resistance to their offspring. Non-native invasives that exhibit herbicide resistence are generally annual species (PNW Weed Management Handbook, 2004).

Resistance may occur in plants by random and infrequent mutations. Through selection, where the herbicide is the selection pressure, susceptible plants are killed while herbicide resistant plants survive to reproduce without competition from susceptible plants. If the herbicide is continually used, resistant plants successfully reproduce and become dominant in the population. Thus the appearance of herbicide resistance in the populations is an example of rapid weed evolution (Prather et al., 2000). There are two pre-requisites for the evolution of herbicide resistance in an invasive plant population: the occurrence of heritable variation for resistance and selection for increased resistance by herbicide application (Cousins and Mortimer, 1995).

Herbicide resistance was first reported in 1957 in California with common groundsel (*Senecio vulgaris*) (Prather et al., 2000). Development of resistance occurs mostly in croplands where repeated applications of a single herbicide select for resistant survivors. However, resistance is known to occur in a few wildland invasives of concern in the Pacific Northwest, including yellow starthistle resistance to picloram and clopyralid (Fuerst et al., 1996; Sabba et al., 2003). A resistant biotype was observed in Washington in a pasture subjected to intensive picloram selective pressure. Reports of resistant strains of perennial ryegrass (*Lolium perenne*) to sulfometuron methyl, Russian thistle (*Salsola tragus*) to chlorosulfuron and sulfometuron and rigid ryegrass (*Lolium rigidum*) to glyphosate have been found in California (Prather et al, 2000). Other resistant species were reported but not documented here since the herbicides of concern were not a part of this EIS.

Resistance to glyphosate is debated in the literature (Owen and Zelaya, 2005). Arguments indicate that not only would the evolution of glyphosate resistance be an issue, but also weed populations shifts would occur in response to the adoption of glyphosate-resistant crops. For example, evolved glyphosate resistance was identified in horseweed (*Conyza Canadensis (L) Cronq*) three years after the adoption of glyphosate-resistant soybeans (VanGessel, 2001). In field situations, resistance to sulfonylurea herbicides has been reported to occur after 3 to 5 years of repeated use (Gunsolus, 1999).

Herbicide factors that contribute to the potential for resistance include long soil residual activity, single target site and specific mode of action, and high effective kill of a wide range of weed species. All of these factors rapidly deplete susceptible genes from the population (Prather et al., 2000). Resistance is avoided or overcome by having multiple herbicides with different modes of action (plant-killing chemistries) available for use (PNW Weed Management Handbook, 2003). The use of short-residual herbicides also reduces selection pressure for herbicide resistance as well as integrating non-herbicide control techniques into a weed management program (Prather et al., 2000).

The repeated use of one herbicide allows these few resistant plants to survive and reproduce. As the number of resistant plants increases, the efficacy of the herbicide diminishes until the herbicide no longer effectively controls the invasive plant populations. Where repeated herbicide use is predicted to be necessary to meet control objectives, strategies must be designed to minimize risk of developing resistance.

To develop resistance avoidance strategies, long-term site plans should recognize which of the various herbicide families have available and effective herbicides if multiple applications are expected to be necessary. Integrated chemical and non-chemical controls are highly effective where feasible because any surviving herbicide resistant plants can be removed from the site.

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 lab evaluation of potential hazards to humans and 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 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 site-specific project design criteria, such as 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 Forest Service conducts risk assessments independent from EPA valuations for herbicide registration, focusing specifically on the type of herbicide uses in forestry applications. 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. 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. All toxicity data, exposure scenarios, and assessments of risk are based upon information in the Forest Service/SERA Risk Assessments unless otherwise noted.

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 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.

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 the most sensitive adverse effect on the test organism. Each Forest Service/SERA 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 any available scientific studies of potential hazards of these other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. There is usually less information available on these substances (compared to the herbicide active ingredient) because they are not subject to the extensive testing that is required for herbicide active ingredients under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act).

Other chemicals associated with the application of herbicides (Impurities, Metabolites, and Inert Ingredients) are discusses in Appendix Q. Potential human risk and environmental effects are analyzed in relevant sections of Chapter 4 and Appendices.

Limitations of 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 uncertainty inherent in any methodology used to assess risk. 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 risk assessment include: providing quantitative bases for comparing and prioritizing risks of alternatives; providing to decision makers and the public an estimate of the risk of the occurrence of an adverse effect under typical and extreme scenarios.

Disadvantages include a high degree of uncertainty in interpretation and extrapolation of data. Uncertainty may result from a 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 Forest Service/SERA Risk Assessments is the most current and thorough that is available. Risk assessments can determine (given a particular set of assumptions) whether there is a basis for asserting that a particular adverse effect is plausible. 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).

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.
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.
Hot Foaming and other Thermal Methods	Effective for spot burning single plants or small populations. Limited to conditions that would be too moist to carry a fire
Foaming	Most effective on seedlings and annuals; some success with perennials. Foaming and hot water techniques limited in distance to the reach of the applicator.
Prescribed Fire	Variable effectiveness. Most use has been in grassland restoration. May cause resprouting or stimulated germination of the treated vegetation. Most effective in combination with other treatments
Biological Control	
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.

Table 3-14 Summary of Treatment Methods	
Treatment Method	**Discussion/Considerations**
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.

Site Restoration/Revegetation

Site restoration or revegetation is part of any long term strategy to reduce invasive plants. Determining the need for active restoration/revegetation versus passive restoration (allowing plants on site to fill in a treated area) is the first choice when addressing this need. Passive restoration may be appropriate where treated sites leave only small gaps of bare ground and native vegetation on site can provide adequate seed source to fill in such gaps.

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). Three components of succession could be manipulated; site availability, species availability, and species performance (Cox and Anderson, 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.

A two step approach, using a model of ‘assisted succession’ was used to accelerate recovery in sagebrush steppe invaded by cheatgrass. The first step was to convert a site from annual to perennial domination. The second step in the process was to insert native species into the stable perennial matrix using such seedbed techniques as tilling or treatment with herbicide (Cox and Anderson, 2004).

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 (Romo, 2005; Bartos and Campbell, 1998; Covington and Moore, 1994; Detwyler, 1971; Kay, 1994; Lesica and DeLuca, 1996; Mills et al., 1994).

With that said, some success has been found using crested wheatgrass as in the 'assisted succession' model discussed above (Cox and Anderson, 2004). Success in establishing native species varied by precipitation patterns and seed bed preparation in plots dominated by crested wheatgrass verses cheatgrass. The study was based in the Great Basin in sagebrush steppe and covered only two years of measurements. While success was shown in amount of native species to germinate and establish when crested wheatgrass was the dominant species, this success was tired to seed bed preparation that created niches for native species development. Crested wheatgrass was not expected to be eliminated with such a strategy, but diversity, structure and function of the resulting community was considered more similar to the original native community.

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 (2004) 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.

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.

The National Strategy for Invasive Species Management (2004) for the Forest Service also encourages the use of native species in rehabilitation and restoration. It encourages the shifting of restoration projects from the use of invasive non-natives to other less invasive and native species.

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.

Regional direction for the use of native plants was issued in 1994 with the PNW Revegetation policy. It set a long term goal for using native plant species as much as possible. It defined an acceptable, non-native as "an annual or short lived perennial that is not persistent or competitive with native vegetation that would be useful for erosion control or as noxious weed competitors".

CHAPTER 4 ENVIROMENTAL 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 section in this document discusses how the analyst responded to uncertainty.

Chapter 4 discloses the direct, indirect and cumulative effects of the alternatives on the environmental components described in Chapter 3. Broad, programmatic effects are considered. Site-specific effects cannot be meaningfully evaluated at a Regional scale, but will be addressed in subsequent site-specific NEPA analysis as projects are proposed. In this respect, the alternatives have no site-specific effects. Effects analysis in this EIS address what generally could occur as a result of invasive plant treatment projects that follow management direction under each alternative.

4.1.1 Basis for Cumulative Effects Analysis

The National Forests are intermingled with other federal, state, county and private ownerships. Herbicides are commonly applied on lands other than National Forest System land for a variety of agricultural, landscaping and invasive plant management purposes.

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 and 90+ percent of this control is through the use of herbicides [33].

Even the highest use estimates of herbicide use on National Forest System lands (Alternative D) would amount to less than three percent of the estimated 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,

33 Based on informal discussions w/state and county agriculture and weed personnel. Includes all land ownerships, not including small-scale private use.

and sulfometuron methyl are not registered for agricultural uses other than rangeland and forestry. Landscaping is another large use of some herbicides. Other herbicide use occurs on other federal, State, and county ownerships, State and private forestry lands, rangeland, utility corridors, and road rights of way.

The small contribution that Forest Service use of herbicide for invasive plant control makes to the statewide totals[34] indicates that the potential contribution of Forest Service uses to cumulative effect from all herbicide use is very small.

Table 4-1 displays the projected use of different herbicides on National Forest System lands included in the alternatives compared to the estimated total use (all land ownerships) within Oregon and Washington. All of the cumulative effects analyses apply this information.

Table 4-1 Projected Use of 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	Forest Service use of herbicides in WA/OR as compared to two-State totals (Typical/worst case percentages)
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

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

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 a herbicide treatment conducted under this EIS, and to another herbicide treatment. For additive doses to occur, the two exposures would have to occur closely together in time, since the herbicides proposed for use are rapidly eliminated from humans and do not significantly bioaccumulate. 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. Combinations of chemicals in low doses (less than one tenth of the RfD) have rarely demonstrated synergistic effects. 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 (ATSDR, 2004.; U.S.EPA/ORD, 2000.). 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 on this topic is included in Appendix Q: Human Health Assessment.

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.

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 best available information regarding prevention and treatment effectiveness (see Appendix D).

Each action alternative would add a Desired Future Condition (DFC) statement, several goals and objectives, and invasive plant management standards to Forest Plans in Region Six. Individual projects and programs would be designed to contribute to achieving goals and objectives[35] and required to comply with standards. In this way, the application of standards has the greatest potential to affect invasive plant management across the Region. This analysis focuses on characteristics of the standards and how they influence the prevention and overall reduction of invasive plants. The alternatives vary in their potential to reduce the extent and spread of invasive plants, because the standards vary by degree of emphasis on prevention, treatment, and restoration/revegetation.

The measuring factors used for comparing the alternatives are:

- Relative change in rate of spread by alternative;
- Estimated acreage of invasive plants treated annually;
- Number of years until invasive plants are controlled.

The current approach (No Action alternative) is not likely to effectively prevent or treat invasive plants. Alternative B is the most likely alternative to prevent the spread of invasive plants, but because it limits use of herbicides, it is the least effective of the action alternatives in treating invasive plants. The Proposed Action is less likely to be as effective at preventing the spread of invasive plants as Alternative B, but is more likely to effectively treat invasive

35 Individual projects in themselves would not be required to or capable of achieving DFC's, goals or objectives.

plants. Alternative D is the least likely of the action alternatives to prevent the spread of invasive plants, but most likely to effectively treat invasive plants. A combination of the prevention standards of Alternative B and the treatment toolbox included in either the Proposed Action or Alternative D would be most likely to effectively prevent and treat (control) invasive plants.

4.2.2 Background

Past and Current Invasive Plant Control 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 1990, the Department of Agriculture set forth a regulation for the coordination of invasive plant management activities among agencies of the USDA and other executive agencies, organization and individuals (USDA 9500-10). Forest Service policy was revised in 1995 (FSM 2080) to emphasize the importance of integrating weed management in ecosystem analysis, assessment and forest planning. 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 strategy that highlights as a national goal effective prevention through partnerships, education and research.

In 1999, Executive Order 13122, signed by President Clinton, set forth the duties of all federal agencies in preventing and managing invasive plants. It also defined invasive species. In response to Executive Order 13112 on Invasive Species, the National Invasive Species Council was established. The Council prepared "Meeting the Invasive Species Challenge" (National Invasive Species Council, 2001), which emphasized prevention, early detection, rapid response, control, and restoration and called for international cooperation in the prevention of invasions.

Current invasive plant management direction for the Forest Service is in "*The National Strategy and Implementation Plan for Invasive Species Management*" (USDA FS, 2004 – see

Appendix S). The management direction proposed for the alternatives in this FEIS are consistent with this strategy.

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 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).

Efforts are also underway in the western states surrounding Region Six. 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. Neither Oregon or Washington have State certified weed-free forage or mulch programs, but Wallowa County, Oregon, 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).

One source of direction for the prevention and management of invasive plants on National Forests in Region Six is the 1988 EIS and 1988 ROD for Competing and Unwanted Vegetation, and the associated 1989 Mediated Agreement.[36] These documents require consideration of invasive plant prevention, but specific direction on how to actually prevent the spread of invasive plants is not provided.[37] 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

36 These documents have been incorporated into the Forest Plans within the Region.
37 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 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

One immeasurable aspect of effectiveness is socially acceptability.[38] Adverse public judgments on planning and management strategies have formidable potential to postpone, modify, or prevent their implementation (Shindler et al., 2002). Citizens and interest groups have brought court challenges, attracted media attention for their cause, and physically/verbally protested actions they considered to be unacceptable, effectively halting initial or ongoing implementation of Forest Service actions.

Scoping and comments to the DEIS revealed at least two major and potentially conflicting perspectives on invasive plants. One perspective is that invasive plants are a major threat to forest ecosystems and that the situation warrants aggressive treatment, including the application of herbicides. This contingent expresses strong concern about placing arbitrary limitations on the tools available to effectively treat invasive plants. The other perspective acknowledges that invasive plants threaten forest ecosystems, but expresses strong concern and skepticism about the use of herbicides. Lawsuits, appeals, and protests can reduce the effectiveness of any alternative by delaying or stopping actions to control invasive plants. The management direction proposed in the action alternatives provides a framework for developing a socially acceptable program for controlling invasive plants.

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 increase invasive plant prevention program effectiveness. Scoping and DEIS comments applauded partnership and collaboration efforts in invasive plant management, and expressed 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). The 2004 “National Strategy and Implementation Plan for Invasive Species Management” (Appendix S) emphasizes partnerships and collaboration at all levels of the agency and across all programs.

38 Social acceptability is defined as consistency with prevailing social norms (Firey, 1960).

4.2.3 Direct and Indirect Effects

Introduction – Effectiveness Indicators

This section compares the relative effectiveness of invasive plant management likely to occur under each alternative. First, prevention standards and practices are discussed and the rate of spread of invasive plants are estimated for each alternative. Next, each alternative is evaluated based on its likelihood to result in effective treatments. Finally, the acres that would be effectively treated each year under each alternative is compared to the spread rate to determine “years to control.” The methodology supporting this analysis is based on the report, Evaluation of Prevention Effectiveness by Alternative (Mazzu and Skrine, 2004) and summarized in Chapter 4.2.4.

Invasive plants are considered to be effectively controlled when acres of plant spread is less than or equal to the annual acres successfully treated. Currently, invasive plants are estimated to spread by about 42,000 acres each year.[39] Each year, the Forest Service treats about 25,000 acres. At this rate, invasive plants would never be effectively controlled.

Years to control could be reduced if fewer acres became infested each year (presumably through effective prevention practices) and/or more acreage is effectively treated. All of the action alternatives include prevention standards that are likely to decrease rates of spread compared to the current condition. Effective treatments are defined as those that reduce the extent invasive plants so that the area can reach its desired condition.

Effectiveness of Prevention

No Action

Under No Action, no new prevention standards would be added to Forest Plans in Region Six as a result of this EIS. No Action would maintain the current low potential to slow the spread of invasive plants.

Action Alternatives

This section discusses the relationship between the standards in each of the action alternatives and the projected rate of spread of invasive plants. Please refer to Table 2-4 for the specific wording of each of the standards (Chapter 2.5).

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39 42,000 acres is based on an average 10 percent rate of spread applied to the current 420,000 acres of infestation (USDA FS, 1999-Stemming).

Standard #1 as written under the action alternatives would reduce seed introduction or spread of invasive plants during Forest Service management activities and reduce conditions promoting invasive plants because it treats the problem of invasive plants at the earliest stages possible. Standard #1 requires planners to assess the invasive plant situation before activities begin. Planners can then develop management recommendations, mitigation measures, or project design criteria (depending on the type of document) that address reducing the potential for invasive plants before invasion can begin or before an established infestation can be spread. Depending on the scale of the document, the Forest Service would be proactive in reducing agency contributions at various levels; at the project, program, watershed, or larger scale.

This standard is ranked as having high potential to change rate of spread because it affects planning across all Forest Service lands (Mazzu and Skrine, 2004). The added language in Alternative B does not substantially change the intent, effectiveness or ranking of this standard (ibid.).

Standard #2 as written under the Proposed Action requires the cleaning of all heavy equipment working outside the limits of road prism prior to entering National Forest System lands. The standard would not affect emergency situations where equipment washing would delay response time.

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 a primary means of importing 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.

Standard #2, as written under the Proposed Action and Alternative D, is ranked as moderately effective because it would reduce spread of invasive plants from heavy equipment use, but would not necessarily reduce the spread from cars, pickup trucks, and other vehicles (Mazzu and Skrine, 2004).

Alternative B includes the additional requirement to clean all equipment and vehicles authorized to operate outside the road prism prior to entry and before leaving the project site or use area where invasive plants are present at a level where transport of seed or propagules is likely. Support vehicles that 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.

Standard #2, as written under Alternative B, is ranked as having high effectiveness (Mazzu and Skrine, 2004). This standard could substantially reduce the rate of spread both in and outside Forest Service land because it reduces long-distance dispersal, one of the main factors in invasion biology. However, this standard may be difficult to implement or enforce. Wash stations are not currently available away from populated area and administration costs may be cost prohibitive (for instance, contract field inspection to ensure washing is done between sites). These difficulties could result in reduced effectiveness of this standard.

Standard #3 in all action alternatives requires use of weed-free straw or mulch to reduce introduction of invasive seeds from outside sources. If State certified straw or mulch is not available, individual forests would require sources to be certified using the North American Weed Management Association (NAWMA) standards (found at www.nawma.org and Appendix O) or a similar certification suite.

Standard #3 is ranked as highly effective because it would reduce invasion potential of a broadly used product throughout National Forest System lands (Mazzu and Skrine, 2004). Tons of straw/mulch potentially providing invasive seed could be eliminated.

An indirect effect would be reduced competition for resources between invasive and native plants within and adjacent to mulched areas. Another indirect effect could 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.

Implementation of this standard may need to be phased-in for the Proposed Action and Alternative B as weed certification programs become established.

Standard #4 varies between the alternatives. As written for the Proposed Action, weed free feed would be required for horses, livestock and all pack stock using Wilderness areas. A similar requirement already applies to about 2.5 million acres of Wilderness in Region Six, which is reflected under No Action and Alternative D (see Chapter 3.2.9 – Congressionally Designated Areas).

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.

Standard #4, as written for the Proposed Action, is ranked as moderately effective because the potential for spread would only be reduced in Wilderness areas only (ibid.). Spread would still occur under other land allocations where infestations developing could then be spread by natural forces to Wilderness areas.

Alternative B would expand the weed free feed requirement to 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.

Standard #4, as written for Alternative B, is ranked as having the highest effectiveness of all alternatives because of its comprehensive coverage of National Forest System lands (ibid.). Also, additional focus on early detection of invasive plants in staging areas would likely reduce the spread of invasive plants more substantially than the Proposed Action.

Alternative D is the same as No Action with approximately 2.5 million acres using weed-free feed. This alternative is least effective of the action alternatives because it covered the fewest acres; potential for spread would still be high and both in and outside of Wilderness areas (ibid.).

Implementation of this standard may need to be phased-in for the Proposed Action and Alternative B as weed certification programs become established.

Standard #5 applies solely to Alternative B[40]. It would require that native vegetation be maintained in and around project areas. 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.

Standard #5, as written for Alternative B, is ranked as being highly effective in reducing the spread of invasive plants at the project level (ibid.). This standard is intended to reduce the disturbance “footprint” of an action, reduce the movement of windblown seed, and provide shade to newly disturbed areas which would discourage the success of invasive plants.

40 Maintaining vegetation as a barrier to the expansion of invasive plant population is included as Objective 2.2 under all action alternatives.

The Proposed Action and Alternative D would be less effective in preventing the spread of invasive plants, because they lack a similar standard. However, current laws, policies, and plans already contribute to retaining native vegetation to achieve desired conditions as described in Objective 2.2 (see Chapter 2.4 for full text of Objective 2.2).

Standard #6 varies between the alternatives. Under the Proposed Action and Alternative D, annual operating plan instructions and grazing allotment management plans are required to consider and incorporate invasive plant prevention measures. The planning and implementation of such measures would occur in cooperation with the permit holder. This standard would reduce the introduction and transport of invasive plant seed as a result of change in grazing practices where successfully implemented. Requiring the consideration of invasive plants and prevention measures during annual operation planning will aid in integrated weed management and reinforce the role of permittees as stewards of public lands.

Prevention measures regarding cattle grazing have been published and are being used in other western states and intermittently in Region Six (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).

Standard #6, as written for the Proposed Action and Alternative D, is ranked as moderately effective in reducing the spread of invasive plants (Mazzu and Skrine, 2004). While the "USDA Forest Service Guide to Noxious Weed Prevention Practices" (Appendix E) is recommended at all levels in the Forest Service, it is not required.

Standard #6, as written for Alternative B, would elevate the importance of the USDA Forest Service Guide to Noxious Weed Prevention Practices in livestock grazing management while still allowing flexibility for grazing managers and grazing permittees to work together to choose effective prevention measures that best suit local allotment conditions, ecology, and desired future conditions. While prevention practices are not required in the Guide, managers and permittees will be required to document their consideration. Implementation of these practices will vary across the Region, but tracking of their implementation will provide much needed information on prevention methods being used.

Standard #7, as written in the Proposed Action, requires the inspection of active gravel, fill, sand stockpiles, quarry sites and borrow material for invasive plants prior to use and transport on National Forest System lands. It would require materials be judged weed free by District or Forest weed specialists. Treatment of infested sources would be required. These material sources must be judged weed free by District or Forest weed specialists before use. It would reduce the introduction of invasive plant seed by reducing the use of contaminated fill materials during road construction or road maintenance activities. Standard #7 is ranked as moderately effective in reducing the rate of spread (ibid.). Contaminated fill spread by road corridors is a classic example of long distance dispersal. By reducing the source of invasion along these pathways of invasion the domino effect of road equipment moving fill to one spot, then other motor vehicles moving the fill further would be reduced. Since the standard does not specifically require treatment or removal of contaminated fill, it leaves some question as to whether seed may still be moved inadvertently.

Standard #7, as written for Alternative B, has the highest effectiveness of all the alternatives because annual inspections and treatment and stockpiling of infested material would be required (ibid.). This increases the likelihood that new infestations would be caught in early stages since a system of stockpiling contaminated fill for treatment will be in place. Standard #7 would reduce confusion regarding whether infestations have been treated and will ensure that contaminated materials are set in a distinct location away from actively used materials.

Standard #8, as written for the Proposed Action and Alternative D, requires consultation with invasive plant specialists on road maintenance activities. While the language varies between the alternatives, the intent of the standard is the same. This standard is designed to elevate the importance of considering invasive plants in planning for road maintenance activities, while allowing flexibility for roads maintenance planners and invasive plant specialists to coordinate and plan road maintenance activities that minimize contributions to (and that may help to avoid) the spread of invasive plants and that best suit local site conditions, ecology, and desired future conditions. Alternative B includes additional language highlighting particular practices, but does not change intent or effects of this standard as quantifiable at the Regional level. All alternatives are considered equal and ranked as highly effective (ibid.).

Standard #9 applies solely to Alternative B. This standard is ranked as highly effective (ibid.). It requires the consideration of road closures and/or road decommissioning for resource issues related to invasive plants. 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 invasive plants 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. Closing or decommissioning roads, minimizing the construction of new roads and minimizing the improvement or widening of existing roads would reduce ground disturbance and reduce the potential for vehicles to spread invasive plant seed.

The Proposed Action and Alternative D would be less effective in preventing the spread of invasive plants because they lack a similar standard. However, the Proposed Action and Alternative D are ranked as moderately effective because Objective 2.4 (full text Chapter 2.4) focus on use of forest-level Access and Travel Management planning to manage OHV travel to reduce spread of invasive plants (Mazzu and Skrine, 2004).

Standard #10, as written for the Proposed Action, follows draft Forest Service national policy, and restricts OHV use to designated routes. Restricting off road travel to designated routes would reduce the chances of invasive plant spreading from transportation corridors into less disturbed environments. Monitoring of spread of invasive plants from vehicles would be more efficient because it could focus on specific routes. Standard #10, as written in the Proposed Action and Alternative B, are ranked as having high effectiveness (ibid.). Alternative D does not have a corollary standard.

Table 4-2 summarizes the effectiveness rankings for the prevention standards in the action alternatives. All of the action alternatives are likely to decrease rates of spread for invasive plants compared to the current rate of 8-12 percent (No Action). However, no data exists that allows for precise estimates of the reduction of rate of spread. Mazzu and Skrine (2004) considered how effectiveness of the prevention standards would result in reduced rate of spread, based on professional judgment. Potential for alternatives to reduce rate of spread is shown in Table 4-2.

