Chapter 4

Environmental Effects

Chapter 4

4 ENVIRONMENTAL EFFECTS

4.1 INTRODUCTION

This chapter provides an analysis of the direct and indirect environmental effects associated with the alternatives. Table S-1 at the end of the Executive Summary provides a summary of effects presented in this chapter. Cumulative effects are presented in Chapter 5. The analysis in this chapter is presented relative to the affected environment descriptions given in Chapter 3. Therefore, each main subsection in Chapter 3 has a corresponding effects subsection in Chapter 4 presented in the same sequence.

Please note, figures and tables in Chapter 4 are numbered differently than they are in all other chapters. Chapter 4 tables and figures are labeled according to the subsection they appear within. For example, Figure 4.1-1 would be the first figure located in subsection 4.1. This numbering system was necessary because of the length of Chapter 4.

The specific subsection sequence is as follows:

- Land Ownership and Use (subsection 4.2)
- Air Quality (subsection 4.3)
- Geology, Soils, and Erosional Processes (subsection 4.4)
- Water Resources (subsection 4.5)
- Vegetation (subsection 4.6)
- Riparian and Wetland Processes (subsection 4.7)
- Fish and Fish Habitat (subsection 4.8)
- Amphibian and Amphibian Habitat (subsection 4.9)

- Birds, Mammals, Other Wildlife, and Their Habitats (subsection 4.10)
- Recreation (subsection 4.11)
- Visual Resources (subsection 4.12)
- Cultural and Indian Trust Resources (subsection 4.13)
- Social and Economic Environment (subsection 4.14)

4.1.1 Analysis Area

The analysis area that defines the affected environment includes the majority of the State of Washington (subsection 3.1, Affected Environment – Introduction; Appendix A, Regional Summaries). The proposed action and the alternatives would directly affect the forested lands that are covered under the Washington Forest Practices Rules. These lands include the non-Federal and non-tribal forestlands of the State (Figure 3-1). These lands are referred to as the "covered lands" or the lands subject to Washington Forest Practices Rules in this Final Environmental Impact Statement (FEIS).

In addition to displaying the covered lands, Figure 3-1 displays the 12 analysis regions (Appendix A, Regional Summaries). These analysis regions are used as the basis for describing some of the regional aspects of the environmental effects in this chapter and Chapter 5 (Cumulative Effects).

4.1.2 Review of the Alternatives

This subsection is included to provide the reader with a short review of the alternatives, immediately prior to reading the effects analyses. This page can be marked, and the short descriptions can be referred to while reading Chapters 4 and 5. However, the reader should refer to Chapter 2, subsection 2.3 (Alternatives Analyzed in Detail) for detailed descriptions.

This EIS analyzes a No-Action Alternative and three action alternatives (Chapter 2, Alternatives). The action alternatives are identified as Alternatives 2, 3, and 4, and the No-Action Alternative is identified as No Action Alternative 1, which has two scenarios. A summary description of each of these No-Action scenarios, along with a summary description of each action alternative is provided below to assist the reader.

4.1.2.1 No-Action Alternative (No Action Alternative 1)

Under this alternative, no Incidental Take Permits (ITPs) or take authorization under any Endangered Species Act (ESA) Section 4(d) rules would be issued. This lack of action would affect the Forest Practices Regulatory Program in a way that is difficult to predict, and a range of outcomes could result. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (Chapter 2, Alternatives) to represent the No-Action Alternative (No Action Alternative 1). Endpoints for this range of outcomes are defined in Chapter 2 and referred to as No Action Alternative 1-Scenario 1 and No Action Alternative 1-Scenario 2. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of

No Action on the individual resources are likely to fall somewhere in-between these two scenarios.

No Action Alternative 1-Scenario 1

Under No Action Alternative 1-Scenario 1, no incidental take would be authorized, and the current rules (which are based on the Forests and Fish Report [FFR] and became effective in July 2001) would remain in effect until altered through the adaptive management program. However, the amount of collaboration and participation among Forests and Fish stakeholders in adaptive management, associated monitoring, and other program elements that depend partly on landowner support and voluntary participation, would be reduced from the status quo. As a result, there would be less public funding for these non-regulatory elements, and the ability to modify the rules over time, based on scientific research, would also be reduced.