Table 4-2 Relative Ranking of Prevention Effectiveness by Alternative Standards.

Standard	Proposed Action	Alternative B	Alternative D
1	High	High	High
2	Moderate	High	Moderate
3	High	High	High
4	Moderate	High	N/A
5	N/A*	High	N/A
6	Moderate	High	Moderate
7	Moderate	High	Moderate
8	High	High	High
9	N/A	High	N/A
10	High	High	N/A
Overall Potential to Reduce Rate of Spread	Moderate to high potential for reducing rate of spread from adherence to new prevention standards.	Highest potential for reducing rate of spread from adherence to new prevention standards.	Moderate potential for reducing rate of spread from adherence to new prevention standards.

* N/A/ means the specific alternative does not have a corollary standard (Chapter 2.4).

Effectiveness of Treatment and Restoration

To a large degree, the effectiveness of an alternative to treat the diverse group of invasive plants known in Region Six depends on the variety of tools available. Thus, alternatives that limit variety of tools also limit the effectiveness of treatments.

All of the alternatives promote integrated weed management principles. A study by Brown et al. (2001) showed that a combination of manual or mechanical and herbicide treatments was more effective than herbicides alone when dealing with such persistent species as spotted knapweed. Herbicide treatment alone was found to be most cost effective in the short-term but the combination of treatments could improve initial control or maintain control over a longer period of time. Biological control combined with herbicides could prove more cost effective if insects could establish and maintain long-term control. Thus, all alternatives would integrate treatment methods.

However, the emphasis of each alternative would tend to result in different treatment mixes, which affects treatment costs and overall effectiveness.

Effectiveness of the alternatives is based upon their capacity to offer a combination of prevention and treatment options that best allow the use of Integrated Weed Management principles to reduce the spread of invasive plants. Having a wide variety of prevention strategies plus treatment tools combined with the ability to adequately restore or revegetate treated areas is key to an ecosystem management approach.

No Action

No Action approves five herbicides; glyphosate, picloram, triclopyr, dicamba, and 2,4,D (last resort). This suite of herbicides is too limited to effectively treat all known types of invasions across the region (Mazzu and Skrine, 2004). In particular, No Action does not include herbicides that selectively treat invasive grasses.

Effectiveness herbicides are available under No Action. Picloram has been used successfully by the Nature Conservancy (Tu et al., 2001), on several invasive species. An eight year study done by Rice et al., (1997) has shown that by 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, picloram helped suppress spotted knapweed seedlings for at least the first post-treatment growing season.

Indirect effects of the limited suite of herbicides available include greater potential for herbicide resistance (see Chapter 3.3.2 for discussion about this topic). The No Action Alternative has two families of herbicides available, and thus has the greatest risk of all the alternatives in creating herbicide resistance in some invasive plant species

Action Alternatives

The following section discusses how the standards in each alternative influence treatment effectiveness. Please refer to Table 2-4 for the specific wording of each of the standards (Chapter 2.5). Treatment/Restoration Standards #11, #12, in all alternatives have the potential to influence treatment effectiveness.

Standard #11, Requires the prioritization of treatment areas (Mazzu and Skrine, 2004)[41]. Deciding what and where treatments should occur first, given limited budgets, is a crucial first step in any integrated weed management program. 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. This standard is ranked as highly effective for all action alternatives (ibid.).

41 . A suggested prioritization strategy is presented in Chapter 3.3.2.

Standard #12, as written under all the action alternatives, is ranked as highly effective (ibid.). By requiring a long-term site strategy, planning for revegetation or restoration needs is completed early in the process. This allows for timely development of adequate quantities of non-invasive plant materials for site restoration. Having the materials on hand immediately after treatment could make the difference in deterring re-infestation.

Standard #13 as written under the Proposed Action adopts language from the draft Forest Service National Native Plant Materials Policy. It requires that native plant materials be the first choice for restoration and rehabilitation, but allows for the use of non-native, non-invasive species if necessary (see Chapter 2.5 for full standard language).

Standard #13, as written in the Proposed Action, is ranked as having the highest effectiveness of the alternatives because it provides a means to restore or revegetate treated areas. It also provides guidance for the development of plant communities resistant to invasion. While the emphasis is on the use of native materials, the manager is not limited to native materials, which can be costly and time consuming to develop an adequate supply. This standard allows for the restoration of native grass communities more readily than the other alternatives.

As written under Alternative B, Standard #13 limits managers to the use of native materials only. It explicitly states that revegetation projects will rarely be undertaken until a native materials supply is developed. This is contrary to the language in the draft Forest Service national policy, which allows the use of non-natives that are not persistent. While an exception of use for non-natives is given, the lack of detail makes interpretation difficult. The standard does not explicitly acknowledge that non-natives may serve a purpose towards restoration.

Standard #13, in Alternative B, may also put other land ownerships susceptible to invasion following wildland fire on National Forest land if native materials were not available. Non-native, non-invasive species revegetation with desirable non-natives can be appropriate where issues such as slope stability or the need to plant competitive species arise. Mixing non-native annuals with native species, for example, can allow rapid coverage to control erosion and reduce invasion until slower germinating natives occupy a site. For example, Alternative B would eliminate use of non-native crested wheatgrass, which the Natural Resources Conservation Service (2003) considers well-adapted for stabilizing soils and competing with invasive plants.

Standard #16 has the greatest potential to affect treatment effectiveness of all the standards. Each alternative allows for the same group of mechanical, manual, cultural and biological techniques, but has a different array of herbicides.

Standard #16 in all action alternatives meets the need for release from the Forest Plan direction established by the 1988 ROD and 1989 Mediated Agreement so that new practices, technologies, and herbicides are available for use by the Forests.

Chapter 2.5 describes the suite of herbicides and application methods available in each alternative. Appendix N provides a link to the document, "*Common Control Measures for Invasive Plants of the Pacific Northwest*." This document summarizes current knowledge about treating invasive plants.

The ranking of effectiveness of the suite of herbicides included in Standard #16 is based on peer-reviewed journals, handbooks (e.g. *The Nature Conservancy Weed Control Handbook and the PNW Weed Management Handbook*), and/or websites of professional organizations.

The herbicide listed in Standard #16 were evaluated based on their effectiveness in controlling the nineteen species covering the most acreage or considered of most threat in Region Six (see Chapter 3.1). In general, since the effectiveness of herbicides varies with site characteristics, alternatives that have the widest variety of herbicides and herbicide families available for use (Alternative D and Proposed Action) have the greatest potential to result in effective treatments.

As written in the Proposed Action, Standard #16 allows for the use of ten herbicides. The list was developed to treat the broadcast array of invasive plants in Region Six and to also have the capability to treat new species that may enter from adjacent land ownerships that were known to be invasive (such as state designated Class A noxious weeds). The additional two herbicides in Alternative D allows treatment of some of these species at a lower cost per acre.

The reduction in costs associated with the use of 2, 4-D may allow for more acres to be treated.

The Proposed Action and Alternative D each have four families available to manage herbicide resistance. The additional two herbicides in Alternative D belong to the same family as do three herbicides in the Proposed Action, so there is no additional advantage in Alternative D for managing herbicide resistance.

Alternative B is likely to be less effective because it lacks sufficient variety of tools for adapting to different environmental circumstances. For example, it provides only one tool, sethoxydim, for invasive grass control. Success using sethoxydim on different grasses varies from good when treating reed canarygrass to no effectiveness on quackgrass (Tu et al, 2001). Alternative B also allows aerial spraying but limitations in ingredients that can be used would reduce its effectiveness in remote, difficult to access terrain. The Proposed Action and Alternative D would both allow for more aerial spraying than Alternative B.

Alternative B also lacks the option to use imazapic and imazapyr, the latter of which has recently been labeled for aquatic use. These herbicide choices may be important for controlling knotweeds and purple loosestrife (Knezevic, no datea; Miller, 2004). Alternative B lacks use of chlorosulfuron, metsulfuron methyl or imazapyr, which are considered most effective for treating perennial pepperweed (Renz, 200; Kruger and Sheley, 1999). Similarly, with reed canarygrass, glyphosate is reported to have moderate effectiveness when combined with burning or when applied in high concentrations. Sulfometuron methyl (not included in Alternative B) provided more effectiveness when applied to pre-emergent or early post-emergent plants (Lyons, 1998).

Herbicide resistance may increase under Alternative B because there are fewer herbicide choices. Alternative B has three families available for managing herbicide resistance. There is greater risk that some invasive plant species will not be controlled (where only non-herbicide methods are available but are ineffective on some species or more costly on some sites, reducing total treatment of invasive plants).

Table 4-3 below lists which invasive species of highest concern are likely to be effectively treated under each alternative, based on information about herbicide treatments in Chapter 3.[42]

Table 4-3 Invasive Plant Species Effectively Treated by Herbicides
Allowed by Standard #16.

Proposed Action	Alternative B	Alternative D
Suite of herbicides adequate to effectively treat knapweeds, hawkweeds, thistles, knotweeds, purple loosestrife, herb Robert, English ivy, scotch broom, false brome, rush skeletonweed, Himalayan blackberry, medusahead rye, yellow toadflax, Dalmation toadflax, leafy spurge, perennial pepperweed, tansy ragwort, sulfur cinquefoil, St. Johnswort, houndstongue, whitetop and cheatgrass	Suite of herbicides adequate to treat knapweeds, hawkweeds, thistles, knotweeds, purple loosestrife, herb Robert, English ivy, scotch broom, false brome, rush skeletonweed, Himalayan blackberry, medusahead rye and reed canarygrass.	Same as Proposed Action

42 Table 3-12 provides more details on which active herbicide ingredients are effective on specific invasive species.

Standard #17, as written under the Proposed Action, requires that when herbicide treatment methods are chosen, the rationale for their choice would be documented. It also includes Objective 3.2, which calls for the reduction in herbicide use over time. No direct changes to treatment effectiveness are expected from this standard (Mazzu and Skrine, 2004).

Standard #17, as written under Alternative B, requires reducing herbicide use over time and limits the use of herbicides as tools of last resort. Under Alternative B, this standard would require the use of other methods first until they are shown ineffective. The delay caused by determining ineffectiveness of other methods could cause an infestation to increase to the point where control is more difficult and, in extreme cases, impossible. Thus, Standard #17 in Alternative B reduces its overall effectiveness.

No corollary standards or objectives apply to Alternative D.

Standard #19, as written in Alternative B, requires that applications of herbicides in riparian areas be minimized and that broadcast spraying in riparian reserve land allocations be prohibited. This would decrease the effectiveness of riparian treatments for some of the most aggressive invasive plants (Mazzu and Skrine, 2004). If such herbicide treatments are avoided in riparian areas, where other methods are known to be ineffective, invasive plants would continue to have adverse effects. No other alternative restricts riparian herbicide use enough to reduce overall effectiveness.

Effectiveness Indicator: Years to Control

The "years to control" indicator compares the rate of spread predicted for each alternative based on prevention effectiveness (see Table 4.2) against the annual acres treated. Average cost of a treatment acre was calculated for each alternative based on the mix of treatment methods approved in each alternative (see Chapter 4.6.2). Annual treatment acres were projected by holding the current funding level constant and applying the average cost of an effectively treated acre.

Table 4-4 displays how annual treatment acres can be compared to annual spread rates to arrive at years to control.

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

Acres Treated Annually	Annual Spread Rate							
	0%	3%	4%	6%	7%	8%	10%	12%
15000	29	63	never	never	never	never	never	never
17500	25	44	84	never	never	never	never	never
20000	22	35	48	never	never	never	never	never
22500	20	29	37	never	never	never	never	never
25000	18	25	30	never	never	never	never	never
27500	17	22	26	44	never	never	never	never
30000	16	20	22	33	59	never	never	never
32500	14	18	20	27	36	never	never	never
35000	13	17	18	23	29	43	never	never
37500	13	15	17	21	24	31	never	never
40000	12	14	15	19	21	25	never	never
42500	11	13	14	17	19	22	48	never
45000	11	13	13	16	17	19	30	never
47500	10	12	13	14	16	17	24	never
50000	10	11	12	14	15	16	21	never
52500	9	11	11	13	14	15	18	30
55000	9	10	11	12	13	14	17	23
57500	9	10	10	11	12	13	15	20
60000	8	9	10	11	11	12	14	18
65000	8	9	9	10	10	11	12	15
70000	7	8	8	9	10	10	11	13
75000	7	8	8	9	9	9	10	11

*This table was created using the spreadsheet formula: Infested acres (current year) = [Infested acres (previous year) divided by Spread rate]. Spread rate included infested acres [1.00] plus the spread [0.08]. The Spread rate and successfully treated acres were then changed. If the infested acres were increasing per year, invasive plants would never be controlled. If treatment or reduced rates of spread resulted in negative infested acres, it was assumed control was achieved one year before the infested acres became negative.

Alternative B includes more emphasis on manual treatment that tend to be more expensive on a per acre basis. Thus, fewer acres would likely be achieved at a constant budget and the years to control increases proportionally.

The analysis indicates that the Proposed Action and Alternative D have more potential to control invasive plants within the foreseeable future than Alternative B, which has more potential to control invasive plants within the foreseeable future than No Action. 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 summarizes the analysis findings. If prevention standards were combined with the treatment acreage associated with the Proposed Action or Alternative D, estimated years to control would likely decrease.

Table 4-5 Years to Control at Current Funding Levels

Alternative	Effectiveness of Prevention	Acres Treated Annually	Estimated Years to Control
No Action	Low potential to reduce rate of spread, current spread rate estimated at 8-12%	25,000	Never unless acres treated increased to 35,000 and rate of spread no more than 8%
Proposed Action	Moderate to high potential to reduce rate of spread	30,000	32 years assuming spread reduced to 6%
Alternative B	High potential to reduce rate of spread	20,000	47 years assuming spread reduced to 4%
Alternative D	Moderate potential to be reduce rate of spread	40,000	21 years assuming spread reduced to 7%
Prevention Standards from B Combined with Treatment Standards from the Proposed Action	High potential to reduce rate of spread	30,000	21 years assuming spread is reduced to 4%
Prevention Standards from B Combined with Treatment Standards from Alternative D	High potential to reduce rate of spread	40,000	14 years assuming spread is reduced to 4%

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. Other land management and use activities such as grazing, vegetation management, fuels management (Healthy Fuels Initiative), and fire suppression will continue to cause ground disturbances and contribute to the introduction, spread and establishment of invasive plants on National Forest System lands.

Land uses and development on lands adjacent to or outside National Forest boundaries will likely continue to decrease effectiveness of Forest Service invasive plant management. For example, the use of invasive plants by landowners for landscaping, while small individually, can collectively result in significant impacts, especially along riparian corridors.

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.

Herbicide use may be repeated over time on the same site. This cumulative effect would be most likely where the treatment toolbox is most limited, as in No Action and Alternative B. The Proposed Action and Alternative D, by virtue of including a greater variety of tools, would be less likely to result in repeated use of the same herbicides. For instance, glyphosate could be used for some aggressive species (e.g. perennial pepperweed, leafy spurge), but repeated treatments would likely be necessary (Mazzu, 2004).

4.2.5 Methodology

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

Effectiveness of the alternatives is based upon their capacity to offer a combination of prevention and treatment options that best allow the use of Integrated Weed Management principles to reduce the spread of invasive plants. Having a wide variety of prevention strategies plus treatment tools combined with the ability to adequately restore or revegetate treated areas is key to an ecosystem management approach.

The first step in assessing effectiveness was to develop of means of comparing rate of spread for invasive plants. Rate of spread has been modeled for some invasive plant species (Higgins and Richardson, 1996; Richards and Dean, 1998; Bergelson et al., 1993). Models will always be limited by how much the stochastic aspect of nature can be incorporated and how many biological interactions they can accommodate (Myers and Bazely 2003). Cousens and Mortimer (1995) point out that a lack of quantitative data hampers the precise calculations of the rates of spread of invasive plant species.

All invasive plant species have unique strategies for spread and resistance to certain treatment methods. Spread of a particular species is based on a complexity of variables including, but not limited to, life history, population growth rate, reproductive capabilities, availability of area to invade, dispersal mechanisms, patterns of dispersal and long versus short-distance dispersal capabilities. It is of note that long distance dispersal mechanisms (movement by transport, animals etc), even if rare, govern the speed of invasion (Neubert and Caswell, 2000).

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. 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 Forest Service, 1999-Stemming). This rate of spread is used in the Forest Service Strategy for Noxious and Non-native Invasive Plant Management (USDA Forest Service, 1999-Stemming) and has been validated as applicable for Region Six by the Region Six Noxious Weed Program Manager (Gary Smith, pers. Communication 2004) 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 a complexity of factors that are not fully understood for the scale of this analysis;
- Favorable conditions for spread of invasive plants on National Forest lands in Region Six are primarily related to management or recreational activities. Depending on the activity, the potential for providing long distance dispersal mechanisms exists;
- The consistent reduction of activities that promotes favorable conditions or introduce invasive plant seed will reduce the potential for invasion;

- Natural vectors such as humans or animals, or natural forces such as wind or water, will continue to spread invasive plant seeds; reduction of spread to zero is not possible.

Prevention Standards - Because rate of spread could not be quantitatively derived at this scale, a relative ranking of the effectiveness of prevention standards was developed.

The relative change in rate of spread due to prevention standards for the action alternatives relative to No Action was estimated and a prevention effectiveness by alternative was ranked (Mazzu and Skrine, 2004). Following the above assumptions, the team evaluated every standard for individual contribution to reducing spread. A summary of the written rationale supporting the team's evaluation is based on the direct and indirect effects provided in Chapter 4.2.3.

Treatment standards – Since non-herbicide treatments available are the same for all alternatives, the effectiveness of these treatments would be equal for all alternatives. The main difference in treatment standards that could affect rate of spread has to do with herbicide choices and the potential for restoring native or desirable vegetation. Essentially the alternative offering the best suite of herbicides that would control the widest variety of species and the most potential for meeting restoration or revegetation needs would be the most effective. The alternative that best treats those difficult-to -control, aggressive species in the Region would also be most effective. A summary of the written rationale supporting the team's evaluation is provided in Chapter 4.2.3.

Treatment acreages - Treatment acreages by alternative for this analysis are consistent with those in Chapter 4.6.2. 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;
- The more expensive a treatment, the less acreage could be treated;
- The less acreage treated, the less reduction in spread (i.e. more plants left to produce seed or spread vegetatively);

- 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 produced and less vegetative spread; 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 and overall size of the invasive plant infestations in Region Six.

4.2.6 Incomplete and Unavailable Information

What information is missing?

No specific data exists regarding the effectiveness of prevention measures evaluated in this document.

Is this relevant to reasonably foreseeable significant adverse impacts essential to a reasoned choice among alternatives?

No. This section discusses the beneficial effects of the prevention standards. 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). 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, see Appendix D).

4.3 Effects of Herbicides 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. Non-herbicide treatments can also affect non-target plants and plant communities; however, these impacts are not the focus of public concern. The effects of non-herbicide methods are disclosed in Appendix J.

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 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 honeybees.

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 that have potential to harm non-target plants. The following bulleted statements apply to herbicide use in general:

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

- The potential to harm non-target species is dependent on herbicide characteristics. Herbicides vary as to their potency, selectivity, and persistence (these terms are defined in Chapter 3.3.2). These factors all play a role in how much harm can occur.
- Measures taken to limit exposure, such as selective application methods (wiping or daubing), may reduce herbicide movement off-site.
- Ectomycorrhizal suppression due to herbicides has not been demonstrated in the literature, however the applicability of these in vitro studies to field conditions is uncertain given the complexity of fungal communities, soil types, and environmental factors that influence forest ecosystems (Busse et al., 2004).

The following section summarizes the effects to plants by active ingredient. The effects are grouped by the mode of action (how the herbicide works to kill target species). Chapter 3.3.2 provides additional details on each active ingredient.

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 that in some circumstances could damage non-target species more readily than the other groups of herbicides proposed. They could be difficult to use in areas where native plants are a large component of a treatment area.

These ingredients would only be used in situations where an invasive plant is the dominant cover species or on aggressive species (such as toadflaxes, houndstongue, perennial pepperweed or reed canarygrass) that have not been effectively treated by other methods or herbicides.

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. In the Pesticide Re-registration Fact Sheet–Picloram (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). The contribution from irrigation is considered inconsequential relative to off-site drift and runoff (SERA, 2003-picloram). Labeling restrictions from these findings were implemented to reduce effects.

Because picloram persists in soil, non-target plant roots can take up picloram (Tu et al, 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, cattle 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.

In summary, susceptible plant species could be adversely affected by the off-site transport of picloram under a variety of different scenarios depending on local site-specific conditions that cannot be generically modeled. More tolerant plant species are not likely to be affected unless they are directly sprayed or subject to substantial drift (SERA, 2003–picloram).

Clopyralid (used in Transline®) is more selective and less persistent than picloram. As with picloram, clopyralid has little effect on grasses and members of the mustard family.

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). Susceptible 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 (SERA, 2003 – triclopyr).

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 three types of ectomychorrhizal fungi associated with conifer roots at concentrations of 1,000 parts per million in laboratory experiments (Estok et al., 1989). Busse et al (2004) found no inhibition of ectomychorrhizal formation in a laboratory experiment using this active ingredient.

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). If plants are accidentally sprayed at the application rates used by the Forest Service, they are likely to be damaged, particularly in the upper ranges of anticipated application rates. The extent and duration of damage will depend on the time of application and plant species (SERA, 1998 – 2,4-D).

One study determined that 2,4-D could affect three species of ectomychorrhizal fungi in laboratory experiments (Estok et al., 1989).

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. Wind erosion may cause impacts in arid regions (SERA, 2004 – dicamba). 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, 2004-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).

In summary, some susceptible plant species could be affected by runoff of dicamba. Damage associated with off-site drift of dicamba would depend on local site-specific conditions, but could occur within a relatively small distance from the application site – i.e., up to 100 feet. Vapor exposures to offsite vegetation could also cause damage. While this cannot be well quantified, it is likely that this effect would be less pronounced with Vanquish than Banvel (SERA, 2004 – dicamba).

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 particles, which prevents it from excessive leaching or from being taken up from the soil by non-target plants and has a low potential to leaching into groundwater systems (Tu et al., 2001; 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 or sociological 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.

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

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 susceptible species, there is a possibility of damage no greater than 50 feet from application sites. Runoff could cause damage to susceptible plants in areas of high rainfall (SERA, 2001-sethoxydim).

See Appendix G "Herbicide Risk Assessment Locator" for the website location of the risk assessments for these Herbicides.

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. Beetles pollinate most of the flowering plants in the world. 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 honeybee. 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 covered in the risk assessment are from direct spray. The active ingredients used in the Proposed Action are not expected to have toxic effects when directly sprayed on honeybees at the typical Forest Service application rate. Table 4-6 lists the potential herbicide doses for bees in a direct spray scenario.

Table 4-6 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 (LD50)
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 (LD50)
Triclopyr TEA	1.0 lb/ac	160 mg/kg	>1,075 mg/kg (LD50)
2,4-D	1.0 lb/ac	163 mg/kg	124 mg/kg (LD50)
NPE	1.67 lbs/ac	268.00 mg/kg	unknown

Herbicide Effects on Plant Diversity and Culturally Important Plants

Just as changes in plant diversity or species composition can occur due to invasive plants, changes can also occur due to treatments. Short-term changes in species dominance can lead to long-term shifts in plant community composition and structure. Repeated treatments over time could favor tolerant species, which in turn could shift pollinators available to a community.

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, a variety of integrated treatments would most likely avoid adverse impacts to native plant diversity.

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 showed diversity and composition are equally important determinants of ecosystem functioning. Maintaining biodiversity is often one of the primary goals of ecosystem management. Reductions in diversity may destabilize trophic dynamics, alter wildlife populations and change nutrient cycles or decomposition rates (Walker and Smith in Luken and Thieret, 1997).

Conifer forests are susceptible to changes in ectomycorrhizal fungi. Ubiquitous in most forests, their complex network of fungal hyphae increase the effective rooting area of host trees, often leading to improved nutrient uptake, seedling survival, and growth (Busse et al, 2004). Adverse effects on ectomychorrhizal fungi and on edible mushrooms from herbicide use have not been demonstrated in laboratory studies (ibid.).

Many culturally important species are associated with specific plant communities. For example, huckleberry at higher elevations (*Vaccinium deliciosum*) can be predictably found in mountain hemlock/subalpine meadow plant communities. The species can be found more predictably in this community than transitional, fire dependent openings (Mack, 2002), which is important information for gathering. Root plants such as Lomatium species are found in numerous plant communities in the Pacific Northwest. Distinct root plant associations were developed in the rocky scablands of the Warm Springs reservation (Helliwell, 1988a) to assist in land management actions to increase availability. Camas (Camassia species) and red yampa (*Perideridia gairdneri*) plant associations were developed in wetland areas for the Warm Springs reservation to also guide management practices (Helliwell, 1988b).