No Action Alternative 1-Senario 2

Again, under No Action Alternative 1-Scenario 2, no ITP would be authorized, and the current rules (which are based on the FFR and became effective in July 2001) would remain in effect, initially. However, the Washington State Legislature would likely direct the Washington Forest Practices Board to repeal the current State rules and re-adopt the less-restrictive rules that were in effect on January 1, 1999. If this were to occur, there would be less stakeholder participation and support of adaptive management, associated monitoring, and other program elements that depend partly on landowner support and voluntary participation as well as substantial reductions in public funding.

4.1.2.2 Alternative 2

Under Alternative 2, the Services would issue ITPs to the State of Washington, based on implementation of the proposed statewide Forest Practices Habitat Conservation Plan (FPHCP). This FPHCP incorporates the current Washington Forest Practices Rules (which are based on the FFR and became effective in July 2001). The ITPs would be valid for a term of 50 years. Because of greater regulatory certainty, stakeholder support and participation, public funding for adaptive management, associated monitoring, and other program elements that depend on landowner support and voluntary participation would be expected to continue at present levels, maintaining high effectiveness.

4.1.2.3 Alternative 3

Under Alternative 3, the Services would not issue ITPs, but NMFS would issue findings under its existing ESA Section 4(d) rule that would limit the application of the prohibition against take so that it did not apply to forest practice activities in Washington. USFWS would adopt a new Section 4(d) rule for bull trout (the USFWS has not, as of yet, initiated any such rule-making, which is subject to public comment). As a result, the take of species, currently listed as threatened (except for the Snake River races - See subsection 2.3.3.1, Alternative 3, General Description), would be authorized based on continued implementation of the current Washington Forest Practices Rules (which are based on the FFR and became effective in July 2001). Take authorization under this alternative would not apply to endangered species or to species that could be listed as threatened in the future. It would not have specific term duration and could be terminated. This alternative would provide landowners with more certainty than under No Action Alternative 1 (but with less certainty than under Alternative 2). Therefore, the level of stakeholder support and participation and public funding for adaptive management, associated monitoring, and other program elements requiring such support would likely be higher than under No Action Alternative 1 (either scenario) (but lower than under Alternative 2).

4.1.2.4 Alternative 4

Under Alternative 4, the Services would issue ITPs to the State of Washington, based on implementation of a statewide Forest Practices HCP. This HCP would incorporate a set of Washington Forest Practices Rules that are more protective of aquatic resources but more restrictive to landowners than the current rules (which are based on the FFR and became effective in July 2001). The ITPs would be valid for a term of 50 years. Alternative 4 would require action by the State Legislature or a court order to initiate additional rule-making by the Washington Forest Practices Board to increase protective measures in the rules. Because landowners would consider that the rules under Alternative 4 are over-protective, there would likely be substantially less stakeholder support and participation and public funding for adaptive management, associated monitoring, and other program elements. Under this Alternative, however, the adaptive management program would be under the direction of the Washington Forest Practices Board and would be less dependent on landowner support, voluntary participation, and public funding to produce outcomes. Based upon the assumption that Alternative 4 provides more conservative rules, there likely would be less emphasis on the need for adaptive management under this alternative. The reader should note that much of the discussion about Alternative 4, in Chapter 4, focuses on the benefits to aquatic resources resulting from more protective Forest Practices Rules under this alternative. However, the potential for landowners to convert their forestlands to other uses, due to the economic impacts of more protective rules, may reduce the beneficial effects to aquatic resources.

4.1.2.5 Alternative Groupings

In the detailed effects analysis of biological and physical processes as well as social and economic issues, distinctions among the alternatives emerge primarily because of two factors: First is the regulatory program associated with an alternative. Second is the effectiveness over time of the adaptive management program to improve regulations under each alternative. While other attributes also create distinctions among the alternatives, they are often divided into three groupings for ease of comparison in the following analysis. No Action Alternative 1-Scenario 2 is generally analyzed separately because it would result in the January 1, 1999 Washington Forest Practices Rules being implemented. Alternative 4 is also analyzed independently because it would result in a distinct set of more-restrictive rules.