Ando et al (2003) studied the residual time of glyphosate and triclopyr on the traditional use species, bracken fern roots, buckbrush shoots, golden fleece foliage and manzanita berries. Residual amounts were found for all species for at least 20 weeks when directly sprayed with glyphosate. Triclopyr amounts were also detected for at least this number of weeks as well. Ando et al. (2003) also accounted for off site drift by sampling twenty sites located along transects at various distances from the application site. Glyphosate was only detected on the day of application and only at three out of twenty sites. These sites were no more than 4.5 meters from the application site (application rates ranged from 0.35 to 4.8 lb/acre; the highest rate was above the Forest Service typical application rate). Triclopyr was detected at seven sites ranging from 1.5 to 30 meters from the site on the day of application (application rates ranged from 0.27 – 1.78 lb/acre; the highest rate slightly above the typical application rate). By the fourth week of sampling, residual amounts could be found at two sites for glyphosate and no sites for triclopyr.

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.

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, especially where difficult species to treat may be found, including sites with culturally important plants.

Proposed Action

Under the Proposed Action, herbicide use would continue to be the most common means of treating invasive plants. Standard #16 provides a ‘toolbox’ of ten herbicides under the Proposed Action. It offers more herbicide treatments options 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 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.

At the project scale, adherence to Standards #16, #19 and #20 would reduce the severity and extent of impacts associated with runoff or drift. Standard #16 restricts aerial applications for the sulfonylurea group to mitigate effects from offsite drift associated with this type of herbicide. Standard #16 also restricts triclopyr to selective applications, which would reduce direct effects to non-target woody species, culturally important species, and ectomychorrhizal fungi. Thus, projects that follow integrated weed management principles and adhere to the standards in the Proposed Action would largely avoid adverse effects to non-target plants (including culturally important plants) and fungi.

Alternative B

Alternative B restricts the number of available herbicides more than the other alternatives. Standard #16 would not allow the use of picloram or any of the five acetolactate synthase-inhibiting herbicides. Projects that adhere to the standards in Alternative B would largely avoid adverse effects to non-target plants (including culturally important plants) and fungi. However, the lack of herbicide variety in Alternative B could force the use of less selective herbicides, such as glyphosate.

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. It allows for all application techniques and does not limit aerial spraying for the sulfonylurea group or broadcast spraying for triclopyr, increasing the potential for drift of the more potent, non-selective or persistent herbicides.

Projects that comply with Alternative D would follow integrated weed management techniques and avoid adverse effects in the majority of projects, however, it allows application techniques could lead to effects on non-target plants and plant communities (including culturally important plants and ectomychorrhizal fungi) that are greater in severity and/extent than the other alternatives. However, these same application techniques and herbicides allowed may result in less need for repeated treatments.

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.

Comparison Factors

The effects of the alternatives by the comparison factors are summarized in Table 4-7. The determination of "relative potential for harm" was based on potency, selectivity, persistence, and application method variations between alternatives. 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 4-7 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*	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
Number of herbicides included in each alternative that have known potential to cause toxic effects to harm honeybees.	3 – 2,4-D, glyphosate and triclopyr*	2 – glyphosate and triclopyr	1-glyphosate	3 – 2,4-D, glyphosate and triclopyr*

* Toxic effects for glyphosate and triclopyr show up only at the highest application rate.

At the project scale, under all action alternatives, choices can be made to avoid situations that could potentially cause adverse effects to non-target plant species. 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 may be used. All alternatives apply integrated weed management principles, so short-term adverse effects would largely be offset by the long-term benefits of treatment.

4.3.4 Cumulative Effects

Chapter 4.3 focuses on the potential effects to groups of native plants from herbicide use that could occur under each alternative. These effects are relatively limited in extent, and may be mitigated by selective application methods or use of herbicides that are less harmful to desired, non-target plants. All alternatives could lead to an eventual reduction in herbicide use on a larger scale, either by objective Standard #17 or by the fact that invasive plants are effectively controlled and less treatment is needed. Adjacent lands would need less treatment as new infestations and sizes of large infestation are reduced in the action alternatives. If chemicals and application methods that are less damaging to non-target plants are demonstrated to be cost-effective, adjacent landowners may be more likely to use the less damaging tools.

There could be an additive cumulative effect to susceptible non-target plant species if herbicide use is repeated over time on the same site. This cumulative effect would be most likely where the treatment toolbox is most limited, as in No Action and Alternative B. The Proposed Action and Alternative D, by virtue of including a greater variety of tools, would be less likely to result in repeated use of the same herbicides.

As made clear in Chapters 1 and 3, entire native plant communities may be degraded or destroyed from competition from invasive plants. In addition, many natural events (for instance, wildland fires) or human activities (for instance, land use and development) influence the distribution and health of native plant communities.

Projects that comply with the standards in the action alternatives are not likely to significantly harm native plant communities; rather, all alternatives are intended and expected to restore native plant communities where they are being adversely affected by invasive plants. Over time, the prevention standards included in the action alternatives will help reduce the extent or intensity of land uses that spread invasive plants or otherwise those risks to native plants, such as grazing, OHV uses, and timber harvesting, resulting in a cumulatively beneficial impact as compared to No Action.

Herbicide use and other activities 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 these cumulative, ongoing risks. The level of risk associated with Alternative D, which has the highest potential for herbicide use and impacts to non-target species, is minor compared to herbicide use, which is minor compared to potential risks to native plant communities across the states of Oregon and Washington from other natural and human influences.

4.3.5 Methodology

Forest Service/SERA 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 and the Nature Conservancy's Weed Control Measures Handbook (Tu et al., 2001) were also used for more species-specific information. By 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-grass-like species. Grass-like species include 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 certain species or families within a group but not others makes an herbicide selective. The more selective an herbicide is, the less potential effects it would cause to 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. Potency was considered relative to the typical application rates used by the Forest Service in the risk assessments.

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

What information is missing?

Studies are not available regarding the effects of herbicides on native, non-target species. The EPA performs studies predominantly on crop species rather than native species. Boutin et al. (2004) concluded that it was likely that species tested were not representative of the habitats found adjacent to agricultural treatment areas, thus risk to native species may be underestimated.

Is this relevant to reasonably foreseeable significant adverse impacts essential to a reasoned choice among alternatives?

No. Herbicide effects to native species can be extrapolated from the risk assessment or herbicide labels. Standard #19 directs that site-specific information, including potential effects of specific herbicides on non-target species, be considered when making a decision to use herbicides.

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 Chapters 4.4 and 4.5.

Terminology

NOAEL – *No-observed-adverse-effect level*: An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered as adverse, or as precursors to adverse effects. In an experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effects.

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.

Results of numerous field studies indicate the likelihood for direct adverse effects to wildlife from herbicide use is low (e.g. Marshall and Vandruff, 2002; Dabbert et al., 1997; Fagerstone et al., 1977; Rice et al., 1997; Sullivan et al., 1998; Cole et al., 1997; Cole et al., 1998; Johnson and Hansen, 1969; Nolte and Fulbright 1997, McMurray et al. 1993a; McMurray et al. 1993b). 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 (Relyea, 2005). In addition, herbicides contain impurities and additives, and produce metabolites that could be toxic to wildlife. A metabolite of triclopyr, 3,56-trichloro-2-pyridinol (TCP), is toxic to animals. The impurity hexachlorobenzene, found in picloram and clopyralid, is carcinogenic. Surfactants added to herbicides can substantially increase toxicity to aquatic species, like amphibians. These substances were evaluated in the relevant risk assessments and, with the exception of surfactants, were found to not contribute substantially to toxic exposures or increase cancer risk (SERA, 2003-triclopyr; SERA, 2003-picloram; SERA, 2003-glyphosate; SERA, 2004-clopryalid).

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 herbicide have relatively greater risk for adverse 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). Some birds and mammals that eat grass include grizzly bears, elk, rabbits and hares, chukar, California quail[43], 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 and the standards within the alternatives that constrain herbicide use. 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[44].
- 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.

Surfactants (NPE) added to herbicides also have the potential to result in harmful doses to birds and mammals that eat vegetation or insects that have been sprayed. The total number of plausible exposure scenarios that exceed the toxicity indices is also shown for each alternative. This number is the same for all alternatives. No estimate of acres treated using NPE surfactants is made because surfactants may not be used, or other additives may be used instead, so there is not a direct correlation between acres treated with herbicide and acres treated with NPE.

The results of the analysis indicate that Alternative D poses the highest potential risk to wildlife from herbicides. It includes the greatest number of plausible scenarios (31 at typical

43 Some bird species (like quail) are primarily herbivorous as adults but require insects as a primary food source as chicks.
44 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.

application rates, and an additional 19 at highest rates[45]) that exceed the toxicity indices. Under Alternative D, approximately 27,300 acres are projected for annual treatment with herbicides[46] 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 from herbicides. It is associated with 5 plausible exposure scenarios at typical application rates, and an additional 8 at highest rates, that 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 Appendix J. 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 or NPE (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. For most species, the size and distribution of actual treatment areas, the dispersed populations of terrestrial wildlife, and the foraging area and behavior of individual animals eliminate the

45 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.
46 The number of acres predicted to be treated with herbicides comes from the economic analysis done for this DEIS.

potential for direct effects at the population level. Herbicide effects analysis relies on information in the Forest Service/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[47] to evaluate toxicity and risk from the herbicides analyzed. Detailed information on the herbicide analysis conducted for this EIS, 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. The estimated dose was compared to the toxicity index (i.e., a threshold dose). An estimated dose less than the toxicity index resulted in no plausible adverse effect. An estimated dose greater than the toxicity index was called a potential adverse effect. If an estimated dose exceeded the toxicity index, it was further evaluated to determine if the dose exceeded a known LOAEL. Generally, this analysis was conducted for both acute and chronic exposures.

When data were insufficient to develop an estimate of chronic dose, acute doses were evaluated against the chronic toxicity index. When the acute dose is less than the chronic toxicity index, there is no plausible risk to the animal, because actual chronic exposures would be less than acute exposures. When the acute dose is greater than the chronic toxicity index, no estimate of risk can be made and potential effects remain uncertain because existing data do not provide sufficient information. However, in this analysis, when an acute dose exceeded a chronic toxicity index, it was counted as exceeding the NOAEL or LOAEL, which overestimates actual risk, and possibly substantially. This situation occurs for clopyralid, dicamba, glyphosate, glyphosate picloram, sethoxydim, sulfometuron methyl, triclopyr and 2,4-D.

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.[48] Quantitative exposure scenarios were conducted for amphibians when sufficient data existed to support the scenario (e.g. sulfometuron methyl). Toxicity data and exposure scenarios for

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47 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.
48 Amphibian exposure scenarios are available for sulfometuron methyl.

fish provide a reasonable surrogate for effects on amphibians because several studies have found that amphibians are less sensitive, or about as sensitive, as fish to some herbicides (Berrill et al. 1994; Berrill et al. 1997; Perkins et al. 2000). Comparison of toxicity values for fish and amphibians for the herbicides analyzed indicate similar sensitivities (see Forest Service/SERA Risk Assessments).

With a few exceptions, the toxicity index used in this analysis for each herbicide represents a sub-lethal effect. Tables 4-8 and 4-9 list the toxicity indices used in the analysis and the potential effects to wildlife at the lowest observable adverse effect level (LOAEL). All toxicity indices represent the lowest dose (e.g. most sensitive endpoint) from the species most sensitive to herbicide effects, for which adequate data are available.

The same methodology was used to quantitatively estimate risk from the use of surfactants added to herbicides prior to their use. Most surfactants used are based on a component known as nonylphenol polyethoxylate (NPE). The use of NPE-based surfactants in any of the 12 herbicides considered in this EIS could result in toxic effects to mammals and birds that eat contaminated vegetation or insects at typical and high application rates (project file worksheets; USDA Forest Service, 2003). Use of NPE is not likely to adversely affect amphibians found in the Pacific Northwest for normal operations.

However, overspray or accidental spills could produce concentrations of NPE that could adversely affect amphibians, particularly in small stagnant ponds.

The use of herbicide mixtures was also considered in the analysis. No mixtures are permitted in Alternative B, so no adverse effects from herbicide mixtures would occur. In the Proposed Action and Alternative D, Standard #16 limits mixtures to three or less active ingredients and allows use only when the sum of the individual hazard quotients is less than 1.0. This standard reduces the likelihood of adverse effects from herbicide mixtures, although some uncertainty remains for potential effects from mixtures. This method is a reasonable approach when analyzing mixtures of chemicals with different or unknown toxicity mechanisms, when expected doses will be below known toxic levels (ATSDR, 2004). It is not known which mixtures, if any, will be used during project implementation, so no quantitative estimates of exposure are calculated as the scale of this EIS. Standard #16 requires projects to conduct the analysis prior to implementation.

Potential effects to Federally listed and Forest Service Sensitive species are discussed later in Chapter 4.7.3).

Table 4-8 Toxicity indices used and LOAELs reported for Mammals.

Classified by Herbicides Included in this EIS (SERA 1998, 2001, 2003, 2004) and NPE surfactants (USDA FS 2003).

Herbicide	Duration*	Endpoint	Dose	Species	Effect Noted at LOAEL
Chlorsulfuron	Acute	NOAEL	75 mg/kg	Rabbit	Decreased weight gain at 200 mg/kg
	Chronic	NOAEL	5 mg/kg/day	Rat	Weight changes at 25 mg/kg/day
Clopyralid	Acute	NOAEL	75 mg/kg	Rat	Decreased weight gain at 250 mg/kg
	Chronic	NOAEL	15 mg/kg/day	Rat	Thickening of gastric epithelium at 150 mg/kg/day
Dicamba	Acute	NOAEL	45 mg/kg[1]	Rat	Decreased pup growth at 120 mg/kg
	Chronic	NOAEL	45 mg/kg/day	Rat	Decreased pup growth at 120 mg/kg
Glyphosate	Acute	NOAEL	175 mg/kg	Rabbit	Diarrhea at 350 mg/kg
	Chronic	NOAEL	175 mg/kg/day	Rabbit	Diarrhea at 350 mg/kg
Imazapic	Acute	NOAEL	350 mg/kg	Rabbit	Decreased body weight at 500 mg/kg
	Chronic	NOAEL[2]	45 mg/kg	Dog	Microscopic muscle effects at 137 mg/kg
Imazapyr	Acute	NOAEL	250 mg/kg	Dog	No effects at highest doses tested
	Chronic	NOAEL	250 mg/kg/day	Dog	No effects at highest doses tested
Metsulfuron methyl	Acute	NOAEL[3]	25 mg/kg	Rat	Decreased weight gain at 500 mg/kg
	Chronic	NOAEL	25 mg/kg/day	Rat	Decreased weight gain at 125 mg/kg
Picloram	Acute	NOAEL	34 mg/kg	Rabbit	Decreased weight gain at 172 mg/kg
	Chronic	NOAEL	7 mg/kg	Dog	Increased liver weight at 35 mg/kg[4]
Sethoxydim	Acute	NOAEL	160 mg/kg[5]	Rabbit	Reduced number of viable fetuses, some dam mortality at 480 mg/kg
	Chronic	NOAEL	9 mg/kg/day	Dog	Mild anemia at 18 mg/kg/day
Sulfometuron methyl	Acute	NOAEL	87 mg/kg	Rat	Decreased body weight at 433 mg/kg
	Chronic	NOAEL	2 mg/kg/day	Rat	Effects on blood and bile ducts at 20 mg/kg/day
Triclopyr[6]	Acute	NOAEL	100 mg/kg	Rat	Malformed fetuses at 300 mg/kg
	Chronic[7]	NOAEL	0.5 mg/kg/day	Dog	Effect on kidney at 2.5 mg/kg/day
2,4-D	Acute	"non-lethal"	10 mg/kg	Rat & Dog	Effects on kidney, blood, and liver
	Chronic	NOAEL	1 mg/kg/day	Rat & Dog	Effects on kidney, blood, and liver at 5 mg/kg/day
NPE Surfactants	Acute	NOAEL	10 mg/kg	Rat	Slight reduction of polysaccharides in liver at 50 mg/kg/day
	Chronic	NOAEL	10 mg/kg/day	Rat	Increased weights of liver, kidneys, ovaries, and decreased live pups at 50 mg/kg/day

* An acute dose is one that occurs over a short time. A chronic dose is a smaller amount given repeatedly over time.

1 Acute values are based on chronic values; if the dose does not cause an effect over a period of 21 weeks, it is reasonable to assume that it will not cause effects after one day of exposure (SERA 2004-dicamba).

2 Imazapic – NOAEL calculated from a LOAEL of 137 mg/kg/day and application of a safety factor of 3 to

Table 4-8 Toxicity indices used and LOAELs reported for Mammals.

Classified by Herbicides Included in this EIS (SERA 1998, 2001, 2003, 2004) and NPE surfactants (USDA FS 2003).

Herbicide	Duration*	Endpoint	Dose	Species	Effect Noted at LOAEL

extrapolate from a LOAEL to a NOAEL.
3 The acute NOAEL of 24 mg/kg is very close to the chronic NOAEL, so chronic value is used for acute exposures as well.
4 USEPA/OPP 1998.
5 Source of the value used by EPA (180 mg/kg) is not well documented, so the lower value of 160 mg/kg from a rabbit study is used as the toxicity index for this analysis.
6 Triclopyr BEE and TEA have equal toxicities to mammals (SERA, 2003a).
7 Value taken from Quast et al. 1976 as cited in SERA, 2003-triclopyr. This represents an extremely conservative approach, explained in more detail in the write up on triclopyr later in this document.
Source: SERA 1998, 2001, 2003, 2004 and USDA FS 2003.

Table 4-9 Toxicity indices used and LOAELs reported for Birds

Classified by the Herbicides Included in this DEIS. (SERA 1998, 2001, 2003, 2004) and NPE surfactants (USDA FS 2003).

Herbicide	Duration*	Enpoint	Dose	Species	Effects Noted at LOAEL
Chlorsulfuron	Acute	NOAEL	1686 mg/kg	Quail	No significant effects at highest dose
	Chronic	NOAEL	140 mg/kg/day	Quail	No significant effects at highest dose
Clopyralid	Acute	NOAEL	670 mg/kg	Mallard & Quail	No signs of toxicity reported, LOAEL not determined
	Chronic[1]	NOAEL	15 mg/kg/day	Rat	Thickening of gastric epithelium at 150 mg/kg/day
Dicamba	Acute	NOAEL	92 mg/kg[2]	Mallard	Decreased hatchability and survival of young at 184 mg/kg
	Chronic	NOAEL	92 mg/kg/day	Mallard	Decreased hatchability and survival of young at 184 mg/kg
Glyphosate	Acute	NOAEL	562 mg/kg	Mallard & Quail	No effects at highest dose
	Chronic	NOAEL	100 mg/kg	Mallard & Quail	No effects on reproduction at highest dose
Imazapic	Acute	NOAEL	1100 mg/kg	Quail	No effects at highest dose
	Chronic	NOAEL	113 mg/kg/day	Quail	Decreased weight gain in chicks at 170 mg/kg/day
Imazapyr	Acute	NOAEL	674 mg/kg	Quail	No effects at highest dose
	Chronic	NOAEL	200 mg/kg/day	Mallard & Quail	No effects at highest dose
Metsulfuron methyl	Acute	NOAEL	1043 mg/kg	Quail	No significant effects at highest dose
	Chronic	NOAEL	120 mg/kg/day	Mallard & Quail	No significant effects at highest dose

Table 4-9 Toxicity indices used and LOAELs reported for Birds
Classified by the Herbicides Included in this DEIS. (SERA 1998, 2001, 2003, 2004) and NPE surfactants (USDA FS 2003).

Herbicide	Duration*	Enpoint	Dose	Species	Effects Noted at LOAEL
Picloram	Acute	NOAEL	1500 mg/kg	Chicken & pheasant	No effect to reproduction. LOAEL not reported
	Chronic[3]	NOAEL	7 mg/kg/day	Dog	Increased liver weight at 35 mg/kg/day
Sethoxydim	Acute	LOAEL	>500 mg/kg	Mallard & Quail	No or low mortality at highest doses tested. LOAEL not available.
	Chronic	LOAEL[4]	10 mg/kg/day	Mallard	Decreased number of normal hatchlings at 10 mg/kg/day
Sulfometuron methyl	Acute	LOAEL	312 mg/kg	Mallard	Decreased weight gain at 625 mg/kg/day
	Chronic5	LOAEL	2 mg/kg/day	Rat	Effects on blood and bile ducts at 20 mg/kg/day
Triclopyr BEE[6]	Acute	LD50	388 mg/kg	Quail	50% mortality at 388 mg/kg
	Chronic	NOAEL	10 mg/kg/day	Mallard & quail	Decreased survival of offspring, reduced eggshell thickness at 20 mg/kg/day
Triclopyr TEA	Acute	LD_{50}	535 mg/kg	Quail	50% mortality at 535 mg/kg
	Chronic	NOAEL	10 mg/kg/day	Mallard & Quail	Decreased survival of offspring, reduced eggshell thickness at 20 mg/kg/day
2,4-D	Acute	LD_{50}	562 mg/kg[7]	Mallard & Quail	50% mortality at 562 mg/kg
	Chronic[8]	NOAEL	1 mg/kg/day	Rat & dog	Effects on kidney, blood, and liver at 5 mg/kg/day
NPE Surfactants[9]	Acute	LOAEL	10 mg/kg	Rat	Slight reduction of polysaccharides in liver at 50 mg/kg/day
	Chronic	LOAEL	10 mg/kg/day	Rat	Increased weights of liver, kidneys, ovaries, and decreased live pups at 50 mg/kg/day

* An acute dose is one that occurs over a short time. A chronic dose is a smaller amount given repeatedly over time.

1 Chronic toxicity studies in birds are not available, so the value from mammal studies is used.

2 Acute values are based on chronic values; if the dose does not cause an effect over a period of 21 weeks, it is reasonable to assume that it will not cause effects after one day of exposure (SERA 2004-dicamba).

3 Chronic toxicity studies in birds are not available, so the value from mammal studies is used.

4 Based on one study in which a NOAEL was not determined, so the LOAEL is used.

5 Birds may be somewhat less sensitive than mammals, but data are limited, so the lower value from mammal studies is used.

6 Unlike in mammals, the toxicities of triclopyr BEE and triclopyr TEA are different for birds, so the indices of the two forms of triclopyr are presented separately

7 Weed Science Society of America 2002.

8 No chronic toxicity data for birds is available; so the mammal chronic value is used. Acute toxicity of 2,4-D to mammals is somewhat lower than it is for birds.

Table 4-9 Toxicity indices used and LOAELs reported for Birds
Classified by the Herbicides Included in this DEIS. (SERA 1998, 2001, 2003, 2004) and NPE surfactants (USDA FS 2003).

Herbicide	Duration*	Enpoint	Dose	Species	Effects Noted at LOAEL

9 Data on birds is not available in published literature, so values from mammals are used.
Source: SERA 1998, 2001, 2003; USDA FS 2003; and Weed Science Society of America 2002.

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 by herbicide that result in exposures exceeding a LOAEL for some species, and herbicides that may adversely affect amphibians.

The number of plausible scenarios is estimated for each alternative based on the suite of herbicides that could be used. It indicates the number of ways that animals could be exposed to a harmful dose of herbicide. "Plausible" includes worst-case scenarios, many of which are very unlikely to actually occur. Individual projects conducted are likely to involve small total acreages, or long narrow road shoulders.[49] The default value used in aquatic exposure scenarios (e.g. amphibians) is a 10-acre treatment area. Herbicide application to larger areas will increase the likelihood of exposure, while a small number of acres will reduce likelihood of exposure, compared to that used in the exposure scenarios. The number of acres treated at one time within one project area is likely to influence the likelihood of exposure to herbicides for wildlife.

Indirect mortality is possible from sublethal effects that could increase susceptibility to predation. Indirect effects to wildlife from cumulative herbicide exposure are also possible. For example, if a sublethal exposure affects an internal organ and the effect is not quickly reversed, then subsequent exposure could cause cumulative damage. All the herbicides in this EIS are excreted rapidly (often within 24-48 hours), and do not accumulate up the food chain, reducing, but not eliminating, the potential for these types of cumulative effects.

The alternatives are discussed from least number of plausible exposure scenarios to most, based on the suite of herbicides selected. The herbicides with greatest potential for harm to

49 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.

birds and mammals are dicamba, glyphosate, picloram, sethoxydim, sulfometuron methyl, triclopyr and 2,4-D.

Alternative B

The combination of herbicides in Alternative B has the least number of herbicide scenarios that exceed toxicity indices for birds or mammals that eat insects or vegetation (Table 4-10). 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 seven 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 herbicides associated with a 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. For these animals to be exposed to potentially harmful doses, these 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 and have 100 percent of their diet contaminated. 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 System land), and the wide distributions of most of their populations, 2,539 acres represents a negligible potential risk to wildlife on a regional scale.

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). Selective applications are much less likely than broadcast sprays to contaminate forage vegetation or insects. 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, some 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). 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 represents 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.

Annual acres estimated per year are based on current herbicide use on and off National Forest System lands applied as predicted under Alternative B. Site-specific choices can be made at the project scale to avoid using herbicides associated with exposure scenarios that may cause harm to birds and mammals.

Table 4-10 Plausible Exposure Scenarios - Birds and Mammals - Alternative B						
(Areas exceeding LOAELs are in bold)		Number of Plausible Exposure Scenarios [1] (Blank cells equal zero scenarios)				
		Above NOAEL		Above LOAEL		
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Application Rate**	**Highest Application Rate**	**Typical Application Rate**	**Highest Application Rate**
Clopyralid	2030	2	3		
Glyphosate	**2031**	1	6		6
Sethoxydim	**508**	2	3	2	2
Triclopyr*	508	2	3	2	2
Total	5077	5	12	2	8
Total acres > LOAEL	**2,539**				
NPE#	N/A	4	5	4	4

1 The number of plausible exposure scenarios is not influenced by the estimated areas treated per year.
+ Highest Application Rate = 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.
# Number of scenarios is not included in totals for each alternative because they are the same for each alternative and potential effects are discussed in the “Background” portion of this section.

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 4-11). 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 12 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. For these animals to be exposed to potentially harmful doses, these 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 and have 100 percent of their diet contaminated.

The Proposed Action represents a 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 on a regional scale.

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). Nevertheless, the potential for some effects to occur cannot be completely ruled out.

Compared to the No Action alternative, the Proposed Action projects more acres treated with herbicide each year, but fewer exposure scenarios that may result exceed the NOAEL or LOAEL. This is due to the availability of herbicides in the Proposed Action that have little or no potential to result in a harmful dose to wildlife (chlorsulfuron, imazapic, imazapyr, and metsulfuron methyl). Acres treated with those herbicides do not contribute to the potential number of scenarios exceeding the NOAEL or LOAEL. In addition, the Proposed Action projects many fewer acres treated with picloram, no use of Dicamba, and restricted use of Triclopyr compared to No Action, so the number of scenarios exceeding NOAEL or LOAEL is lower for the Proposed Action, even though the projected number of acres treated is higher.

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.

Annual acres estimated per year are based on current herbicide use on and off National Forest System lands applied as predicted under the Proposed Action. Site-specific choices can be made at the project scale to avoid using herbicides associated with exposure scenarios that may cause harm to birds and mammals.

Table 4-11 Plausible Exposure Scenarios - Birds and Mammals - Proposed Action

(Acres exceeding LOAELs are in bold)		Number of Plausible Exposure Scenarios[1] (blank cells indicated zero scenarios)			
		Above NOAEL		Above LOAEL	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Application Rate**	**Highest Application Rate+**	**Typical Application Rate**	**Highest Application Rate**
Chlorsulfuron	620				
Clopyralid	4,648	2	3		
Glyphosate	**4,649**	1	6		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		
Triclopyr*	930				
Total	18,579	9	21	3	11
Total acres > LOAEL	**8,989**				
NPE#	N/A	4	5	4	4

1 The number of plausible exposure scenarios is not influenced by the estimated areas treated per year.

+ Highest Application Rate = 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.

Number of scenarios not included in totals for each alternative because they are the same for each alternative and potential effects are discussed in the "Background" portion of this section.

No Action

The combination of herbicides in No Action has the second highest total potential for adverse effects to birds or mammals that eat insects or vegetation (Table 4-12). The four herbicides used in this alternative (dicamba, glyphosate, picloram, and triclopyr) could result in 16 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, so the exposure scenarios for triclopyr that exceed a LOAEL are counted in the total. Estimated doses of triclopyr 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. Estimated doses for dicamba equal or exceed LOAELs for large mammals and birds that eat vegetation, and small mammals and birds that eat insects, but only at the highest application rate.

Two of the four herbicides permitted in this alternative exceed LOAELs when used in broadcast applications at the typical application rate. Glyphosate and dicamba exceed 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. For these animals to be exposed to potentially harmful doses, these 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 and have 100 percent of their diet contaminated.

No Action 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 System land), and the wide distributions of most of their populations, 13,646 acres annually represents a negligible risk to wildlife on a regional scale.

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.

Annual acres estimated per year are based on current herbicide use on National Forest System lands in the Region.

Table 4-12 Plausible Exposure Scenarios - Birds and Mammals - No Action

(Acres exceeding LOAELs are in bold)		Number of Plausible Exposure Scenarios [1] (blank cells indicated zero scenarios)			
		Above NOAEL		Above LOAEL	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Application Rate**	**Highest Application Rate+**	**Typical Application Rate**	**Highest Application Rate**
Dicamba	**182**		6		6
Glyphosate	**1,365**	1	6		6
Picloram	**11,050**	2	5	1	2
Triclopyr*	**409**	6	8	4	7
Total	13,646	9	25	5	21
Total acres > LOAEL	**13,646**				
NPE#	N/A	4	5	4	4

Table 4-12 Plausible Exposure Scenarios - Birds and Mammals - No Action

(Acres exceeding LOAELs are in bold)		Number of Plausible Exposure Scenarios [1] (blank cells indicated zero scenarios)			
		Above NOAEL		Above LOAEL	
Herbicide Included	Estimated Acres Treated Per Year	Typical Application Rate	Highest Application Rate+	Typical Application Rate	Highest Application Rate

1 The number of plausible exposure scenarios is not influenced by the estimated areas treated per year.
+ Highest Application Rate = 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.
# Number of scenarios not included in totals for each alternative because they are the same for each alternative and potential effects are discussed in the "Background" portion of this section.

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 4-13). The 12 herbicides used in this alternative could result in 25 scenarios that exceed the toxicity indices at typical application rates. At the highest labeled application rates, an additional 20 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, 1998-2,4-D) 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. These results are consistent with EPA in their draft Registration Eligibility Document for 2,4-D which states that "use of 2, 4-D on terrestrial sites presents…potential risks to…mammals and birds…" (EPA/OPP, 2004).

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. For these animals to be exposed to potentially harmful doses, these 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 and have 100 percent of their diet contaminated.

Alternative D has 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 System land), and the wide distributions of most of their populations, 27,299 acres represents a negligible risk to wildlife on a regional scale.

All other scenarios in this alternative exceed only the toxicity indices but 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. Because the ester form of 2,4-D is more toxic to aquatic organisms than the salt, mortality is much more likely with a spill of the 2,4-D ester.

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. Under typical circumstances, 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.

Annual acres estimated per year are based on current herbicide use on and off National Forest System lands applied as predicted under Alternative D (2,4-D use predicted to be extensive due to its high effectiveness and low cost). Site-specific choices can be made at the project scale to avoid using herbicides associated with exposure scenarios that may cause harm to birds and mammals.

Table 4-13 Plausible Exposure Scenarios - Birds and Mammals - Alternative D

(Acres exceeding LOAELs are in bold)		Number of Plausible Exposure Scenarios [1] (blank cells indicated zero scenarios)			
		Above NOAEL		Above LOAEL	
Herbicide Included	**Estimated Acres Treated Per Year**	**Typical Application Rate**	**Highest Application Rate+**	**Typical Application Rate**	**Highest Application Rate**
Chlorsulfuron	1,147				
Clopyralid	688	2	3		
Dicamba	**688**		6		6
Glyphosate	**3,441**	1	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**	6	8	4	7
2,4-D	**13,765**	10	10	10	10
Total	**34,410**	25	45	17	34
Total acres > LOAEL	**27,299**				
NPE#					

1 The number of plausible exposure scenarios is not influenced by the estimated areas treated per year.
+ Highest Application Rate = 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.
# Number of scenarios not included in totals for each alternative because they are the same for each alternative and potential effects are discussed in the "Background" portion of this section.

Alternative Comparison

Table 4-14 compares the alternatives by the measuring factors. The number of plausible exposure scenarios for each alternative is based on the toxicity information presented above. Harmful doses are those displayed for "above the LOAEL" in the previous tables for each alternative. Table 4-14 also displays the number of acres where these scenarios could occur, projected annually for each alternative, based on current use on and off national forest applied to each alternative based on a static budget (see Chapter 4.6. for more information).

The more acres treated with a substance associated with plausible exposure scenarios, the greater the potential for a scenario to actually occur. Under all alternatives, site-specific choices can be made to avoid herbicides associated with exposure scenarios that may cause harm to animals.

Table 4-14 Summary of Effects by Measuring Factors

Measuring factor	Alternative B	Proposed Action	No Action	Alternative D
The maximum number of plausible herbicide exposure scenarios in each alternative that could result in harmful doses to birds and mammals	12	21	25	45
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. Herbicide use on Region Six National Forests could contribute to some cumulative effects, but data is lacking that would permit any quantitative estimates of cumulative exposure or risk.

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 types of pesticides, but the herbicide triclopyr and the insecticide chlorpyrifos share a common metabolite, TCP, that is toxic to aquatic organisms[50.] Thus, the use of triclopyr could add to TCP exposure resulting from the use of chlorpyrifos. Another example of a potential cumulative effect is from hexachlorobenzene, a ubiquitous industrial pollutant, which is found

50 The combined risk from chlorpyrifos and triclopyr sources of TCP was considered quantitatively for fish in the triclopyr risk assessment (SERA, 2003-triclopyr). Combined application of chlorpyrifos and triclopyr did not result in concentrations of TCP that were toxic to fish (SERA, 2003-triclopyr, p. 4-31).

in both picloram and clopyralid. While the amounts of hexachlorobenzene added to the environment from Forest Service use of picloram and clopyralid do not represent a substantial addition in comparison to existing background levels (SERA, 2003-picloram, SERA, 2004-clopyralid), it could be considered a cumulative effect.

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 lawn care, road maintenance, utility corridors, or private forest land. The maximum estimated use on National Forest System 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 (see Forest Service/SERA Risk Assessments, 1998, 2001, 2003 and 2004). Also, adverse effects would occur to individual animals, rather than populations.

The small contribution that Forest Service use of herbicide for invasive plant control makes to the statewide totals for herbicide use indicate that the potential cumulative effect on a regional scale is very small. Likewise, the relatively small differences between the alternatives, in comparison to the totals, make insignificant any differences between the alternatives in potential for cumulative effects to wildlife. The potential for cumulative effects at more local scales must be evaluated at the project level.

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 LD_{50} or other value may be use. When an LD_{50} is used, the potential adverse effect is determined to occur at any dose above 0.1 of the LD_{50}. This value is typically used for regulatory purposes and appears to be a reasonably conservative level (Hill, 1994). It is also the level of concern used by EPA, Office of Pesticide Programs, Environmental Fate and Effects Division (EFED) for evaluating risks to federally listed wildlife (EPA 2004). 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). Because of the design of toxicity studies, reported LOAEL values are often factors of three to ten times higher than the corresponding NOAEL values. 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 reasonably protective "worst-case" 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 (Appendix P). 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 the number of acres likely to be treated annually with those herbicides. The predicted number of acres treated per year was taken from Chapter 4.6.

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

The following discussion responds to requirements found in CFR 1502.22.

What information is missing?

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 completely up-do-date 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, relevant data that are lacking include:

- For several herbicide/species group combinations, both NOAEL and LOAEL values have not been determined.
- The toxicity of the herbicides to amphibians, reptiles, terrestrial invertebrates, birds, and other animals found in Region Six is either unknown or limited, and cannot be fully characterized with the available data on surrogate species.
- 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 less data available for birds than mammals, so mammal toxicity values must be used in bird exposure scenarios for some of the herbicides considered in this EIS.

Is this relevant to reasonably foreseeable significant adverse impacts essential to a reasoned choice among alternatives?

No. Inventorying invasive plants on National Forests is a never-ending job. Inventories will never be completely up-to-date due to the nature of invasive plant growth and expansion.

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. 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 are desirable, but are considerably more costly than laboratory studies, and are difficult to conduct in such a way that conclusive data is produced (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 are 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

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: (1) Exposure for workers and the public to the potential risks associated with manual/mechanical treatments of invasive plants; and (2) 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 handpulling 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 4-15 compares the alternatives in terms of acres of non-herbicide treatments and worker days of exposure related to that acreage.

Table 4-15 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, Forest Service/SERA Risk Assessments were used to evaluate how many worker or public exposure scenarios that potentially exceed the RfD are plausible based on the relative mix of herbicides 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/SERA Risk Assessments, refer to SERA, 2001-Preparation.

Herbicide application workers are exposed to the same hazards as manual/mechanical treatment workers associated with working in an outdoor wildland environment. They may also be exposed to machinery noise from pumps, vehicles, and aircraft.

The human health hazards associated with each herbicide active ingredient 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 for the most sensitive effect. Precautionary factors are then applied to the NOAEL to develop a RfD (Reference Dose) to serve as a benchmark for estimating risk of health effects from herbicide application practices considered in the EIS. These procedures are detailed in the EIS Appendix Q: Human Health Risk Assessment. Appendix Q also details the potential for health effects on sensitive subgroups of the human population from the use of herbicides proposed in this EIS.

Judgments about the potential hazards of herbicides to humans are necessarily based in large part on the results of toxicity tests on laboratory animals. Supplemental information on actual human poisoning incidents and effects on human populations is analyzed. For a background discussion of all toxicological tests and endpoints considered in Forest Service/SERA Risk Assessments, refer to SERA, 2001.

Formulated herbicides as applied in Forest Service invasive plant treatments may contain additional compounds besides the active herbicide ingredient that are called impurities or inert ingredients. Other additives, called adjuvants, may be mixed with the diluted formulation before spraying to either enhance the herbicide activity, or to modify undesirable properties of the spray mixture. Additionally, when organisms in the environment internalize chemical herbicide formulation in their physiologic systems, they may transform them into other compounds called metabolites.

In addition to the analysis of potential hazards to human health from every herbicide active ingredient, Forest Service/SERA Risk Assessments evaluate any available scientific studies of potential hazards of other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. There is usually less information available on these substances because they are not subject to the extensive testing that is required for the herbicide active ingredients under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act). Under FIFRA, inerts are classified into one of four categories, called Lists, based on available toxicity information (see Appendix Q: Human Health Risk Assessment, Chapter 5.1.2). In some cases, toxicity data on inerts and adjuvants is produced to comply with other federal laws, such as the Federal Food, Drug, and Cosmetic Act.

Of these categories of substances, only the surfactant NPE has been tested and data produced that identify specific and quantifiable hazards to human health. The Forest Service risk assessment (Bakke, 2003) identified that NPE may contain nonylphenol, an EPA List 1[51] 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 Appendix: Human Health 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 1.0, and toxic effects are unlikely for that specific herbicide application.

Herbicide Exposure Analysis

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 could be exposed through the drift of herbicide spray through contact with sprayed vegetation, or by eating contaminated food items such as berries or edible mushrooms. The public may also be exposed by eating game or fish containing herbicide residues, or by drinking water that contains such residues.

51 “List 1” inerts are “Inerts of toxicological concern” reference Appendix Q: Human Health Risk Assessment.

Worker Herbicide Exposure Analysis

Herbicide applicators are most likely to be exposed to herbicides. Two types of worker exposure assessments are considered: occupational and accidental/incidental. Occupational exposure assessment is used to designate exposures that involve estimates of absorbed dose based on 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. The human health risk assessment (Appendix Q) 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).

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, nose or lungs. Forest Service/SERA Risk Assessment methodology for estimating internalized worker exposures from typical operations encompasses the exposures predicted from multiple routes. Additionally, contact with herbicide formulations may cause irritation at the location of the exposure, especially the eyes, and also exposed skin. 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 herbicide application. The risk assessments estimate risks from acute exposures to the public from drinking contaminated water from two sources: from a stream, which herbicide residues have contaminated by runoff or leaches from an adjacent herbicide application, and from a pond, which is contaminated by the spilled contents of a 200-gallon tanker truck that contains herbicide solution. Forest Service/SERA Risk Assessments also estimate risks from long-term exposures to the public from drinking water from a pond contaminated by runoff from an adjacent treated area. Some of these scenarios are realistic and plausible; others simulate extreme worst-case exposures from 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.

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, 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 realistic 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 specific physiologic effect, 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; EPA offers no further categorization of exceedances of the RfD. 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. For specific situations where a HQ>10 is identified, the specific physiologic effect and the relationship between the NOAEL and the LOAEL may be evaluated to more precisely determine whether a toxic effect is actually likely to occur (Durkin, personal communication).

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, public notification 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[52]). 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). The HQ>10 incidences are all acute (short-term) exposures, and most result from accidents.
- 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. The dicamba HQ>10 scenarios are all acute exposures and result from accidents. 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 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 based on current herbicide use on and off national forest, applied to each alternative assuming a static budget (see Chapter 4.6. for more information). The number of exposure scenarios shown for

52 See glossary for definition of reference dose.

each alternative is based on the herbicide and application methods allowed. The number of exposure scenarios is not influenced by the projected treatment acres displayed.

The more acres treated with a substance associated with exposure scenarios, the greater the potential for a scenario to actually occur. Under all alternatives, site-specific choices can be made to avoid herbicides associated with exposure scenarios that may cause harm to human health.

The EIS does not estimate the number of acres treated with NPE surfactants for each alternative. 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.

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 runoff/leaching from an adjacent treated area 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 runoff/leaching from an adjacent treated area 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, and the projected level of exposure is based on a single forest application monitoring study.

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 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, Alternaitve 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.

The tables below sum the occurrences of HQ's for all herbicides (plus NPE) considered for use in each alternative. The underlying scenarios and calculated HQ's are documented in the Appendix Q-Human Health Assessment.

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 hexachlorobenzene (HCB). NPE, an adjuvant of potential toxicological concern, is also available. Refer to Tables 4-16, 4-17, 4-18, 4-28, 4-29, and 4-30 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's cancer risk benchmark 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 runoff/leaching from an adjacent treated area for any herbicide in this alternative that exceed the RfD.

Table 4-16 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[1]**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Glyphosate	1365				
Picloram	11,050		1*		
Triclopyr	409		2		4
Dicamba	182		3		
Total	**13,646**				
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 benchmark of 1 in one million.
1 The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-17 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		3
Dicamba	182		2		1
Total	13,646				
Annual Acres where Scenarios May Occur		**0**	**591**	**0**	**591**
NPE	**N/A**		**1**		

Table 4-18 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		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

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 selective, directed spray applications (e.g., 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 4-19, 4-20, 4-21, 4-28, 4-29, and 4-30, for risks to workers and the public regarding the Proposed Action.

Aerial applications of the herbicides chlorsulfuron, metsulfuron methyl, and sulfometuron methyl will not be conducted, so aerial applicator HQ's are not included. The risks of direct spray scenarios to the public is greatly reduced, but HQ's are still calculated based on a possibility of accidental direct spray from a ground boom sprayer.

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 benchmark 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 runoff/leaching from an adjacent treated area for any herbicide in this alternative that exceed the RfD.

Table 4-19 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[1]**	**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				
Picloram	2,790		1*		

Table 4-19 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[1]**	**Typical exposure scenario**	**Worst Case exposure scenario**	**Typical exposure scenario**	**Worst Case exposure scenario**
Sethoxydim	930				
Sulfometuron methyl	620		2		
Triclopyr	930		2		2
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 benchmark of 1 in one million.

1 The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-20 Public 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
Total	18,597				
Annual Acres where Scenarios May Occur		**0**	**930**	**0**	**930**
NPE	N/A		1		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-21 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					
NPE		1	1		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

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 selective directed spray applications (e.g. 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 4-22, 4-23, 4-24, 4-28, 4-29, and 4-30 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 runoff/leaching from an adjacent treated area for any herbicide in this alternative that exceed the RfD.

Table 4-22 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		2
Total	5077				
Annual Acres where Scenarios May Occur		**0**	**508**	**0**	**508**
NPE	N/A		3		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-23 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		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-24 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					
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 4-25, 4-26, 4-27, 4-28, 4-29, and 4-30 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 benchmark 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 runoff/leaching from an adjacent treated area 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.

Annual acres estimated per year are based on current herbicide use on an off National Forest System lands applied as predicted under Alternative D (2, 4-D use herbicide predicted to be extensive due to its high effectiveness and low cost). Site-specific choices can be made at the project scale to avoid using herbicides associated with exposure scenarios that may cause harm to workers or the public.

Table 4-25 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[1]**	**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		4
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 benchmark of 1 in one million.
1 The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-26 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	3
Chlorsulfuron	1,147				
Clopyralid	688				
Dicamba	688		2		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		

* The number of exposure scenarios is not influenced by the estimated acres treated per year.

Table 4-27 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*	1
Chlorsulfuron			1		
Clopyralid			1		
Dicamba					1
Glyphosate			1		
Imazapic			1		
Imazapyr					
Metsulfuron methyl					
Picloram			1		
Sethoxydim					

Table 4-27 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**
Sulfometuron methyl					
Triclopyr					1
NPE		1	1		

* Alternative D has the only herbicide exposure scenario among all alternatives that exceeds the RfD for drinking stream water contaminated by runoff/leaching from an adjacent treated area 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. All other exceedances result from the accidental scenario of drinking from a pond immediately after a large spill.

Summary Tables

Table 4-28 Number of Plausible Exposure Scenarios (excludes drinking water scenarios)

	Worker Herbicide				**Worker NPE**				**Public Herbicide**				**Public NPE**			
	Typical Exposure scenario		**Maximum Exposure scenario**		**Typical Exposure scenario**		**Maximum Exposure scenario**		**Typical Exposure scenario**		**Maximum Exposure scenario**		**Typical Exposure scenario**		**Maximum Exposure scenario**	
	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*	4			3				4	4			1	
Proposed Action			6*	2			3				2	1			1	
Alternative B			2	2			3				2	1			1	
Alternative D	1		10*	7			3		2	1	7	7			1	

* One scenario (ground broadcast application workers using picloram), predicts a cancer risk of 2 in one million, which exceeds the EPA cancer risk benchmark of 1 in one million.

Table 4-29 Public Consumption of Contaminated Water: Herbicide + NPE				
	Typical Exposure Scenario		Maximum Exposure Scenario	
	HQ 2 - 10	HQ > 10	HQ 2 - 10	HQ > 10
No Action	1		2	2
Proposed Action	1		6	
Alternative B	1		3	
Alternative D	1	2	6	3

4.5.3 Alternative Comparison

Table 4-30 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	30,719	44,948	8,602
Total Herbicide and NPE WORKER Scenarios that Exceed RfD	Typical Worst-Case	0 13	0 11	0 7	1 20
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 9	0 4	0 4	3 15
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 runoff / leaching	Typical Worst-Case	0 0	0 0	0 0	0 1
Treatment Acres where Risk of Public Drinking Water Contaminated by runoff / leaching >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 4	1 6	1 3	2 9

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 for the surfactant NPE (HQ= 5) from an extreme accidental scenario: a child drinks from a small pond after an accidental spill of 200 gallons of a herbicide field solution containing NPE.

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 significant. People may be injured more than once given the hazardous outdoor working conditions and use of chainsaws or heavy equipment. Some adverse health effects from operating motorized equipment are cumulative and non-reversible, such as hearing loss and repetitive stress injuries. Forestry workers may be exposed to these 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 risks to the public is insignificant, because they would not be operating the machinery and are unlikely to be in close proximity when invasive plant treatments are being conducted.

Herbicide application workers will be exposed to some of the same hazards from working in an outdoor environment as those who are conducting manual/mechanical treatments. Workers exposed to pumps and aircraft engines are at risk of cumulative hearing loss, though exposures would likely be of shorter duration and frequency than for chainsaw or road brushing workers. The potential for cumulative health effects to workers and the public from repeated exposures to the herbicides applied to treat invasive plants in EIS alternatives 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 benchmark(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 in this EIS would not substantially affect cumulative health risks from the overall use of these herbicides in the human environment.

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 Forest Service/SERA Risk Assessments are described in SERA, 2001-Preparation. To evaluate potential risks to human health and the environment, Forest Service/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). Forest Service/SERA 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). Acute RfD's are quantified levels of exposure established by the U.S. Environmental Protection Agency's (EPA) to be considered protective of a single exposure. In EPA has not established an acute RfD for some herbicides considered in this EIS; Forest Service/SERA Risk Assessments will do so where available data are sufficient. Chronic 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 used 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 benchmark 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 Chapter 3.3.2, Herbicide Risk Assessments for additional discussion of the methodologies used to estimate risks to human health in this EIS.

4.5.6 Incomplete or Unavailable Information

Forest Service/SERA Risk Assessments identify and evaluate incomplete and unavailable information that is potentially relevant to human health effects resulting from herbicide use in EIS alternatives. Information is necessarily incomplete on potential toxic doses of most herbicides in human, and on the variation in dos-response among individuals in the human population. SERA (2001) discuses how the Forest Service/SERA Risk Assessments apply generally-accepted scientific and regulatory methodologies to encompass these uncertainties in predictions of risk.

Individual Forest Service/SERA Risk Assessments identify and evaluate missing information for that particular herbicide and its relevance to risk estimates. Such missing information may involve any of the three elements needed for risk assessments: hazard; exposure; or dose-response relationships. A peer-review panel of subject matter experts reviews the assumptions, methodologies and analysis of significance of any such missing information. SERA addresses and incorporates the finding of peer review in the final herbicide risk assessment.