In contrast, No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 each initially continue current Washington Forest Practices Rules. The distinction in these alternatives lies, therefore, not in the initial regulations, but in the differing effect upon those initial regulations that would occur over time as a result of the adaptive management program. Predicting precisely this effect over time – Which biological processes will be affected and to what degree? Which regulatory prescriptions will be improved and to what degree? What will be the pace of regulatory improvement? – is impossible. Much will depend on the results of research and monitoring projects within the program itself. Nevertheless, it is possible to predict the general effectiveness of the adaptive management program under each alternative based on the amount of participation and support it receives from stakeholders, as well as likely State and Federal funding.

To facilitate the analysis of the alternatives, this chapter will first describe the expected effectiveness of the adaptive management program under each alternative and use three examples to illustrate how different resource effects might emerge over time. Following the discussion of the adaptive management program, the chapter will analyze the initial regulatory program associated with the three groupings of alternatives. The reader then can estimate how the adaptive management program would affect resources under each alternative over time.

4.1.3 Available Information

Less than complete knowledge exists about many of the resource conditions and their relationships with watershed input processes and forest practices. Physical and ecological relationships associated with riparian management in forested landscapes represent a complex and evolving science. In developing the environmental effects sections of this EIS, the analysis team examined the available data and knowledge about relationships used to estimate the effects of the alternatives. The data and level of analysis used were commensurate with the importance of possible effects. Much of the analysis was based on the geographic information system (GIS) databases of Washington DNR and other agencies, using the most current databases available.

When encountering an information gap, the analysis team generally either collected the information or developed the information through modeling. In some cases, however, the effort required to obtain the information was prohibitively expensive or required too long a period of time, relative to the value of the information to be obtained. In these cases, the team concluded that the missing information would have added precision to estimates or better specified a relationship; however, they concluded that the basic data and central relationships were sufficiently well established in the respective sciences that the new information would be very unlikely to change conclusions. Thus, the new information would have added precision, but was not considered necessary to provide adequate information for the decision-makers to make a reasoned choice among the alternatives.

4.1.4 Evaluation Criteria and Effects Evaluations

Evaluation criteria for resource effects are defined for each of the resource topic areas within their individual subsections in this chapter. The criteria are briefly described immediately before the detailed discussion of environmental effects for each resource topic.

The scientists who conducted the analysis for this EIS based the effects analysis on best professional judgment after weighing all of the quantitative and qualitative evaluation criteria that were developed, as well as their review of the scientific literature. They also considered the fact that each alternative incorporates a level of effectiveness for the associated adaptive management program, allowing for change in the rules over time based on feedback from research and monitoring activities. The efficiency and time-lag involved for each adaptive management program was also evaluated.

Finally, the issue of uncertainty was considered. Because lack of information sometimes existed to make definitive statements regarding effects, some uncertainty is associated with each effects analysis. In a few cases, the amount of uncertainty associated with the analysis is quite high; in these cases, the high uncertainty is noted along with a description of the expected effects. Further, in a few cases the amount of uncertainty will likely change over time; this type of uncertainty is also noted and the potential effects described.

As described in Chapter 2, the FPHCP and associated ITP have a proposed permit duration of 50 years. Consequently, the effects analysis in the EIS generally considers "long term" to mean approximately a 50-year period, but in some circumstances could be longer. Given the definition of "long-term," a "short-term" period is considered to be less than 10 years.

4.1.5 Adaptive Management

Adaptive management is often used in habitat conservation planning as a means of addressing scientific uncertainty regarding the biological requirements of covered species and/or the cause-and-effect relationships between proposed management actions and those species. The primary benefit of incorporating adaptive management in conservation plans is to provide a mechanism for changing management prescriptions necessary to meet the goals, objectives, and targets of the plan and to ensure the adequate protection of covered species. The alternatives presented in Chapter 2 of this FEIS describe differing levels of collaboration and support for the adaptive management program developed within the FFR and, in the case of Alternative 4, describe a non-FFR adaptive management program that operates without the requirement of collaboration embodied in the Timber, Fish, and Wildlife (TFW) Agreement and the FFR. As described in Chapter 2, differing levels of collaboration and support for the adaptive management program would have implications on its effectiveness in the protection of covered species and their habitats for the other alternatives (Table 4.1-1).