The prediction of potential toxic effects from human exposure to multiple chemicals, natural and synthesized also involves necessarily incomplete and unavailable information, considering the complexity and unpredictability of potential multiple chemical exposures. Forest Service/SERA Risk Assessments evaluate the potential effects of exposure to multiple chemicals in herbicide formulations considered for use in this EIS. To estimate potential health effects for human dose-response combinations of multiple chemicals including compounds not considered in the EIS, the EIS uses the generally-accepted peer-reviewed scientific methodology developed by the U. S EPA and the U.S. Public Health Service described in Appendix Q.

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 System 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 System 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 was 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.

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 4-31 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 account for about 61 percent of total treatment expenditures. The action alternatives are compared to this baseline.

Table 4-31 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).

Reapplication requirements and opportunities to use multiple treatment types on the same treatment are impossible to quantify at this scale. It is impossible to adequately consider how these variables would impact cost or how they might influence the number of treatable acres by each alternative. However, since it is assumed that reapplication requirements and opportunities to use multiple treatment types will be similar amongst the alternatives, this analysis adequately exposes each alternative's relative ability to treat a certain number of acres.

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

Alternative B 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

Alternative D 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 4-32). 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 4-32 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 4-33 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 4-33 Treatment Acres by Alternative Holding Total Cost Constant at $4.8 MM

	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%

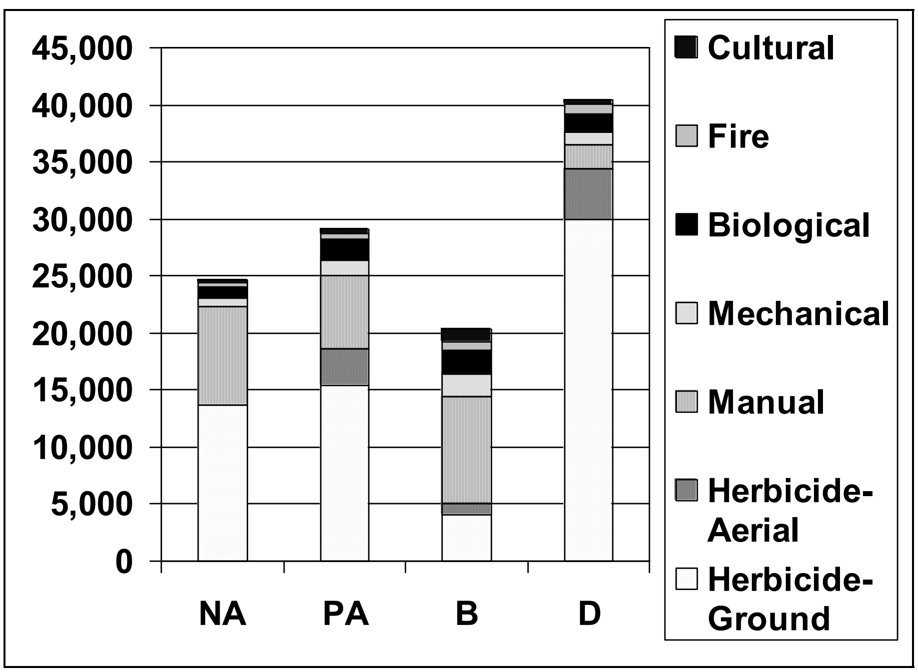

Figure 4-1 Acres Treated Annually by Type Holding Budget Constraint at $4.8 MM

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 requirements for cleaning of all equipment and vehicles, as well as all heavy equipment, authorized to operate outside the road prism on National Forest System lands. Alternative B also requires that for actions conducted or authorized by the Forest Service in areas where invasive plants are present at a level where transport of invasive plant seed or vegetative propagules is likely and a concern, all equipment and vehicles that have operated outside the limits of the road prism will be cleaned before leaving the project site.

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.

The costs of implementing this standard could lead to less heavy equipment work because costs may become prohibitive. Administrative costs for timber, other vegetation management, roads, livestock grazing, fire, fuels, recreation, and minerals and mining programs and projects in infested areas under Alternative B could increase to the point where programs and projects could not be funded.

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. This standard may need to be phased-in as programs to certify weed free straw and mulch become established.

Standard #4 requires the use of certified weed free or pelletized feed with variations by alternative. For the Proposed Action, State, NAWMA, or similarly certified weed free or pelletized feed is required when used in Wilderness Areas or at Wilderness trailheads. Similar weed free feed standards already apply to about 2.5 million acres of National Forest system lands in the Region (mostly in Wilderness and other specially designated areas, see discussion of congressionally designated areas in Chapter 3). Weed free feed requirements can 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, potentially resulting in additional purchase, travel and transportation costs to the user. The Proposed Action requires weed free feed on about 2.1 million additional acres when compared to No Action or Alternative D. Alternative B expands the weed free feed requirement to all 24.9 million acres of National Forest System lands in Region Six.

Note regarding design of this standard: It is acknowledged in Chapter 3 (see Recreation and Recreation Management) that no formal state or NAWMA certification programs currently exist for Oregon or Washington. This limitation has not hindered weed free feed requirements from already being in place on about 2.5 million acres of National Forest System land in the Region or in keeping individual counties (Wallowa County, Oregon) and Forest Service Districts (Eagle Cap Ranger District, Wallowa-Whitman) from implementing such restrictions. Current weed free feed restrictions are in place to protect some of the unique characteristics for which these areas were designated. There has been expressed interest in creating weed free certification programs from farmers, livestock users, counties, and weed boards (see public comments). There has also been concern that Region Six is falling behind other western Forest Service Regions and States by not having more encompassing weed free feed requirements on National Forest System lands. Implementation and enforcement of this standard may need to be phased-in as programs to certify weed free straw and mulch become established.

The Forest Service acknowledges that enforcement of this standard will be difficult and partnerships and collaboration with livestock users and groups will be key in the programs success and in the protection of commonly valued resources. The alternatives represent an appropriate range, from weed free requirements on no additional acres in No Action and Alternative D, to such requirements for all National Forest System land in Alternative B. The Proposed Action takes a moderate approach by requiring weed free or pelletized feed at Wilderness trailheads and in Wilderness Areas; areas that currently have relatively low invasive plant infestation rates and have been designated as unique and worthy of added protections.

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. 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.

Land managers may experience difficulty demonstrating they have complied with this standard if the public raises issues about where vegetation must be retained, how much vegetation must be retained, what vegetation must be retained, for how long vegetation must be retained, etc. This standard may become a point of litigation for projects, which would tend to increase costs or reduce the number of projects implemented.

Standard # 6 applies to all action alternatives. Standard #6 adds a requirement to incorporate invasive plant prevention practices (such as those in the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E)) into annual operating instructions and when revising allotment management plans. Planning and implementation of these measures will occur in cooperation with the grazing permit holder. This standard elevates the importance of invasive plant prevention practices and will contribute to a more consistent and appropriate application of prevention practices in livestock management that best suit local allotment conditions, ecology, and desired future conditions. Requiring incorporation of invasive plant prevention practices in range management may result in some limitations on livestock grazing, including changes in grazing locations, timing, intensity, and outputs. However, specific effects of this standard are currently unknowable as they are dependent on individual forest implementation of practices that are appropriate for local conditions.

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. 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 requires consultation with invasive plant specialists on road maintenance activities. While the language varies between the alternatives (see explanation in Chapter 2.2) the intent of the standard is the same for all action alternatives. This standard is designed to elevate the importance of considering invasive plants in planning for road maintenance activities, while allowing flexibility for roads maintenance planners and invasive plant specialists to coordinate and plan road maintenance activities that minimize contributions to (and that may help to avoid) the spread of invasive plants and that best suit local site conditions, ecology, and desired future conditions. It increases the cost of these projects, reducing accomplishment where budgets remain static. Region Six 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 includes additional language highlighting particular practices, but does not change intent or effects of this standard as quantifiable at the Regional level. All alternatives are considered equally effective.

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 at this regional scale.

Standard #10 applies to the Proposed Action and Alternative B. It limits OHV use to a system of designated roads, trails, and areas. 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 Forest Service is currently working on a national policy regarding OHV use. Comment period for the proposed rule, 36 CFR Parts 212, 251, 261, and 295 (Travel Management; Designated Routes and Areas for Motor Vehicle Use, see Appendix R), closed in September 2004, but a final rule release has not been announced. In summary, the policy would require the establishment of a system of roads, trails, and areas designated for motor vehicle use; and prohibit the use of motor vehicles off the designated system, as well as motor vehicle use on the system that is not consistent with the classes of vehicles and if applicable, the time of year, designated for use. Under the Proposed Action and Alternative B, Region Six would in directly implement the proposed rule as it is currently drafted. All action alternatives address OHV use in Objective 2.5, only Alternative D includes no additional standard for OHV use. Rather, Alternative D and No Action rely on potentially forthcoming national Forest Service Policy for OHV management.

The effects of the prevention standards that are the basis for alternative comparison in Chapter 2.6 include: increased cost of heavy equipment; increased cost or decreased access for pack stock users; adjustments to grazing permits; and reduced access due to motor vehicle use. These effects are discussed in detail in Chapters 4.6.4 through 4.6.7.

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 prism, 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 prism, 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 prism. Table 4-34 and Figure 4-2 display annual costs associated with the use of heavy equipment.

Table 4-34 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%

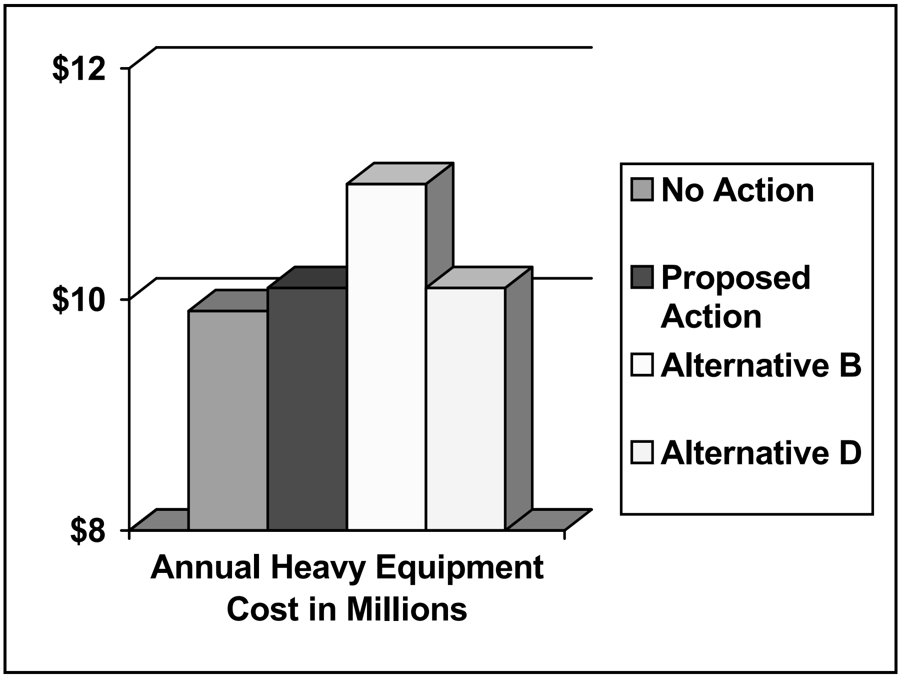

Figure 4-2 Annual Heavy Equipment Costs (in Millions)

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 can be more expensive to purchase, distribution locations for weed-free feed may be limited, and pack stock users may have to plan ahead to obtain the feed, or to allow time for animals to adjust to a different feed type. The measure of this effect is acres of National Forest where weed free feed requirements apply.

Pack stock users may experience additional travel costs to comply with this standard. Some people may also decide not to use certain National Forest System 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 System lands in the Region. Refer to Table 4-35. This alternative requires weed free feed on 5 times as many acres as the Proposed Action and 10 times more than No Action and Alternative D. Thus, Alternative B has the greatest effects to pack stock 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 not quite twice (about 2.1 million additional acres) as much land than the No Action Alternative or Alternative D. Thus the Proposed Action is less costly to pack stock 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 2.5 million acres in Region Six already require weed free feed under current direction. This direction will not change as a result of potential decisions associated with this EIS.

Table 4-35 Acres Where Weed Free Feed Would Be Required

Alternative	Acres Where Weed-Free Feed is Required
No Action	2.5 million
Proposed Action	4.6 million
Alternative B	24.9 million
Alternative D	2.5 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 Forests. 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, and may require some phase in 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. No additional restrictions on pack stock and other livestock users are foreseeable. Regardless of choice of alternative, pack stock and other recreational use will to some degree continue to be a source of invasive plant spread (see Chapter 3 for more discussion on this mechanism of dispersal).

4.6.6 Tendency for Standards to Affect Range Allotments and Permittees

Direct and Indirect Effects

All the action alternatives require incorporation of invasive plant prevention practices in annual operating instructions and allotment management plans. Since invasive plants are already considered to some degree in many grazing management plans, the effect of this standard is mainly Regional consistency. Alternative B takes this standard a step further by requiring specific documentation of how practices from the USDA Forest Service Guide to Noxious Weed Prevention Practices (Appendix E) are considered in plans.

The effects on livestock grazing levels and permttees under all action alternatives could include, but are not limited to:

- Changes in livestock movement patterns that require additional labor or may reduce outputs for certain allotments.
- Alterations to season of use (length, turn-on, turn-off, etc.) and intensity of use that could reduce outputs.
- Resting of pastures resulting in reduction of livestock use and output.
- Active restoration of native plant communities, which requires allotment resting for one to two seasons and could reduce livestock use and output. In some cases fencing can be used to mitigate impacts.
- Delayed reintroduction of livestock following wildfires resulting in reduce livestock use and outputs over time.

Ultimately, invasive plant prevention practices may result in some reduction to livestock grazing, but prevention of invasive plants is only one consideration; multiple factors including range condition, stream protection, and endangered species management will also influence allotment management.

An actual reduction in Animal Unit Month (AUMs) attributed to invasive plant management, cannot be quantified at the Regional scale due to unavailable data, variability between allotments, and the ongoing process of Allotment Management Plan revision. Alternative B with its additional documentation requirements may tend to improve the consistency of prevention application across the Forests and thus may be more likely to result in limitations on livestock grazing, including changes in grazing locations, timing, intensity, and outputs.

Effects on grazing and range management are displayed in Table 4-36.

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. Thus, factors other than invasive plant management would continue to influence grazing levels regardless of alternative selected in this EIS. Invasive Plant management and other land management practices may positively influence forage quantity or quality and result in beneficial impacts to grazing.

Table 4-36 Effects on Grazing and Range Management

Alternative	Effects on Grazing and Range Management
No Action	No Direct Effects.
Proposed Action	Some limitations on livestock grazing, including changes in grazing locations, timing, intensity, and outputs are anticipated. However, these effects are not quantifiable at the Regional scale.
Alternative B	Alternative B would likely increase consistency of application across the Forests, but this difference is not quantifiable at the Regional scale
Alternative D	Same as Proposed Action

4.6.7 Tendency for Standard to Affect Road and Off-Highway Vehicle Access

Direct and Indirect Effects

The Proposed Action and Alternative B include standards that will result in OHV closures. Alternative B also requires use of weed-free corrals and OHV staging areas and calls for the closure or decommissioning of nonessential roads where invasive plant spread is of high risk. Alternative D possess no corollary standards.

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 implementing Standards #9 and Standard #10 are unknown and cannot be predicted due to the complexity of the factors as discussed in Chapter 3 and earlier in Chapter 4. Alternative B tends to results in more road closures than the other alternatives.

Additional analysis and decision processes would be required before land use changes would become effective on any National Forest in the Region.

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 being drafted, would limit OHV use to designated roads, trails and areas, and have effects similar to the Proposed Action and Alternative B. There may be no differences between alternatives once this national policy is adopted and in place.

OHV use outside of National Forest System lands would not be affected by the national policy. Invasive plant management or other factors may lead to reductions in public access throughout the states. The amount of access reduction triggered by this EIS is likely to be small compared to access reduced as a result of the national policy and other factors.

Table 4-37 Effects of Road and OHV Use Closures

Alternative	Effects on Road and OHV use Closures
No Action	No Direct Effect. New restrictions on OHV use may occur from new national policy.
Proposed Action	No new road closures expected from invasive plant prevention standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft national policy.
Alternative B	Tendency for more roads to be closed or decommissioned due to wording of standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft national policy.
Alternative D	Same as No Action.

4.6.8 Alternative Comparison

Table 4-38 compares the alternatives by the measuring factors.

Table 4-38 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%
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.	No new road closures expected from invasive plant prevention standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft national policy.	Tendency for more roads to be closed or decommissioned due to wording of standards. OHV use allowed only on specifically designated roads, trails, and areas, based on implementation of draft national policy.	Same as No Action.
Tendency for standards to affect grazing locations, timing, intensity and outputs	Reduces grazing levels, due to rangeland grazing capacities being diminished by invasive plants.	Reduces grazing levels, due to more consistent applications of prevention measures.	Highest tendency to reduce grazing levels, due to more rigid and consistent application of prevention measures.	Same as Proposed Action
Acres of National Forest where weed free feed would be required	2.5 million	4.6 million	24.9 million	2.5 million

4.7 Other Issues

4.7.1 Soil Productivity

Introduction

Herbicides have the potential to affect 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. 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. Transient effects to soil microorganisms from use of herbicides. Soil texture, organic matter content, and soil moisture level, among others factors, influence the persistence of herbicide and longevity of the effects. 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. 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 and sulfometuron methyl are of particular concern, due to their toxicity to soil microorganisms and persistence in the soil. 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). Picloram, applied at typical rates, may change microbial metabolism, however, 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 (ibid.).

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.

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.

Direct and Indirect Effects

Table 4-39 displays annual acreage of herbicide use on National Forest System lands in Region Six, predicted for picloram and sulfometuron methyl, along with other herbicide use for each alternative. The acreage estimates are based on current herbicide use on and off National Forest System lands, given static budget and the standards under each alternative.

The effects of using picloram and/or sulfometuron methyl in the No Action, Proposed Action, and Alternative B and Alternative D are not expected to be significant, particularly at this Regional scale. 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). Adherence to this standard is expected to effectively reduce risk of significant adverse effects to soils.

Table 4-39 Predicted Annual Acreage of Herbicide use - NFS lands, Region Six

	Annual Acreage Picloram	Annual Acreage Sulfometuron Methyl	Annual Acreage Other Herbicides	Total Annual Acreage – All Herbicides
No Action	11,000	0	2,600	13,600
Proposed Action	3,000	600	15,200	18,800
Alternative B	0	0	5,100	5,100
Alternative D	6,900	1,100	26,400	34,400

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 National Forest System lands from other sources, though it is more likely that they would move off National Forest System lands to other ownerships. Nation-wide, Forest Service use of picloram is less than one percent of agricultural use (SERA, 2003-picloram), while Forest Service use of sulfometuron methyl nationwide is less than one percent of all use in California (SERA, 2003-sulfometuron methyl). Agricultural use of herbicides does not likely influence soils on National Forest System lands.

Many other natural (i.e., wildland fire) and human influences (land development and use) may result in adverse effects on soils and soil productivity. The potential adverse effects to soils from these alternatives are small in comparison to the potential effects of invasive plants themselves (see Chapter 3) and other influences. In the long run, restoration of healthy native plant communities envisioned under all alternatives in this EIS will have beneficial impacts on soils.

Unknown Information and Approach to Uncertainty

What information is missing?

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.

Is this relevant to reasonably foreseeable significant adverse impact essential to a reasoned choice among alternatives?

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

All alternatives (including No Action) allow herbicide use near streams and other water bodies. During scoping, the public expressed concern that herbicide use, especially in riparian areas, could contaminate water and harm fish and other aquatic species. Concerns about sub-lethal[53] effects to fish from herbicides were also expressed. The Fisheries Biological Assessments (BAs) and Appendix J, Effects of Non-Herbicide Methods of Invasive Plant Treatments on Wildlife, Fish and Plants, address the effects of non-herbicide treatment on aquatic organism and their habitat.

Treatment of aquatic invasive plants (invasive plants that are submerged in or float on water) is outside the scope of this analysis.

Below is a discussion of how aquatic organisms are likely to be exposed to herbicides as a result of future invasive plant treatments, followed by discussions of potential direct, indirect, and cumulative effects on the aquatic community. No treatments are authorized to be implemented by this EIS; each site-specific project must conclude appropriate NEPA and Endangered Species Act consultation before implementation.

Likelihood of Exposure to Herbicides

Herbicides used to control terrestrial invasive plants can enter water through atmospheric deposition (from large scale agriculture operations), spray drift, surface water runoff, percolation, groundwater contamination, and direct application. These routes may result in indirect effects to aquatic organisms and their habitat. Standards #18 through #22 in all action alternatives are designed to minimize or avoid water contamination from herbicides. These standards include: herbicides and herbicide mixtures; application methods and timing of application; and project design/mitigations, including treatment buffers.

The likelihood of herbicides entering the water depends on the type of treatment and mode of transport, which are described below.

Water Contamination from Drift. Herbicide drift is one of the mechanisms of herbicide movement when applied as a spray. Drift or off-target movement can result in unintended injury to native plant species, contamination of surface waters, and contamination of

53 Sub-lethal effects are those that may lead to harmful, but non-lethal effects that may impact the ability of fish and 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.

ecologically sensitive areas. Drift occurs when fine droplets of liquid herbicide become windborne and are transported to adjacent areas. It is a physical process that depends on droplet size and weather conditions rather than specific properties of an herbicide. The herbicide droplets can be subsequently deposited on surface waters that either contain aquatic species or serve as runoff conduits to water containing aquatic species. Risk assessments made for this EIS modeled off-site drift using AgDRIFT (Teske et al., 2001). Further details of AGDRIFT are available at www.agdrift.com .

Drift associated with backpack (directed foliar applications) is likely to be low although studies quantitatively assessing drift after backpack applications have not been encountered. Application pressure, nozzle size, nozzle type, spray angle, and spray volume are all factors in determining droplet size. The risk of direct effects from herbicide treatment is expected to be limited to off-site drift from spray applications (aerial, boom, and backpack). Standards #20 through #22 in all of the alternatives will reduce the risk of surface water contamination from spray drift.

In certain situations, contamination of sensitive areas, wetlands and open waters may occur during aerial spraying. Three herbicides included in the Proposed Action and Alternative D (chlorsulfuron, metsulfuron methyl, and sulfometuron methyl) are of particular concern because of the higher potential for impacts to non-target vegetation. Standard #16 in the Proposed Action prohibits aerial application of these herbicides:. Alternative B does not allow the use of chlorsulfuron, metsulfuron methyl, and sulfometuron methyl at all. In addition, the use of triclopyr is limited to selective application techniques only (e.g., spot spraying, wiping, basal bark, cut stump, injection) under both the Proposed Action and Alternative B. These restrictions under the Proposed Action and Alternative B will decrease the likelihood of any contamination of sensitive aquatic areas. The likelihood of contaminating sensitive areas is greater under Alternatives D because aerial application of the above three mentioned herbicides, and the possibility of broadcast application triclopyr.

Water Contamination from Runoff, Leaching, and Percolation. All herbicides can potentially enter streams and other water bodies through water transported by runoff, leaching, or percolation. Water contamination from rain events could transport chemicals to waterways, and convey them to aquatic species habitat. Soil type and chemical stability, solubility, and toxicity can determine the extent to which an herbicide will migrate and impact surface waters and groundwater. For example, picloram is highly soluble and readily leaches through sandy soil. It is also resistant to biotic and abiotic degradation processes. It can also move from target plants, through roots, down into the soil, and into nearby non-target plants. Given this capability, Standard 19 under all of the action alternatives helps protect riparian vegetation when using picloram by recommending treatment buffers. Glyphosate and 2,4-D, though very soluble, bind well with organic matter in soils and are not easily leached. All of the herbicides proposed for use under all of the alternatives are susceptible to transport in surface runoff, especially if applications are followed immediately by high rainfall events.

Table 4-40 below shows the likelihood of herbicide exposure based on differences within each alternative under Standard #16. Key differences between the alternatives are the number and type of herbicides proposed, and limitations of application methods.

Table 4-40 Factors for Determining Herbicide Exposure to Aquatic Organisms.

Factors	No Action	Proposed Action	Alternative B	Alternative D
Number of Herbicides Proposed	**5 active ingredients** are permitted (except on the Malheur NF): glyphosate, picloram, triclopyr, dicamba, and 2,4-D.	**10 Active Ingredients:** chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr.	**4 Active Ingredients:** clopyralid, glyphosate, sethoxydim, and triclopyr.	**12 Active Ingredients:** 2,4-D, chlorsulfuron, clopyralid, **dicambia**, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr
Application Methods	All application methods consistent with label requirements are permitted.	All application methods consistent with label requirements are permitted. Chlorsulfuron, metsulfuron methyl, and sulfometuron methyl will not be applied aerially. Use of triclopyr limited to selective application techniques.	All application methods consistent with label requirements are permitted. Use of triclopyr limited to selective application techniques	Same as No Action
Likelihood of Exposure to Herbicides	Likely – No specific restrictions on herbicide use, but fewer choices of herbicides. Anticipate some risk of exposure depending on the choice of herbicides and application method	Likely – less risk of exposure because of restrictions on the use of chlorsulfuron, metsulfuron methyl, sulfometuron methyl, and triclopyr	Less likely – less risk of exposure because of less herbicide use overall, the absence of chlorsulfuron, metsulfuron methyl, sulfometuron methyl, and use restrictions on triclopyr	Most likely – higher potential for exposure, particularly from the aerial application of chlorsulfuron, metsulfuron methyl, sulfometuron methyl and broadcast application of triclopyr.

Exposure to herbicides is plausible for aquatic organisms under each alternative. Alternative D poses the highest likelihood of exposing aquatic organisms to herbicides, and Alternative B has the lowest likelihood of exposure. Actual effects will vary depending on site-specific conditions and the design of the site-specific project. Appropriate project design and application of Standards 18-22 will minimize or avoid exposure of aquatic organisms to herbicides under all the action alternatives.

Effects on the Aquatic Community

The aquatic community consists of macrophytes (large aquatic plants) and phytoplankton (free floating algae), macroinvertebrates (aquatic insects and clams), fish, birds, and mammals (such as muskrats and otters). All of these organisms are interrelated in the aquatic community through the food chain. Organisms that play a role in the aquatic community require a certain set of physical and chemical conditions to exist, such as nutrient requirements, oxygen, light, and space. For purposes of this analysis, discussions will focus on fish, aquatic invertebrates, algae, and aquatic plants.

Aquatic food chains are dependent on primary production as a source of energy within the ecosystem. For aquatic systems, primary production can occur in the water or out of the water in riparian areas. Numerous invertebrate species feed directly on primary producers through feeding functions such as grazing, scraping, shredding, and collecting. Other invertebrate and fish species feed on these invertebrates, which then become food for fish or other predators. For example, the Bliss Rapids snail (federally listed species) is known to graze on microscopic organisms found on the upper most surfaces of rocks. Any impact to the growth or availability of these organisms could ultimately impact the Bliss Rapids snail.

Herbicides may be toxic to aquatic plants and invertebrates, thus indirectly affecting fish by reducing primary production or the trophic structure of invertebrate communities. Low concentrations of herbicides can affect benthic algae communities (NOAA, 2002). The variation in toxicity to aquatic organisms between different formulations for the same herbicide can be substantial (SERA, 2003-glyphosate). In addition, timing of application can result in different effects. For example, a springtime application of glyphosate, at recommended rates, in a lake ecosystem, where dissolved oxygen levels are low or water temperatures are elevated, could be hazardous to young of the year fish (Folmar et al., 1979).

Forest Service/SERA Risk Assessments modeled exposures for each herbicide considered under all of the alternatives (SERA, 1998; 2001; 2003; 2004). These risk assessments model the amount of chemical that can reach water under several different scenarios, then compares results to existing monitoring data to check the accuracy of the model. Both acute and chronic exposures to representatives of the aquatic community were evaluated. Acute exposures are short-term while chronic exposures occur over time. These exposure scenarios include herbicide entering water through erosion, run off and/or drift. Table 4-41 summarizes the results of the exposure scenarios for application at the typical and highest allowable application rate. Refer to previous table for type of herbicide included under each alternative.

Table 4-41 Forest Service SERA Exposure Results for Sensitive Aquatic Organisms

	Chlorsulfuron	**Clopyralid**	**Dicamba**	**Glyphosate**	**Imazapic**	**Imazapyr**	**Metsulfuron Methyl**	**Picloram**	**Sethoxydim**	**Sulfometron Methyl**	**Triclopyr**	**2,4-D**
ACUTE EXPOSURES – short term												
Fish	--	--	--	♦	--	--	--	--	--	--	--	--
Aquatic invertebrates	--	--	--	--	--	--	--	--	--	--	--	--
Algae	♦	--	♦		--	--	--	--		♦		--
Aquatic plants	*	--	--	--	♦	*	*	♦	--	*	*	*
CHRONIC EXPOSURES – over time												
Fish	--	--	--	--	--	--	--	--	--	--	--	--
Aquatic invertebrates	--	--	--	--	--	--	--	--	--	--	--	--
Algae	--	--	--	--	--	--	--	--	--	--	--	--
Aquatic plants	--	--	--	--	--	--	--	--	--	--	--	--

'—' Predicted concentrations less than the estimated or measured 'no observable effect concentration' (NOEC)

'*' Predicted concentrations greater than the estimated or measured 'no observable effect concentration' at typical application rates.

'♦' Predicted concentrations greater than the estimated or measured 'no observable effect concentration at highest allowed application rates only.

Proposed Action. Under the Proposed Action, acute exposures of clopyralid and sethoxydim are less than the estimated or measured NOEC for all representatives of the aquatic community. Herbicides that result in predicted concentrations greater than the estimated or measured NOEC at the highest allowable application rate only are: glyphosate for fish, chlorsulfuron and sulfometron methyl for algae, and imazapic and picloram for aquatic plants. At typical application rates chlorsulfuron, imazapyr, metsulfuron methyl, sulfometron methyl, and triclopyr predicted concentrations are greater than the estimated or measured NOEC for aquatic plants only. The majority of herbicides under the Proposed Action may impact aquatic plants. However, these impacts would be indirect because this EIS does not include the treatment of floating or submerged aquatic plants. None of the herbicides included under the Proposed Action exceeded the NOEC for aquatic invertebrates tested. Chronic exposures for all herbicides did not exceed the NOEC for any of the representatives of the aquatic community.

Alternative B. Under Alternative B, acute exposures of clopyralid and sethoxydim are less than the estimated or measured NOEC for all representatives of the aquatic community. Glyphosate is the only herbicide that results in predicted concentrations greater than the estimated or measured NOEC at the highest allowable application rate only for fish. Triclopyr results in predicted concentrations greater than the estimated or measured NOEC at typical application rates for aquatic plants only. None of the herbicides exceeded the NOEC for aquatic invertebrates tested. Chronic exposures for all herbicides did not exceed the NOEC for any of the representatives of the aquatic community.

Alternative D. In addition to the results for all herbicides mentioned in the Proposed Action and Alternative B, dicamba results in predicted concentrations greater than the estimated or measured NOEC at the highest allowable application rate only for algae. For aquatic plants, 2,4-D results in predicted concentrations greater than the estimated or measured NOEC at typical application rates for aquatic plants only. None of the herbicides exceeded the NOEC for aquatic invertebrates tested. Chronic exposures for all herbicides did not exceed the NOEC for any of the representatives of the aquatic community.

No Action. No Action includes the use of five herbicides - glyphosate, triclopyr, dicamba, picloram and 2,4-D (a tool of last resort). Results of their continued use would be similar to what was identified for each herbicide under the above alternatives. None of the herbicides exceeded the NOEC for aquatic invertebrates tested. Chronic exposures for all herbicides did not exceed the NOEC for any of the representatives of the aquatic community.

While the alternatives vary in terms of numbers of herbicides available for use, all alternatives result in potential effects to aquatic organisms. However, acute exposures to aquatic organism are not likely to result in harm under foreseeable conditions.

The treatment/restoration standards in all action alternatives are designed to minimize site-specific effects from herbicides to aquatic organisms and other non-target species. All action alternatives include Standard #15 to ensure herbicide applicators are licensed and herbicide transportation and handling plans are in place prior to treatment. 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.

Direct Effects

Application of herbicides under the Proposed Action, Alternative B, Alternative D, and No Action are not expected to result in mortality to aquatic species other than algae and aquatic vascular plants. While the amount of herbicides or chemicals expected to reach water are expected to be very low under the Proposed Action and Alternative B, the Forest Service cannot conclude with certainty that the levels of chemicals that could potentially reach streams with aquatic organisms will be zero.

Aquatic Plants and Algae. Toxic levels for algae and vascular plants may be of concern because they form a food supply, habitat, or both for aquatic organisms. Aquatic plants are a natural, and important, component of aquatic communities. Aquatic plants, especially phytoplankton, are consumed by small invertebrate animals, which are in turn consumed by larger animals such as birds or fish. Phytoplankton can also be consumed directly by certain fish. Small fish can be consumed by larger fish and by birds. Any impact to a component of the aquatic community may have a ripple effect on the food web.

Based on the risk assessments used for this EIS, typical application rates of chlorsulfuron, imazapyr, metsulfuron methyl, sulfometron methyl, triclopyr, and 2,4-D result in exposures that exceed the NOEC for aquatic plants. Whereas only the highest allowed application rates for imazapic and picloram result in acute exposure to aquatic plants. Using appropriate application rates, timing and application techniques of herbicides can have minimal impact on aquatic plant populations. Effects can be avoided through adherence to Standards #16, #18, #19, and #20.

Fish and Invertebrates. Most direct effects from all of the alternatives on aquatic fish and invertebrates are likely to be from sub-lethal herbicide effects, rather than from direct mortality as a result of herbicide exposure. This is discussed further in Chapter 4.7.3.

It is unlikely that the use of herbicides proposed in this EIS would cause fish kills at the concentrations of the active ingredients likely to occur in water. Mortality to fish is not expected, or likely from operational use because dilution, degradation, adsorption and other factors reduce the amount of herbicide that could enter a water body. In rare circumstances, high concentrations of herbicides could wash into streams from rainfalls shortly after herbicide application along road ditches or other surfaces that rapidly generate overland flows, or as a result of an accidental spill. In such instances, localized fish kills are plausible in small tributary streams or small, enclosed water bodies where contaminated flows would not be readily diluted.

Indirect Effects

Identified inert ingredients and adjuvants found in herbicide formulations include some relatively innocuous substances, such as distilled water. Ingredients found in herbicide formulations could also include toxic substances, such as kerosene and naphthalene. Risk assessments discuss the effects of inert ingredients to aquatic biota. Inert ingredients found in herbicide formulations are known to and classified by the US EPA and the risk assessors (SERA, 2003, Risk Assessments). Effects of inert ingredients are included in risk assessment of specific formulations.

Effects of surfactants to aquatic species have received some study. In general, aquatic species are more susceptible to adverse effects from surfactants than terrestrial species. At least some of the aquatic sensitivity to surfactants is due to irritation of gill membranes and alteration of their permeability and molecular exchange properties. Concern has been expressed about the potential for surfactants increasing the movement of other harmful materials, such as pesticides, into soils. Herbicide mobility can be increased by the use of surfactants, but effects to mobility are unlikely due to the relatively low concentration of surfactants in the soil/water matrix at Forest Service application rates (Bakke, 2003). Forest Service use of surfactants is not likely to reach levels of concern for estrogenic effects to fish (Bakke, 2003).

Nonylphenol polyethoxylate-based (NPE) surfactants are commonly used as an additive in Forest Service herbicide applications. A separate risk assessment (Bakke, 2003) for NPE surfactants was completed because concerns have been expressed about the acute toxicity to aquatic organisms of the chemical components and breakdown products of NPE surfactants.

Most studies of herbicide effects on fish observe the effect of short-period exposure to high concentrations of herbicides, rather than the low concentrations over an extended period more likely to be found in forest streams, lakes and ponds. Therefore, direct effects to fish would not be readily apparent. The potential for an accidental spill or improper use of herbicides may result in the contamination of water, thereby adversely affecting fish and invertebrates.

The combination of POEA surfactant and glyphosate may be harmful to fish other invertebrates because they breathe by movement of water, The combination of POEA surfactant and glyphosate has been shown to cause inflammation of gill tissue in fish, and to reduce survival rates especially for young fish (Folmar et al, 1979; Servizi, 1987). Folmare demonstrated that the surfactant POEA is actually more toxic to fish than the herbicide it is mixed with (Folmar, 1979). This agrees with the conclusion in the SERA Risk Assessment for glyphosate (SERA, 2003). One formulation of glyphosate (with POEA surfactants) resulted in observable, sub-lethal effects to fish at maximum label doses. Formulations of glyphosate that do not contain POEA surfactants are available and labeled for aquatic use, and may be used near water as needed under all alternatives. Thus, the risks associated with glyphosate will depend largely on formulations applied in the vicinity of streams, and application rates and methods specified for site-specific projects.

The Garlon IV formulation of triclopyr contains either kerosene or diesel fuel, both of which are know to be toxic to fish. Analysis conducted for site-specific projects should provide a greater understanding of the true risks associated with triclopyr under the Proposed Action.

Improper application of herbicides may cause changes in the quality of water in and near sprayed areas. After herbicide applications, nutrients are lost from soil into water at a greater rate. Acting as fertilizers, these nutrients encourage growth of algae, which decrease the oxygen content of the water. Air, soil and runoff temperatures may increase due to significant losses of ground cover in significantly large sprayed areas. The decrease in dissolved oxygen in the water, along with an increase in temperature affects the survival of cold water fish species. Herbicides like imazapyr at concentrations greater than NOEC are stable in conditions at the bottom of ponds, and will continue to kill aquatic plants growing there until degradation of the herbicide occurs. The decomposition of plants compromises water quality, alters pH, and changes habitat conditions for all aquatic species. It is unlikely that this would occur as a result of this EIS because imazapyr is not labeled for use in riparian areas.

As noted previously, risk assessments indicate that a formulation of glyphosate resulted in predicted concentrations greater than the estimated or measured NOEC for fish at highest allowed application rates. The use of glyphosate is included in all alternatives. Aquatic plants are more susceptible to herbicides than fish, thus effects on the aquatic food web may occur.

Indirect effects on aquatic organisms depend on the timing of application and amount and type of herbicides, inerts, metabolites, and/or adjuvants that reach aquatic habitats. Where herbicides are applied at recommended rates, the toxic effects to aquatic life may be insignificant and non-measurable.

Aquatic Plants and Algae. Herbicides used in riparian areas for weed management may indirectly impact aquatic vegetation and phytoplankton. Emergent aquatic vegetation provides hiding cover or refuge for aquatic organisms. Herbicides leaching into surface water can result in indirect effects to aquatic species via adverse effects to phytoplankton, algae, rooted aquatic macrophytes, and other aquatic plants. A significant reduction of primary productivity or aquatic plants and algae could decrease oxygen levels and indirectly impact other aquatic organisms and their habitat.

When significant amounts of aquatic vegetation are killed the plant nutrients, nitrogen and phosphorus, which are often limiting to phytoplankton growth, can be released into the water. These nutrients can allow excessive phytoplankton growth, called blooms, that cause the water to take on a green coloration and water clarity is decreased. Blooms such as this, can also occur naturally, are sometimes considered undesirable but are temporary. Substantial mortality to aquatic vegetation is not expected, or likely from operational use because dilution, degradation, adsorption and other factors reduce the amount of herbicide that could enter a water body.

Fish and Invertebrates. The most common reason for fish-kills due to herbicide application is the indirect effect of lowered dissolved oxygen (DO) in the water. Fish populations can withstand the everyday fluctuations of DO but many types of fish cannot tolerate prolonged periods of low DO. Natural fish-kills can occur in highly productive waters when phytoplankton populations die and cease producing oxygen after prolonged cloudy warm weather. When large amounts of aquatic plants are killed by an herbicide application the decaying vegetation and lack of oxygen production may cause DO to become so low that fish cannot survive in the water and a fish-kill occurs. If an herbicide that is effective on higher plants and not phytoplankton is used the potential for a fish-kill can be minimized because phytoplankton will continue to produce oxygen. Also, the likelihood of fish-kills is less in cooler water because it can hold more oxygen than warm water. It is very unlikely that implementation of projects under all of the alternatives result in fish-kills. Fish have avoidance mechanisms and are mobile allowing them to move to other parts of a lake or stream in order to avoid adverse conditions. However, under certain circumstances such as an accidental spill in an enclosed water body, fish-kills could occur. The likelihood of a fish-kill happening as a result of any alternative in this EIS is extremely low given the proposed standards and the exclusion of treatment for floating or submerged invasive plants.

Cumulative Effects

National Forests occupy large percentages of headwater watersheds in the region. Most, but not all, National Forest lands in Region Six are upstream of other sources of herbicides. Water flowing off National Forest System lands in the region often flow into larger stream networks with mixed ownership. Poorly-maintained dirt roads and ditches on National Forest System lands can route sediments, nutrients, and herbicides directly into surface waters. Thus, roads and ditches have replaced headwater streams but rather than filter and process pollutants, they deliver them directly to surface waters (Larimore and Smith, 1963).

The herbicides considered in this EIS are eliminated rapidly from the bodies of aquatic animals and do not bio-accumulate up the food chain. Therefore, cumulative effects are unlikely to be different from the direct and indirect effects of each application. Forest Service use of herbicides is typically a small percent of the herbicides used in a large watershed of mixed ownership (see Basis for Cumulative Effects Analysis Chapter 4.1.1.) and such use is unlikely to contribute substantially to downstream effects because the concentrations would be very low.

Monitoring has occurred to determine whether detectable levels of herbicide reach streams in a field situation. In the Klamath River watershed (California), detectable levels of 2,4-D and triclopyr were found in streams following heavy rainfall (Wofford et al., 2001). However, concentrations of these herbicides were ten to one thousand times less than the estimated NOEC for aquatic species. Rashin and Graber (1993) also found triclopyr, 2,4-D, and glyphosate in surface water following aerial application, attributed to off-target swath displacement and drift. Environmental concentrations of these herbicides were four to ten times less than the estimated NOEC for aquatic species.

Methodology, Unknown Information and Approach to Uncertainty

Forest Service/SERA Risk Assessments for this EIS were modeled for each herbicide considered under this EIS (SERA, 1998; 2001; 2003; 2004). The risk assessments model the amount of chemical that can reach water under several different scenarios, then compares results to existing monitoring data to check the accuracy of the model. A stream or water body contaminated by runoff and percolation immediately after application of an herbicide is the scenario used to predict acute exposure to aquatic species (Worksheet F06 and Tables 3-1 and 3-2, risk assessments). Herbicide concentration levels in water are estimated from monitoring and modeling data. Dissipation, degradation and other environmental processes are considered to predict chronic exposure for aquatic species (Worksheet F09 and Tables 3-1 and 3-2, risk assessments). Calculations are detailed in worksheets, which can be duplicated using site-specific information to predict potential concentrations of chemicals in surface water. This information can then be used to evaluate the potential effects to aquatic organisms and water quality.

Under the risk assessments, three types of estimates were used for the concentration of each herbicide in ambient water: acute, accidental, and longer-term exposure. The accidental exposure scenario is based on a spill of a fixed amount of herbicide into a water body of a fixed size (0.25 acres in surface area and 1 meter deep) assuming instantaneous mixing. The acute exposure scenario is associated with peak concentrations in a pond or lake that might be expected after the application of an herbicide to a 10 acre block that is adjacent to and drains into a small stream or pond. The longer-term exposure scenario is based on average concentrations that might be expected after a similar application – i.e., a 10 acre block that is adjacent to and drains into a small stream or pond.

What information is missing?

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 limited. See the discussion of effects in Chapter 4.4 for more information.

Contamination of water by herbicides and changes in water chemistry and temperature all increase stress on fish. Although herbicides are widely used in forestry, their overall impact on water quality, and fish breeding and survival has not been studied thoroughly.

Information about sub-lethal herbicide effects to fish is also limited. For some herbicides, the risk assessments were based on studies that identified the NOEC for sublethal effects directly (See SERA, 2003-chlorsulfuron; 2003-imazapic; 2003-metsulfuron methyl; 2003-sulfometuron methyl; 1998-2,4-D; and Bakke, 2003). These risk assessments were most likely to adequately encompass risk of sub-lethal effects to fish, and their significance to fish populations. For other herbicides, the risk assessment estimated NOECs from lethal doses (LC_{50}'s, which may not encompass concern for sub-lethal effects. The estimated NOECs are very conservative, in part to take into account potential sub-lethal effects.

Is this relevant to reasonably foreseeable significant adverse impacts essential to a reasoned choice among alternatives?

No, the approach of using worst-case scenarios and applying strict standards for use of herbicides resolves the need for additional information. Reasonably foreseeable adverse impacts are fully disclosed.

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. Appendix J, the Effects of Non-Herbicide Methods of Invasive Plant Treatments on Wildlife, Fish and Plant addresses the effects of non-herbicide treatment.

4.7.3 Threatened, Endangered and Sensitive Species

Introduction

Invasive plant management has the potential to affect federally listed and Forest Service Sensitive (TES) plant, wildlife, and fish species. Forest Service policy related to the National Forest Management Act, the Endangered Species Act (ESA), and manual direction (FSM 2670) require analysis of effects to threatened, endangered, and sensitive 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.

Effects determinations for TES plants, animals and fish are the same for all alternatives, even though the alternatives result in different kinds of risk, as described in Chapters 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 TES species. Standard #20 was specifically developed to ensure that such mitigation takes place. However, adverse effects could occur under any alternative for some treatment methods on individuals. Some projects must have a short-term adverse effect to individual plants in order to provide a long-term benefit to listed and TES species.

Threatened and Endangered Plants

Direct and Indirect Effects

Direct and indirect effects of non-herbicide treatments to non-target plants are disclosed in Appendix J. Direct and indirect effects from herbicide treatments to non-target plants are disclosed in Chapter 4.3. Treatments to control invasive plants may indirectly harm native plants as discussed under Issue #2. However, invasive plant treatments are more likely to benefit listed plant species. Careful treatment around listed populations would reduce competition from invasive plants for resources, increase habitat quality, and improve chances for expansion of listed plant species.

Herbicide treatments have the potential to affect listed 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 commercial 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 these individuals, but would not affect the species as a whole. This is primarily because very little habitat for the above three species exists on National Forest System lands; the vast majority of the species is found outside of the project area. In the case of McDonald's rock-cress, even though invasive plant seed may be brought in to its habitat from OHVs or equipment related to fire suppression, the high serpentine content and barren, rocky soils would limit the spread of invasives. What species could germinate would be easily identified and treated because very little plant cover exists in the habitat for this species.

Given the beneficial effects from restoring native habitat and reducing competition from invasive species, individual impacts would not affect the species as a whole. In most cases, these effects on individuals could be mitigated through Standard #20 by such means as buffering, timing of treatments during dormancy, exclosures or flagging of individuals before treatments.

The following table (Table 4-42) summarizes the effects determinations made on federally listed documented and suspected plant species for this EIS in Region Six. The differences between the alternatives (including No Action) do not result in different effects determinations for federally listed plans at this programmatic scale. All action alternatives are likely to adversely affect some listed species. No Effect determinations were given to those species with no known locations on National Forest System lands and little to no habitat available. Not Likely to Adversely Affect (NLAA) determinations are applied to those species that had very little habitat on National Forests in Region Six, were not in habitats susceptible to invasive plants, or were known to tolerate herbicide treatments without 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. Because no restriction on aerially spraying sulfonylurea active ingredients is required in Alternative D, there may be more risk to listed plants from drift of these potent substances.

The EPA has issued pesticide use limitations for Wallowa County, Oregon to protect MacFarlane's four-o'clock. These limitations are currently voluntary, but may become a requirement in the future. 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 (www.epa.gov/espp/oregon/wallow.htm). This extra restriction would limit adverse effects on this species in these specific areas, if instituted.

One species documented in Region Six is also most likely to be adversely affected by invasive plant treatments, but not because of aerial spraying. Showy stickseed has only one known occurrence on theWenatchee National Forest. Its habitat consists of unstable, rocky slopes that are difficult to traverse without causing soils to move and potentially damage individuals. Adverse impacts could occur from the application of any type of treatment. Without such treatments, though, the dalmation toadflax present would threaten to outcompete individuals and invade its only known population, hence affecting the species as a whole. While some effects may occur, the benefits would outweigh individual damage.

Table 4-42 Potential Effects and Determination Statements for Federally Listed Plants Effects Determinations apply to all alternatives.

LAA = Likely to Adversely Affect; NLAA = Not Likely to Adversely Affect; NE = No Effect
S = Suspected; not documented on Forest Service lands

Species and Listing Category	Determination and Basis for Determination
Showy Stickseed *Hackelia venusta* Endangered	LAA. One known site currently threatened by invasive plants. Difficult terrain and loose soils may cause damage to plants downslope.
Wenatchee Mountain Checkermallow *Sidalcea □elissa var. calva* Endangered	NLAA. (for species and critical habitat). One site on Forest Service land with no current invasive plant problems. Invasive plant treatments occurring on DNR land have shown no negative effect.

Table 4-42 Potential Effects and Determination Statements for Federally Listed Plants Effects Determinations apply to all alternatives.