Collaboration and support for adaptive management manifests itself in a wide variety of ways, all of which have implications for its effectiveness. Collaborating interests establish and pursue joint priorities through the adaptive management program. Landowners identify and contribute forest sites for both short term and long term research. Access to private lands is provided to monitoring crews. Scientific expertise is

Table 4.1-1. Differences Between the Alternatives in the Effectiveness of Their Adaptive Management Research and Monitoring Programs in Meeting Resource Performance Targets and Differences in Species Coverage by Federal Assurances (ITPs or ESA Section 4(d) Take Authorization).

DEIS Alternative	Initial Forest Practices Prescriptions	Effectiveness of Adaptive Management Research and Monitoring Program in Meeting Resource Performance Targets	Species Coverage by Federal Assurances
No Action Alt. 1-Scenario 2	Rules in Effect on January 1, 1999	Lowest	None
No Action Alt. 1-Scenario 1	Current Washington Forest Practices Rules	Low	None
Alternative 2	Current Washington Forest Practices Rules	High	Aquatic Species (ITPs)
Alternative 3	Current Washington Forest Practices Rules	Moderate	Threatened Species Covered by ESA Section 4(d)
Alternative 4	More Protective Forest Practices Rules	Non-FFR (low)	Aquatic Species (ITPs)

contributed without reimbursement. Peer review among State, private, Federal, and tribal biologists increases and maintains the credibility and integrity of ongoing research and new study designs. The coalition of collaborators effectively advocates for State, Federal, and private funding of research and monitoring activities. Funding, in turn, improves the amount, pace, and rigor of scientific investigations conducted under the adaptive management program. Finally, maintenance of the collaboration ensures timely consideration of its recommendations by the Washington Forest Practices Board.

A policy on adaptive management consistent with FFR has been adopted in regulation by the Washington Forest Practices Board to further the purposes of the Forest Practices Act (Washington Administrative Code [WAC] 222-12-045). It is designed to rely on the collaboration and support embedded in FFR to modify the regulations and their application by ensuring that any modification be based on cooperative research, monitoring and evaluation (Chapter 2, Alternatives). Because of this reliance, varying degrees of effectiveness in the adaptive management program will result in differing rates of improvement in the Washington Forest Practices Rules over time. In addition, each alternative has a different level of uncertainty associated with its degree of effectiveness at protecting covered species and their habitats. Therefore, adaptive management may be a more important component for an alternative with more uncertainty versus an alternative with less uncertainty. For example, some of the prescriptions in No Action Alternative 1-Scenario 2 have high levels of uncertainty. Thus, a robust and comprehensive adaptive management program would be critical to ensuring prescriptions are improved through research and monitoring.

The regulatory prescriptions under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 are more restrictive than No Action Alternative 1-Scenario 2, and have less uncertainly associated with their effectiveness. Still, some uncertainty exists. Thus, adaptive management is important, although probably less so than with No Action Alternative 1-Scenario 2. Although the initial regulatory program under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 are the same (i.e., the existing FFR-derived rules), the differences in the effectiveness of the adaptive management program, and the resulting effects over time on improvements in the rules by the Washington Forest Practices Board, distinguish these alternatives from each other (Figure 4.1-1).