LAA = Likely to Adversely Affect; NLAA = Not Likely to Adversely Affect; NE = No Effect
S = Suspected; not documented on Forest Service lands

Species and Listing Category	Determination and Basis for Determination
MacDonald's Rockcress *Arabis macdonaldiana* Endangered	NLAA. Very small portion of known populations found in the project area. Habitat is in a plant community with low susceptibility to invasive plants. If invasives were brought it, effects would be easily mitigated due to sparse nature of plant cover.
Gentner's fritillary *Fritillaria gentneri* Endangered	NLAA. Found in plant communities susceptible to invasion, but majority of populations are not on Forest Service land. Potential habitat is present, but limited. Surveys completed regularly.
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. Surveys completed regularly.
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)	NE. Considered extirpated in Region Six. Closest population in San Luis Obispo county, CA.
Water howellia *Howellia aquatilis* Threatened (S)	NE. Closest known location is downstream of the Columbia River Gorge National Scenic Area.
Western Lily *Lilium occidentale* Endangered (S)	NE. All known locations are south of Siuslaw National Forest. Potential habitat exists but susceptibility to invasion is low.
Cook's Lomatium *Lomatium □eliss* Endangered (S)	NLAA. Found in plant communities susceptible to invasion, but very little potential habitat on Forest Service land. Surveys completed regularly.
Rough Popcorn Flower *Plagiobothyrus hirtus* Endangered (S)	NE. Highly unlikely to be found. Species requires unique soil requirements in low elevation floodplains not found near Forest Service land.
Nelson's Checkermallow *Sidalcea nelsoniana* Threatened (S)	NE. No known locations and very little potential habitat exists on Forest Service land. Surveys completed regularly.

Table 4-42 Potential Effects and Determination Statements for Federally Listed Plants Effects Determinations apply to all alternatives.

LAA = Likely to Adversely Affect; NLAA = Not Likely to Adversely Affect; NE = No Effect
S = Suspected; not documented on Forest Service lands

Species and Listing Category	Determination and Basis for Determination
Ute Ladies Tresses *Spiranthes diluvalis* Threatened	NLAA. No known locations on Forest Service land and habitat very limited. Surveys completed regularly.

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 TES 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 individuals of federally listed species under all land ownership. The restoration of native habitat due to these combined treatments would provide a beneficial cumulative effect to listed species.

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 Calochortus (or Mariposa Lily) alone has eight species on the list.

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, triclopyr), but studies are laboratory based and results difficult to extrapolate to field situations (see Chapter 4.3 or soils analysis). 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.

Threatened and Endangered Wildlife

Invasive plants are adversely affecting habitat for grizzly bear, woodland caribou, western snowy plover, 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.[54]

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 potential for impacts to listed species. The effects determinations reflect potential effects from a small number of future projects; the vast majority of invasive plant treatments are expected to have no or discountable effects to listed species. If there is any possibility of an adverse effect from any future project, then the effects determination in this plan-level EIS was listed as “likely to adversely affect.” The potential for adverse effect occurs in all alternatives, so there is no difference between the alternatives in the effects determinations.

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 Forest Service/SERA Risk Assessments that correlate laboratory results to wildlife using exposure scenarios. Potential effects from NPE-based surfactants were adapted from USDA Forest Service, 2003. Results of exposure scenarios were applied to federally listed species of similar type (i.e. mammal, bird, etc.), body size, and diet[55]. The scientific uncertainty discussed in Chapter 4.4 also applies to the discussions on federally listed species.

Direct and Indirect Effects

54 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”) and in the Biological Assessment for this EIS.
55 Results of exposure scenarios are detailed in a report in Appendix P, “Summary of Herbicide Effects to Wildlife”.

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 Appendix J, "The Effects of Non-Herbicidal Methods of Invasive Plant Treatment on Wildlife, Fish and Plants," and Appendix P, "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 or near ground-level when mowing is conducted to improve habitat for the food plant, *Viola adunca*. But, mowing, other machinery, foot traffic, or other cultural methods have the potential to trample butterfly larvae. 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 has not been documented on National Forest System land. The one locations of its food plant, Kinkaid's lupine, on National Forest System land is not currently affected by invasive plants.

Therefore, invasive plant treatments are not likely to adversely affect Fender's blue butterfly. Potential effects to the food plant of the Fender's blue butterfly (Kincaid's lupine) are also 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, NPE, 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.

The use of herbicide mixtures was also considered in the analysis. No mixtures are permitted in Alternative B, so no adverse effects from herbicide mixtures would occur. In the Proposed Action and Alternative D, Standard #16 limits mixtures to three or less active ingredients and allows use only when the sum of the individual hazard quotients is less than 1.0. This standard reduces the likelihood of adverse effects from herbicide mixtures, although some uncertainty remains for potential effects from mixtures. But this method is a reasonable approach when analyzing mixtures of chemicals with different or unknown toxicity mechanisms, when expected does will be below known toxic levels (ATSDR, 2004). It is not known which mixtures, if any, will be used during project implementation, so no quantitative estimates of exposure are calculated as the scale of this EIS. Standard #16 requires projects to conduct the analysis prior to implementation.

Actual herbicide or NPE 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 4-43. 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 or NPE residues on vegetation from broadcast spray applications. Estimated doses to a grizzly bear- or caribou-sized herbivore for triclopyr, 2,4-D, and NPE exceed known LOAEL's for these chemicals.

Grizzly bears are unlikely to be exposed to doses of herbicide or NPE that would exceed the toxicity indices, or cause adverse effects because grass is not usually 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. Sucoff et al. (2001) found that spraying eggs of Karner blue butterfly (*Lycaeides elissa samuelis*) with a glyphosate- triclopyr mixture reduced egg hatching, but other herbicides and mixtures did not affect egg hatching. Herbicides have been used in some butterfly habitat without apparent adverse effects to butterfly populations (Bramble et al., 1997; Bramble et al., 1999).

Table 4-43 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.
? No reliable data exists.
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	NPE
Grizzly Bear	--	--	★♦	♦	--	--	--	♦ --	--	♦	★	★	★
Gray Wolf	--	--	--	--	--	--	--	--	--	--	★[2]	★	♦[2]
Canada Lynx	--	--	--	--	--	--	--	--	--	--	★[2]	★	♦[2]
Woodland Caribou	--	--	★♦	♦	--	--	--	♦ --	--	♦	★	★	★
American Brown Pelican	--	--	--	--	--	--	--	--	--	--	--	--	--
Bald Eagle	--	--	--	--	--	--	--	--	--	--	--	--	--
No. Spotted	--	♦	--	--	--	--	--	--	♦[2]	--	♦[2]	★[2]	♦[2]

Table 4-43 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.

? No reliable data exists.

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	NPE
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.

2 These scenarios exceed the toxicity index only for assumed chronic exposures. There is no chronic exposure estimate available, so acute exposure was compared to the chronic toxicity index, which overestimates risk, and likely substantially so. It is more accurate to state that risks are unknown, but in keeping with the "worst-case" analysis presented here, the scenarios are counted as exceeding the toxicity index.

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 4-44) summarizes the potential effects to each listed species. Determinations are based on the possibility of adverse effects at the project level, when the standards in this EIS are implemented, rather than only on the effects of the standards themselves. The uncertainty regarding herbicide exposure or proximity of disturbance prevent making a determination of "not likely to adversely affect" (NLAA) for some species. The vast majority of projects conducted under this EIS 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. Disturbance to snowy plover habitat does occur during the removal of the European beach grass, which is interpreted here to be an adverse effect. 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, but could create adverse effects during implementation.

Table 4-44 Potential effects and Determination Statements for Federally Listed Wildlife

Effect determination apply to all alternatives

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.
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.

Table 4-44 Potential effects and Determination Statements for Federally Listed Wildlife

Effect determination apply to all alternatives

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
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 Direct spray of prey to with 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 or NPE 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.
Fender's blue butterfly ***Endangered***	None anticipated because habitat is not currently affected by invasive plants.	NLAA This species has not been documented to occur on National Forest Land. Projects adjacent to habitat might have indirect effects, but effects are not likely because current monitoring would provide very early detection of invasive plants and allow low-impact removal.

Cumulative Effects

Herbicide and NPE use on Region Six National Forests could contribute to some cumulative effects, but data is lacking that would permit any quantitative estimates of cumulative exposure or risk. 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 other chemicals, as well as 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 minimal potential for cumulative effects from herbicide or NPE due to projects conducted under this EIS. Minimal herbicide and NPE exposure is possible for bald eagle, 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", Appendix P), reducing, but not eliminating, the potential for cumulative effects from exposure.

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.

Listed species can also be exposed to other chemicals, such as insecticides, rodenticides, fungicides, and others. This project does not include the use of any other types of pesticides, but the herbicide triclopyr and the insecticide chlorpyrifos share a common metabolite, TCP. Thus, the use of triclopyr could add to TCP exposure resulting from the use of chlorpyrifos. Another example of a potential cumulative effect is from hexachlorobenzene, a ubiquitous industrial pollutant, which is found in both picloram and clopyralid. While the amounts of hexachlorobenzene added to the environment from picloram and clopyralid do not represent a substantial addition in comparison to existing background levels (SERA, 2003-picloram; SERA, 2004-clopyralid), it could be considered a cumulative effect.

The small contribution that Forest Service use of herbicide for invasive plant control makes to the statewide totals for herbicide use indicate that the potential cumulative effect on a regional scale is very small. Likewise, the relatively small differences between the alternatives, in comparison to the totals, make insignificant any differences between the alternatives in potential for cumulative effects to wildlife. The potential for cumulative effects a more local scales must be evaluated at the project level.

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[56] 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.

56 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").

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.

The types of and potential for direct and indirect effects to wildlife are discussed in more detail in Chapter 4.4; these effect apply to Forest Service Sensitive species as well. Direct effects from non-herbicidal methods of invasive plant treatment include disturbance caused by noise, smoke, aircraft, people and vehicles. Results of numerous field studies indicate the likelihood for direct adverse effects to wildlife from herbicide use is low (e.g. Marshall and Vandruff, 2002; Dabbert et al., 1997; Fagerstone et al., 1977; Rice et al., 1997; Sullivan et al., 1998; Cole et al., 1997; Cole et al. 1998; Johnson and Hansen, 1969; Nolte and Fulbright, 1997, McMurray et al., 1993a; McMurray et al., 1993b). But the use of herbicides to treat invasive plants does have the potential to harm free-ranging wildlife.

Since data do not exist regarding the toxicity of herbicides to 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 4-45 lists the exposure groups, the exposure scenarios and the members of each group used for this analysis. Exposure scenarios are described in Appendix P.

Table 4-45 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	Greater sage grouse[1], sharp-tailed grouse, Columbian sharp-tailed grouse

Table 4-45 Exposure Groups, Exposure Scenarios, and Species Included		
Exposure Group	**Exposure Scenarios**	**Species Included**
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, green-tailed towhee, tricolored blackbird, bobolink, greater yellowlegs, upland sandpiper, yellow rail, bufflehead, harlequin duck
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 4-46) summarizes the potential effects to each sensitive species group.

Table 4-46 Potential Effects to Sensitive Species.
Impact determinations apply to all alternatives.

Sensitive Species Group	Potential Impacts	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, sulfometuron methyl, triclopyr, 2,4-D, or NPE 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 2,4-D, or NPE 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 2,4-D, or NPE.	No Effect. Disturbance unlikely to reach an intensity or duration that would cause an adverse affect. Worst-case herbicide exposure is not plausible for these species.
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 2,4-D, and NPE 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. Field study showed lower concentrations of herbicide residue in shrews than worst case scenario (Newton et al. 1990). 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, sethoxydim, sulfometuron methyl, triclopyr 2,4-D, or NPE, 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 4-46 Potential Effects to Sensitive Species.
Impact determinations apply to all alternatives.

Sensitive Species Group	Potential Impacts	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, 2,4-D, or NPE 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, 2,4-D, or NPE 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. NPE is likely to harm amphibians only in an accidental spill (USDA FS 2003).	MINL. Treatment areas would be very small relative to species distributions. Riparian weeds are usually treated with selective methods. Potential remains for some adverse effects to individuals.
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. Data is insufficient to evaluate risk from NPE. 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 4-46 Potential Effects to Sensitive Species.
Impact determinations apply to all alternatives.

Sensitive Species Group	Potential Impacts	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. Risks must be further evaluated at the project level.

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 individual animals 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 Forest Service use of herbicide for invasive plant control makes to the statewide totals[57] for herbicide use indicates that the potential cumulative effect from Forest Service 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.

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

Federally-Listed Fish, Mollusks, and Critical Habitat

Coordination with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration - Fisheries Division - has occurred for this EIS. The effects determinations made for Essential Fish Habitat (EFH)[58], federally listed fish and mollusks (Bliss Rapids Snail), are discussed in this section and are further elaborated on in the Biological Assessment (BA) for this EIS. For purposes of this EIS, effects to listed aquatic species are determined by assuming a worst case scenario, which leads to an adverse affect determination based on the possibility of an adverse affect at the project scale.

Life history information on fish and mollusk species listed as threatened, endangered, or proposed 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") and in the Fisheries BA. These documents also address the effects of non-herbicide treatment methods on PETS species. Because these non-herbicide treatment effects were not the focus of concern, this section will discuss effects of herbicide treatment only.

Additional supporting information for direct and indirect effects to PET species is found in the Aquatic Organism section Chapter 4.7.2). Discussions on the likelihood of herbicide exposure to aquatic organisms are also covered in Chapter 4.7.2.

Proposed Standards #15 through #22 relate to herbicide treatment and restoration. Standards #18 through #22 can be considered as mitigations to herbicide treatment. Non-herbicide treatment and restoration Standards #11 through #14, #17, and #23 were determined to have no effects on aquatic listed species because these standards apply to the administrative aspect of treating invasive plants and not implementation.

Because this EIS does not include project-level information, there is not sufficient information on how these herbicides will be applied to determine that there would be no effect whatsoever on PETS species and their habitat. The primary concern is that herbicides may enter the water body and could directly or indirectly impact PETS species as discussed below and in the Aquatic Organism section, Chapter 4.7.2.

The greatest likelihood of effects to PETS species and their habitat is associated with "high risk" treatment projects in sensitive areas. High risk projects are defined as projects that are

58 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.

treated with aerial herbicide applications, treated with broadcast herbicide applications (e.g. backpack or boom spray), the use of heavy equipment in riparian areas, and indirect treatment of water corridors (i.e. ditches) directly feeding streams with federally-listed aquatic species or critical habitat. Invasive plant treatment projects that pose a high risk to federally listed species will be monitored.

Standards #15 and #17 are unrelated to changes in on-the-ground activities that would result in effects to listed species and their habitat. Standards #18 through #22 provide mitigation direction that are intended to avoid, eliminate, or reduce potential effects from implementing herbicide-related treatments. Standard #16 was determined to have the potential for direct and indirect effects to PETS species and their habitat. However, Standards #18 through #22 would mitigate these potential effects. The majority of this section will focus on the effects from herbicide treatment on listed aquatic species and their habitat via components of pathway indicators.

Direct Effects

Application of herbicides under all of the alternatives is not expected to result in mortality to aquatic PETS species. While the amount of herbicides or chemicals expected to reach water are expected to be very low under the Alternative B and the Proposed Action, the Forest Service cannot conclude with certainty that the levels of chemicals that could potentially reach streams with PETS species and critical habitat will be zero.

Most direct effects from all of the alternatives on PETS species are likely to be from sub-lethal herbicide effects, rather than from direct mortality as a result of herbicide exposure. Sub-lethal effects are considered under the ESA to constitute “take”, if the sub-lethal effect “harms” a listed aquatic species (50 CFR 222.102). The ecological significance of sub-lethal effects depends on the degree to which they influence behavior essential to the survival and reproductive potential of individual listed aquatic species. Sub-lethal effects are not readily apparent. When small changes in the health of individual fish are observed (e.g., a small percent change in the activity of a certain enzyme, an increase in oxygen consumption), it may not be possible to infer a significant loss of essential behavior patterns of aquatic PETS species in the wild.

Product formulations sometimes include unspecified inactive ingredients and adjuvants with unknown toxic effects to listed fish. For example, the combination of POEA surfactant and glyphosate has been shown to cause inflammation of gill tissue in fish, and to reduce survival rates especially for young fish (Folmar et al, 1979; Servizi, 1987). Roundup is known to have the POEA surfactant and is therefore toxic to fish, while the product Rodeo, which contains the same active ingredient (glyphosate), but no surfactants, has very low toxicity.

The risk of direct effects from drift as a result of "high risk" broadcast spray applications (aerial, boom, and backpack) from overspray is likely to occur in small streams and stream margins, and small, enclosed water bodies. Higher herbicide concentrations can result in smaller streams with limited dilution capacity. Stream margins providing rearing habitat to fry and juveniles are often poorly mixed relative to the main stream channel, and high herbicide concentrations can result from overspray/drift exposure. Thus, direct exposure of stream or lake margins to overspray or drift can result in a high risk potential to vulnerable aquatic PETS species life stages.

Project design and/or mitigations required under Standard #20 will reduce the risk of surface water contamination from spray drift. Standard #20 requires that site-specific project design use wind speed and direction, nozzle type and size, buffers, and other unspecified factors to reduce or eliminate the risk of effects to aquatic PETS species from herbicide exposure resulting from spray applications. The site-specific design criteria employed will be specified at the project level.

Indirect Effects

Indirect effects are analyzed and discussed below by addressing certain components of the matrix of pathway indicators and cross-walking those indicators with critical habitat elements or primary constituent elements.

Chemical Toxicity. Herbicides (along with inert ingredients, adjuvants, metabolites, and impurities) can indirectly enter surface water through a variety of routes. Plants treated with herbicides may release chemicals into the soil via root systems or rinsing during rainfall events, treated plant biomass containing slowly decaying herbicides can become incorporated with soil organic matter, or overspray onto soil can result in soil contamination. Soil can be moved into surface water through wind erosion, soil movement, or leaching.

The Forest Service risk assessments conducted by Syracuse Environmental Research Associates (SERA) include extensive review of the available literature regarding the effects of herbicides and herbicide formulations to aquatic species. The concentration resulting in lethal effects to fifty percent of fish exposed to an herbicide or herbicide formulation (LC_{50} value) is the most commonly identified toxicity level for each herbicide. The chronic no observed effect concentration (NOEC) was identified where data was available, and estimated using a variety of methods when chronic toxicity data was not available. This is explained further in the Fisheries BA.

Effects can include changes in behaviors or body functions that are not directly lethal to the aquatic PETS species, but could have reproductive, juvenile to adult survival, or other consequences. The most common sub-lethal effect was changes in the size of liver or kidneys, the organs primarily responsible for xenobiotic metabolism and excretion. One or two herbicides had behavioral effects. In no instance have aquatic PETS species analyzed in this EIS been directly tested for these levels of toxicity, so estimated toxicity is extrapolated using data from sensitive or closely related fish species or invertebrates.

Herbicide treatment methods can result in indirect introduction of chemicals to surface water. Chemical concentrations, duration of exposure, sensitivity of the species to the chemical (which can vary with life stage) all affect the level of toxicity to aquatic PETS species. Chemical characteristics such as decay rate and strength of bond to soil particles affect the concentration of the chemical in water. Environmental factors such as soil particle size, amount of organic matter in the soil, moisture level, and temperature affect decay rate, which in turn affects chemical concentrations in water.

Dissolved Oxygen and Nutrients. Significant herbicide treatment in riparian areas could result in increases in nutrient delivery and have possible effects on dissolved oxygen. However, treatments are generally not confined to riparian areas and typically do not negatively impact significant portions of the total riparian vegetation resulting in a sudden influx of nutrients to surface water.

Herbicides leaching into surface water can result in indirect effects to aquatic PETS species via adverse effects to phytoplankton, algae, rooted aquatic macrophytes, and other aquatic plants. A significant reduction of primary productivity or aquatic plants and algae could decrease oxygen levels and indirectly impact aquatic PETS species and their critical habitat.

Water Temperature. Depending on site-specific conditions, intensive and extensive herbicide treatment immediately adjacent to surface water can result in the loss of enough riparian vegetation to affect summer or winter water temperatures.

Aquatic PETS species have specific needs in term of water temperature, which affects metabolism and food requirements. In the summer, increasing water temperatures decreases the solubility of dissolved oxygen in water, decreasing dissolved oxygen and affecting aquatic PETS species. In the winter in cold climates, riparian vegetation aids in moderating radiant heat loss from the stream.

Many factors affect water temperature. Herbicidal treatments may likely decrease riparian vegetative shading in certain areas thereby increasing the amount of solar radiation striking the water resulting in a warming effect. This loss of shade can persist for a year to several years, depending on the success of invasive plant treatment, stream size and location, growing conditions for the replacement plants, and the density and height of the invasive plants when treated. The reason for treatment of invasive plants is to improve ecosystem and riparian function by removing invasive plants and supporting the growth of native vegetation. Any loss of shade is expected to be temporary, until appropriate vegetation reaches and surpasses the height of the invasive plants that were removed. This warming effect would be insignificant and short-term and not enough to adversely affect aquatic PETS species and their habitat.

Turbidity and Fine Sediment. Herbicide treatments do not kill invasive plants immediately. As treated vegetation dies and loses root strength, soil can be moved into surface water through water movement, soil movement, or wind. There would have to be a significant amount of vegetation die-off next to the stream in order to significantly increase levels of turbidity and fine sediment.

Instream Habitat and Riparian Structure. Invasive plant treatment in riparian areas is intended to change the vegetative composition to restore the structure and function of riparian areas. Loss or reduction in riparian vegetation due to treatment of invasive plants is expected in the short-term. The length of time before suitable vegetation returns to perform important riparian functions will vary considerably across Region Six. Emergent aquatic vegetation can be affected indirectly and riparian vegetation can be affected directly by herbicide treatment. In general, improved riparian structure and function due to invasive plant treatment will benefit listed aquatic species, though there could be localized, short-term effects to their habitat.

Food Resources. Aquatic PETS species are indirectly affected when their food source is impacted. Aquatic food chains are dependent on primary production as a source of energy within the ecosystem. For aquatic systems, primary production can occur in the water or out of the water in riparian areas. Numerous invertebrate species feed directly on primary producers through feeding functions such as grazing, scraping, shredding, and collecting. Other invertebrate and fish species feed on these invertebrates, which then become food for fish or other predators. For example, the Bliss Rapids snail is known to graze on microscopic organisms found on the upper most surfaces of rocks. Any impact to the growth or availability of these microscopic organisms will ultimately impact the Bliss Rapids snail.

Inputs of plant matter and insects are important sources of nutrients and energy in some aquatic systems, particularly small, heavily vegetated headwater streams. Changes in the composition of riparian vegetation due to invasive plant treatment could potentially cause short-term changes in the timing and composition of these food sources. However, these changes are expected to favor native food sources and ultimately benefit aquatic PETS species.

The significance of effects to aquatic PETS species is related to the intensity and extent of invasive plant treatment in riparian areas. Because aquatic plants are an important food source for some aquatic PETS species and their prey, it is important to consider the feeding habits of aquatic PETS species when assessing indirect impacts via food resources. For example, the feeding habits of the Warner sucker mainly depend on habitat and life history stage, with adult suckers becoming more generalized than juveniles. Invertebrates, particularly planktonic crustaceans, make up most of the larvae stage diet because of their physiology. As the suckers grow, they gradually become generalized benthic feeders on diatoms, filamentous algae, and detritus. Any negative impacts to aquatic plants or macrophytes will ultimately impact the Warner sucker.

Chronic and Acute Exposure

The potential for adverse effects from exposure to herbicides was analyzed using exposure estimates in the Forest Service/SERA Risk Assessments and comparing those estimates to toxicity thresholds for each herbicide. Toxicity thresholds (or "toxicity indices") were determined using EPA protocol for effects to federally-listed aquatic organisms[59]. The results of the analysis indicate that modeled concentrations of glyphosate, picloram, sethoxydim, triclopyr, and 2, 4-D ester exceed the toxicity indices for fish at typical and highest application rates. 2,4-D amine does not exceed the toxicity index for any application rate or exposure assumption[60], Table 4-47.

59 These results differ slightly from the results displayed in Table 4-41 (Chapter 4.7.2) because of differences in the protocol used for the calculations.
60 Details of the analysis can be found in the project files, the Forest Service/ SERA Risk Assessment , and the Fisheries Biological Assessment.

Table 4-47 Acute Exposure Results for Sensitive Aquatic Organisms - EPA Protocol

	Chlorsulfuron	Clopyralid	Dicamba	Glyphosate w/o Surfactant	Glyphosate with Surfactant	Imazapic	Imazapyr	Metsulfuron Methyl	Picloram	Sethoxydim	Sulfometron Methyl	Triclopyr TEA	Triclopyr BEE	2,4-D ester	2,4-D amine
ACUTE EXPOSURES – short term															
Fish	--	--	--	*	*	--	--	--	*	*	--	*	*	*	--
Aquatic invertebrates	--	--	--	--	♦	--	--	--	--	--	--	--	♦	--	--
Algae	*	--	--	--	♦	--	*	--	--		♦	*	*	*	*
Aquatic plants	*	--	--	--	--	♦	*	*	♦	--	*	*	*	*	*

'—' Predicted concentrations less than the estimated or measured 'no observable effect concentration' (NOEC)
'*' Predicted concentrations greater than the estimated or measured 'no observable effect concentration' at typical application rates.
'♦' Predicted concentrations greater than the estimated or measured 'no observable effect concentration at highest allowed application rates only.

The toxicity metric values (estimated or measured NOEC values) used in the analysis were selected as the most likely to protect against acute sub-lethal effects (for a more complete explanation, see Fisheries BA). Therefore, exceedence levels shown in Table 4-47 above represents at least a greater than discountable risk of acute sub-lethal effects. For aquatic species, exposure above the chronic toxicity concentrations is not mathematically possible for any of the herbicides modeled. Results for chronic exposures are not shown in the table above because predicted concentrations are less than the estimated or measured NOEC for all herbicides.

Proposed Action. Under the Proposed Action, herbicides that could plausibly cause acute adverse effects to fish are glyphosate (with and without surfactant), triclopyr (TEA and BEE), picloram, and sethoxydim. Predicted concentrations for glyphosate with surfactant are greater than the estimated or measured NOEC at the highest allowable application rate for aquatic invertebrates and algae. The combination of POEA surfactant and glyphosate has been shown to cause inflammation of gill tissue in fish, and to reduce survival rates for juvenile fish (Folmar et al, 1979; Servizi, 1987). Folmare (1979) demonstrated that the surfactant POEA is actually more toxic to fish than glyphosate. The LOC exceedences for glyphosate without surfactant appear to be a function of the high glyphosate application rates, rather than glyphosate being more toxic. Thus, the risks associated with glyphosate will depend largely on formulations applied in the vicinity of streams, and application rates and methods specified for site-specific projects.

The exposure scenario modeled in the Forest Service/SERA Risk Assessments probably significantly overestimates the risk of acute adverse effects resulting from triclopyr application, under the Proposed Action. Standard #16 of the Proposed Action states that triclopyr will only be used in spot applications, thus the risk assessment scenario of treating a plot of 10 acres at the maximum application rate of 10 lbs. a.e. per acre is likely to be in excess of actual use. However, the Garlon IV formulation of triclopyr contains either kerosene or diesel fuel, both of which are know to be toxic to fish, and could be a concern.

Alternative B. Under Alternative B, predicted concentrations for clopyralid for any of the aquatic groups tested were less than the estimated or measured NOEC. Herbicides that resulted in predicted concentrations greater than the estimated or measured NOEC at typical application rates to fish are glyphosate (with and without surfactant), triclopyr (TEA and BEE), and sethoxydim. Glyphosate with surfactant also exceeded the NOEC at the highest allowable application rate for aquatic invertebrates and algae. The same discussion related to these specific herbicides under the Proposed Action applies. The exposure scenario modeled in the Forest Service/SERA Risk Assessments are overestimated for acute adverse affects from triclopyr application. Adverse effects are unlikely because treating 10 acres at the maximum application rate of 10 lbs. a.e. per acre is likely to be in excess of actual use.

Alternative D. In addition to the results for all herbicides mentioned in the Proposed Action and Alternative B, predicted concentrations for dicambia for any of the aquatic groups were less than the estimated or measured NOEC. For aquatic plants and algae, 2,4-D ester and 2,4-D amine results in prediction concentrations greater than the estimated or measured NOEC at typical application rates.

No Action. No Action includes the use of five herbicides - glyphosate, triclopyr, dicamba, picloram and 2,4-D (a tool of last resort). Results of their continued use would be similar to what was identified for each herbicide under the above alternatives.

Effects to Critical Habitat

Under current Forest Service management direction (NWFP Aquatic Conservation Strategy (ACS) and Pacfish/Infish) and the standards proposed in the action alternatives, site-specific projects cannot have a negative impact, in the long term, on riparian-dependent resources or ecological processes at the watershed scale. Each site-specific project must maintain or restore the physical and biological processes required by riparian dependent resources at the watershed scale or broader to comply with ACS and Pacfish/Infish. Management direction prohibits activities in riparian areas that retard or prevent attainment of these objectives. These objectives address all of the physical and biological features that are essential to the conservation of bull trout (e.g. primary constituent elements) or anadromous fish (e.g. essential features).

The potential, site-specific effects from the implementation of invasive plant projects on critical habitat will be evaluated at the project level at the time specific actions are proposed.

Currently, the FWS and/or NOAAF Matrix of Pathways and Indicators are used in every 7(a)(2) consultation to assess the effects of a proposed action on habitat important to listed fish species. The habitat indicators in the Matrix of Pathways and Indicators are nearly identical to the physical and biological features addressed by the primary constituent elements (PCEs) and essential features of critical habitat.

Although, some PCEs and essential features are not directly identified in the "Matrices," the existing indicators indirectly address them. All of the PCEs or essential features have been and will continue to be indirectly or directly assessed using the "Matrices" or alternative analysis tools.

The implementation of mitigation Standards 18-22, in addition to project level mitigation measures will reduce adverse affects to listed species' habitats during herbicide and non-herbicide treatment methods to a very minimum, as discussed in the Aquatic Organism section, Chapter 4.7.2.

Water Quality Indicators. Changes in water temperature resulting from herbicide use to control invasive plants would be negligible to non-existent. Invasive plants provide little to no shade to streams, and the risk for adverse affects to native vegetation is low with backpack or hand operated sprayers. In those rare instances where solid patches of riparian vegetation is removed by herbicide treatment, short-term, increases in surface erosion may result. These impacts will likely not be significant and will diminish as vegetation re-establishes treated areas. No large-scale changes in vegetation cover or stand structure (e.g. timber to grass) will result from the herbicide treatment proposed in this EIS. Herbicide treatment of invasive plants is expected to result in a low risk of water contamination because of the new Forest Plan standards included under all of the action alternatives, and the additional site-specific mitigations developed at the project level. Mitigations developed at the project level will apply Standard #19, which provides direction for reducing or eliminating adverse affects: "…use site-specific soil characteristics, proximity to surface water and local water table depth to determine herbicide formulation, size of buffers needed, and application method and timing. Only those herbicides and herbicide mixtures registered for aquatic use will be considered when evaluating herbicide use near streams or surface water."

Habitat Access Indicators. The application of herbicides would not create physical barriers to aquatic PETS species.

Habitat Element Indicators. Herbicide use would not affect substrate, large woody debris, pool quality, off-channel habitat, and refugia. Large trees that provide shade and large wood would not be impacted by the use of herbicides as proposed under the alternatives.

Channel Condition Indicators. Ground based herbicide application would result in reduction of invasive plants within riparian areas and along stream banks. No adverse impacts to stream bank stability are expected. Reduction of invasive plants along stream banks and riparian areas will benefit native plant species and result in improved stream bank stability and riparian condition in the long-term.

Flow/Hydrology Indicators. Chemical treatment of invasive plants is expected to result in no measurable effect to peak/base flow or water yield of watersheds.

Watershed Condition Indicators. No new roads or watershed scale disturbances will result from the use of herbicides to treat invasive plants. Invasive and noxious plants are a threat to overall watershed ecological condition. Long-term beneficial effects from the reduction of invasive plants in riparian areas, wetlands, and streams and subsequent increases in desirable vegetation will result in improved watershed conditions.

Conclusion

Allowing the use of herbicides for invasive plant treatment and resulting site-specific projects may cause some short- and long-term adverse effects on aquatic PETS species even though the projects will eventually provide important long-term benefits. Most of these potential adverse effects will be eliminated or minimized through application of current management direction (e.g. ACS, Pacfish/Infish) and the new Forest Plan standards proposed in this EIS.

Effect determinations at the project level are expected to vary. Some projects conducted according to the standards proposed in this EIS are not likely to adversely affect aquatic PETS species and their habitat because they will avoid the addition of significant amounts of sediment into aquatic habitats, and minimize the introduction of herbicides into these same habitats. Toxic levels of herbicides are unlikely to enter streams or lakes (i.e., noxious weeds are removed by mechanical means or with herbicides applied with hand sprayers at a sufficient distance from the water body). For example, application of herbicides at the lowest application rate consistent with the intended purpose using spot application with a low-pressure backpack sprayer away from the water body is not likely to result in an adverse affect to aquatic PETS species.

Activities under all of the action alternatives include bank stabilization or shaping following the removal of invasive plants, or preparation of planting areas. These activities could have direct or indirect, negative short-term impacts to aquatic PETS species during critical life stages such as migration, breeding/spawning, and juvenile rearing. Effects may result in disturbance (i.e., physical, behavioral, or physiological stressors), displacement, or alteration of habitats. Such impacts include physical interaction with eggs, juveniles, adults, and short-term sedimentation during any near stream work associated with invasive plant treatment and removal.

Effects on aquatic PETS species from all invasive plant treatments would be evaluated more precisely at the project scale. Treatments would not be expected to remove or degrade suitable habitat for any listed aquatic species because (1) suitable habitat would not be considered a target for elimination, and (2) management direction in all alternatives require treatments to avoid or reduce effects to species.

In terms of effects to aquatic PETS species, there are no substantial differences between the alternatives. Herbicide exposure to aquatic PETS species is possible in all alternatives, 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 likely 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 4-48 summarizes the potential effects to each listed aquatic species. The determination for all listed fish is either “not likely to adversely affect” (NLAA) or “likely to adversely affect” (LAA) because some projects could be conducted in riparian areas adjacent to habitat for listed aquatic species, and the uncertainty that all adverse effects can be mitigated for all projects. At the project scale, potential effects will be more precisely analyzed and adverse effects will be avoided or minimized as required by Standards #19 and #20.

Table 4-48 Potential Effects to Proposed, Endangered, and Threatened Aquatic Species.

Species	ESA Status	ESA Determination
Snake River Sockeye Salmon	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
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
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	NLAA
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
Oregon Coast Coho	Proposed	NLJ
Southwest Washington/Lower Columbia Coho	Proposed	NLJ

NLJ = Not likely jeopardize the continued existence of

Cumulative Effects

Cumulative effects were discussed for aquatic organisms in Chapter 4.7.2. 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 National Forest System 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 and/or sources of sediment.

It is unlikely that herbicide exposure from invasive plant projects would add to or accumulate with past or future herbicide exposures on other projects because the herbicides considered in this EIS do not bioaccumulate. The alternatives considered do not include the use of any other types of pesticides, but the herbicide triclopyr and the insecticide chlorpyrifos share a common metabolite TCP, that is toxic to aquatic organisms[61]. Thus, the use of triclopyr could add to TCP exposure resulting from the use of chlorpyrifos. Another example of a potential cumulative effect is from hexachlorobenzene, a ubiquitous industrial pollutant, which is found in both picloram and clopyralid. While the amounts of hexachlorobenzene added to the environment from Forest Service use of picloram and clopyralid do not represent a substantial addition in comparison to existing background levels (SERA, 2003-picloram; 2003-clopyralid), it could be considered a cumulative effect.

Herbicide use for invasive plant treatment, within the project area, is insignificant in comparison to total herbicide use on other ownerships and for other purposes (NCFAP, 1998) (Chapter 4.1.1).

If effects to aquatic PETS species do occur, they will most likely be sub-lethal rather than direct mortality from herbicide exposure, with the exception of an accidental spill. Sub-lethal effects include changes in behavior that render ESA species susceptible to predation, compromised immune system, and effects to organs. The ultimate consequence of many "sub-lethal" effects to juveniles may not manifest until later in the life cycle (smoltification, ocean survival, reproductive success, etc).

Most of the potential sublethal effects to aquatic PETS species from the herbicides and adjuvants proposed for use have not been investigated in regards to toxicological endpoints that are generally considered important to the overall health and fitness of aquatic PETS species. These toxicological endpoints are defined as:

- Direct and indirect mortality at any life history stage
- Increase or decrease in growth
- Changes in reproductive behavior
- Reduction in number of eggs produced, eggs fertilized, or eggs hatched

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61 The combined risk from chlorpyrifos and triclopyr sources of TCP was considered quantitatively for fish in the triclopyr risk assessment (SERA, 2003-tricloypr). Combined application of chlorpyrifos and triclopyr did not result in concentrations of TCP that were toxic to fish (SERA, 2003-triclopyr).

- Developmental abnormalities, including behavioral deficits or physical deformities
- Reduced ability to osmoregulate or adapt to salinity gradients
- Reduced ability to tolerate shift in other environmental variables
- Increased susceptibility to disease and/or predation
- Changes in migratory behavior

To address uncertainties relating to sublethal effects, project-level planning documents should incorporate additional mitigation or conservation measures.

Implementation of any of the alternatives may produce actions that will either have no effect or some adverse affect on ESA listed aquatic species. However, the ultimate effect of implementing any of the alternatives is likely to be a benefit to aquatic species by restoring native vegetation and thereby restoring riparian vegetative structure and ecosystem function. Consequently, most potential adverse effects are expected to be short-term and serve to improve the long-term viability of listed species.

Forest Service Sensitive Aquatic and Commercially Important Fish Species

Direct, Indirect and Cumulative Effects

Effects on sensitive and commercially important fish species are similar to those discussed under Aquatic Organism (Chapter 4.7.2) and Federally-listed Aquatic Species (Chapter 4.7.3). Table 4-49 summarizes the potential effects to each sensitive species.

Table 4-49 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
Sockeye Salmon - Lake Pleasant	MINL
Sockeye Salmon - Quinalt Lake	MINL
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

Table 4-49 Potential Effects to Sensitive Fish Species

Sensitive Species	Determination
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.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a Federal fisheries management plan.

The objective of this EFH assessment is to determine whether or not any of the action alternatives "may adversely affect" designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area.

Identification of EFH. Pursuant to the MSA the Pacific Fisheries Management Council (PFMC) has designated EFH for federally managed fisheries within the waters of Washington, Oregon, and California. Designated EFH for groundfish and coastal pelagic species encompasses all waters from the mean high water line, and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon and California, seaward to the boundary of the U.S. exclusive economic zone (370.4 km)(PFMC, 1998, 1998a). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable artificial barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years)(PFMC, 1999). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception to the Canadian border (PFMC, 1999).

Detailed descriptions and identifications of EFH are contained in the fishery management plans for groundfish (PFMC, 1998), coastal pelagic species (PFMC, 1998a), and Pacific salmon (PFMC, 1999).

Effects

As described in detail in the Fisheries BA and the Aquatic Organism section (Chapter 4.7.2), activities under all of the alternatives may result in short-term adverse effects to a variety of habitat parameters. The assessment of potential adverse effects from elements of the alternatives on EFH is based on information in Section 5.0 of the Fisheries BA. Essential fish habitat could be impacted in the same manner as critical habitat.

Most of these potential short-term adverse effects will be avoided through the incorporation of Standards #18 through #22. Potential effects on habitat include:

- Temporary loss of riparian function in areas under heavy mechanical treatment.
- Short-term increases in turbidity pursuant to manual and mechanical treatment activities.
- Potential introduction of herbicides into water bodies through atmospheric deposition, spray drift, surface water runoff, percolation, groundwater contamination, and direct application.

Conclusion

All alternatives are expected to adversely affect EFH for Pacific salmon species listed in Table 4-50. These adverse effects, however, will be short-term in nature and avoided or minimized to the extent possible through application of Standards #18 through #22 and additional mitigations at the project scale. The long-term effects of any of the alternatives will be to improve essential fish habitat throughout Region Six.

Table 4-50 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
Southwest Washington/Lower Columbia Coho	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

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, 2001).

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 System 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. 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 reserved or Executive Order 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

Table 4-51 below summarizes the unavoidable potential adverse effects to environmental and human health associated with the invasive plant management alternatives considered in this EIS. Significant environmental impact would not be expected under reasonably foreseeable circumstances, as the standards applied to projects under all alternatives are expected to be effective. However, some potential effects are not, or cannot be fully mitigated. An accidental herbicide spill, for instance, may kill non-target species even though a spill plan is in place.

All reasonable mitigation measures appropriate to this regional scale were considered in the development of the standards. Additional mitigation at this scale would unreasonably hamper land manager's ability to treat invasive plants and meet desired conditions, goals and objectives.

Table 4-48 focuses on adverse effects, the numerous beneficial effects of the alternatives (such as reduced spread of invasive plants) are not evaluated here.

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Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
Herbicide Effects on Non-target Species and Fungi (Chapter 4.3)	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. Alternative D has the highest potential to harm non-target plants and native plant communities. Under both No Action and Alternative D, native plant families affected by these herbicides could be harmed, decreasing their dominance. Healthy native plant communities would continue to decrease in acreage, especially in highly susceptible plant communities where difficult-to-treat species, including sites with culturally important plants. Adverse effects would most likely be localized and short term, although an accidental spill could result in more intense effects (greater number or extent of non-target plants and fungi affected).	At the project scale, under all action alternatives, choices can be made to avoid situations that could potentially cause adverse effects to non-target plant species. Short-term adverse effects would largely be offset by the long-term benefits of treatment. Projects that follow integrated weed management principles and adhere to the standards in the Proposed Action and Alternative B would largely avoid adverse effects to non-target plants and fungi.
Herbicide effects on pollinators (Chapter 4.3.3)	Plants that are dependent on a particular insect for pollination may experience a decrease in reproductive capabilities if their pollinator is impacted by herbicides. All alternatives allow herbicide use that at maximum label rates could harm honeybees. The active ingredients used in the Proposed Action and Alternative B are not expected to have toxic effects when directly sprayed on honeybees at the typical Forest Service application rate. 2-4,D, which is approved in No Action and Alternative D could affect pollinators at the typical Forest Service application rate. Adverse effects would most likely be localized and short term, although an accidental spill could result in more intense effects (more honeybees killed).	Follow standards that are part of the selected alternative. Develop mitigation at the project scale to reduce effect of herbicides, especially 2,4-D. 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 may be used. At the project scale, under all action alternatives, choices can be made to avoid situations that could potentially cause adverse effects pollinators.

Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
Herbicide Effects on wildlife and Amphibians (Chapter 4.4)	Birds or mammals that eat grass or insects are most susceptible to harm (death, illness or other adverse effect to individual animals) from herbicides. Alternative D poses the highest potential risk to wildlife from herbicides. In contrast, Alternative B poses the lowest potential risk to wildlife from herbicides. The management direction included in all alternatives (including No Action), as well as environmental conditions and animal behavior, would tend to minimize the magnitude of actual impacts. The Proposed Action represents a 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, the estimated herbicide use under the Proposed Action represents a negligible risk to wildlife on a regional scale. Adverse effects would most likely be localized and short term, although an accidental spill could result in more animals affected over a larger area.	Follow standards that are part of the selected alternative. Develop mitigation at the project scale. 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. 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.
Herbicide Effects on Human Health (Chapter 4.5)	Invasive plant treatments may result in risks to human health, including contamination of drinking water. 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. 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. One herbicide exposure scenario exceeds the "reference dose" for drinking stream water contaminated by runoff/leaching from an adjacent treated area for any herbicide.	Decision-makers would determine when to implement mitigation measures on specific treatment projects. A public notification plan would be required in all action alternatives. 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. Occupational Health and Safety Administration (OSHA) standards, along with agency, industry and manufacturers' recommendations reduce the potential exposure and risk of injury to workers. No mitigation measures are known to fully eliminate risks. No additional mitigation measures are known to eliminate risk to human health associated with

Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
	Alternative B is considered the alternative with the overall least risk of herbicide-related health effects to workers and to the public. 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. 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. Adverse effects to people would most likely be localized and short term, although an accidental spill could result in greater harm, especially to workers.	herbicide use, with the exception of no herbicide use at all. At the project scale, choices can be made to avoid chemical exposures that could harm human health.
Effects of Manual Labor on Workers (Chapter 4.5)	Worker injuries associated with invasive plant treatments 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. Risk to workers is directly correlated with acres of manual treatment; which range from 8,600 acres per year in Alternative D to over 44, 000 acres per year under Alternative B.	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. No mitigation measures are known to fully eliminate risks. The risk to workers is inherent to forestry work. Workers on Forest Service projects are subject to OSHA standards.
Relative Costs (Chapter 4.6.2)	Alternative B has the potential adverse effect of increasing average cost of treatments and reducing the acreage that could be treated in a given year.	Cost-effectiveness would be considered at the project scale so that treatments under all alternatives are done as efficiently as possible.
Effect of Prevention Standard 1 on land users and uses (Chapter (4.6.3)	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 in all action alternatives, especially Alternative B. Uses and outputs would tend to decline, but the extent is considered very limited and not measurable.	For all alternatives, flexibility in timing, location, or intensity of land use could be adjusted to minimize adverse effects to programs and uses. No further mitigation needed.

Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
Effect of Prevention Standard 2 on land users and uses (Chapter 4.6.3)	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. 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.	No reasonable way to eliminate this cost of doing business. If Alternative B is selected, mobile washing stations would be required to make the standard feasible. No further mitigation needed.
Effect of Prevention Standard 4 on land users and uses (Chapter (4.6.3)	Weed free feed requirements can 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, potentially resulting in additional purchase, travel and transportation costs to the user. The Proposed Action requires weed free feed on about 2.1 million additional acres when compared to 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.	Enforcement of weed free feed requirements standard would be phased in as appropriate certification processes and weed free feeds become reasonably available. No further mitigation needed.
Effect of Prevention Standard 5 on land users and uses (Chapter (4.6.3)	Applies solely to Alternative B. 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.	At the project scale, mitigation measures may be developed that reduce conflicts between this standard and other vegetation management goals and objectives. No further mitigation needed.
Effect of Prevention Standard 6 on land users and uses (Chapter (4.6.3)	Some limitations on livestock grazing, including changes in grazing locations, timing, intensity, and outputs may occur. The extent of the effect is determined by multiple factors that could not be predicted at the regional scale. Changes in livestock movement patterns that require additional labor or may reduce outputs for certain allotments. Alterations to season of use (length, turn-on, turn-off, etc.) and intensity of use that could reduce outputs. 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.	At the project scale, mitigation measures may be developed that reduce conflicts between this standard and livestock objectives. No further mitigation needed.
Effect of Prevention	All alternatives increase costs of rock source development. Under Alternative B, this cost is highest due to the requirement to inspect source sites annually.	No reasonable way to eliminate this cost of doing business. No further mitigation needed.

Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
Standard 7 on land users and uses (Chapter 4.6.3)		
Effect of Prevention Standard 8 on land users and uses (Chapter 4.6.3)	The additional work estimated to result from this standard in all alternatives is nearly a one percent increase in road maintenance costs.	No reasonable way to eliminate this cost of doing business. No further mitigation needed.
Effect of Prevention Standard 9 and 10 on land users and uses (Chapter 4.6.3)	Implementation of this standard would likely result 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 at the regional scale.	Road closures would be considered in access and travel management projects across the region. Effects on land users would be minimized to the extent possible. At the project scale, choices can be made to minimize effects on access to areas for people with disabilities, dispersed recreation opportunities, fire suppression access, and costs of land use and management.
Herbicide Effects on Soil Productivity (Chapter (4.7.1)	Picloram, applied at typical rates, may affect microbial metabolism, though detectable effects to soil productivity are not expected. Other herbicides have been shown to affect soil microorganisms for a few days.	Applied thoughtfully, herbicides can provide these benefits while minimizing effects to soil organisms. 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).

Table 4-51 Adverse Effects that Cannot be Avoided

Adverse Effect	Magnitude of Effect without Additional Mitigation	Forest Service Intended Response and Rationale
Herbicide Effects on Aquatic Organisms (Chapter 4.7.2)	Herbicides have direct effects on algae and aquatic vascular plants (Anton, et al. 1994; Roshon, et al. 1999). Since these form a food supply, habitat, or both for aquatic organisms, this toxicity may be problematic. Glyphosate does degrade relatively quickly and for acute exposures, at the highest allowable 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). Whereas, glyphosate was the only herbicide that could potentially exceed the NOEC for fish at the highest allowable application rate. None of the herbicides exceeded the NOEC for aquatic invertebrates tested. Sub-lethal herbicide effects that have been recorded include reductions in reproductive success, weight loss, physiological effects, as well as reductions in growth, prey capture ability and swimming ability (NOAA, 2002). Herbicides may be toxic to aquatic plants and invertebrates, thus indirectly affecting fish by reducing primary production or the trophic structure of invertebrate communities.	Timing of application can result in different effects. For example, a springtime application of Glyphosate, at recommended rates, in a lentic ecosystem, where dissolved oxygen levels are low or water temperatures are elevated, could be hazardous to young of the year fish (Folmar et al. 1979). Applied thoughtfully, herbicides can provide these benefits while minimizing effects to aquatic organisms. The herbicides considered in this EIS are eliminated rapidly from the bodies of aquatic animals and do not bio-accumulate up the food chain.
Effects to Special Status Species (Chapter 4.7.3)	All alternatives are associated with "likely to adversely affect" findings for some species listed under the Endangered Species Act. Sensitive species are similarly potentially affected.	Biological evaluations and consultation would occur at the project scale and effects to special status species minimized as per standards in all action alternatives. No further mitigation needed at the regional scale. At the project scale, benefits to special status species expected to far outweigh potential for adverse effects.
Effects on Tribes and Treaty Rights (Chapter 4.7.4)	American Indians and Hispanics are groups that may be disproportionately affected by the standards proposed in the action alternatives. No significant, discernible differences between alternatives relative to environmental justice were found at the Regional scale. None of the alternatives, including No Action, would change, restrict or abrogate treaty reserved or Executive Order rights. However, implementation of the standards may affect natural resources on which the tribes depend.	Continue working with groups so that effects are understood and can be minimized at the project scale. Worker health and safety would be protected by adherence to OSHA and Forest Plan standards. Ongoing consultation with tribes and others during all phases of project planning and implementation effectively resolves these issues.

4.8.2 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 the proposed invasive plant management direction on land management and use activities.

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.