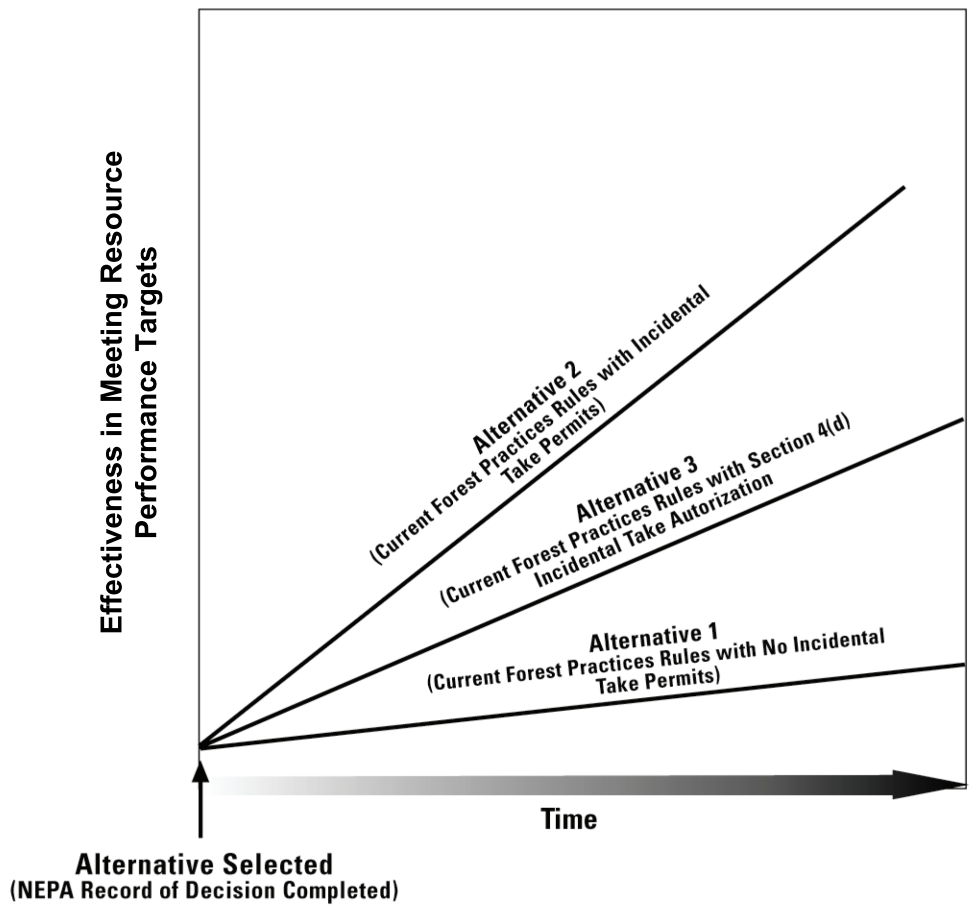
Alternative 4 has the most restrictive protection measures and therefore the least uncertainty associated with its effectiveness. Because the regulatory program under Alternative 4 presents fewer scientific uncertainties at the outset, there would be reduced resource uncertainties for the adaptive management program under Alternative 4 to address initially. However, uncertainty may increase over time as a consequence of actions likely to result from the more restrictive Alternative 4 (e.g., extensive, no-harvest buffers). Likely outcomes would include: 1) an increase in the rate of forestland conversion, particularly in areas around Puget Sound, 2) an increased incidence of forest health problems such as insect and disease outbreaks, and 3) an increase in the likelihood of wildfire. The adaptive management program under Alternative 4 would be solely dependent upon State funding and directed by the Washington Forest Practices Board with no collaborative, consensus-based policy committee to serve in an advisory capacity.

This subsection outlines the differences in the adaptive management processes among alternatives. Because those differences are largely qualitative, it is not possible to accurately predict how or when those differences would manifest themselves in future specific changes to rules or future effects on resource values. However, examples can illustrate how the differences in the adaptive management program would lead to differing effects among these alternatives over time.

4.1.5.1 Evaluation Criteria

The evaluation of adaptive management is based on its effectiveness as a result of the degree of program support likely provided under each alternative. Support is measured qualitatively in terms of expected participation and collaboration by stakeholders and expected future funding (See discussion above). The evaluation also uses examples from the current adaptive management program research and monitoring topics to describe the implications of varying levels of program support in terms of habitat effects. That is, given different levels of program support, how might habitat conditions for fish and target amphibians be affected? The examples have been taken from Schedule L-1 of the FFR (FPHCP Appendix B). Schedule L-1 lists research and monitoring priorities that are designed to address the greatest scientific uncertainties surrounding the recommended FFR protection measures (which are now included in the Washington Forest Practices Rules). Schedule L-1 serves as the basis for research and monitoring project development. The results of research and monitoring efforts will allow policymakers to determine if it is necessary to modify Washington Forest Practices Rules to achieve established performance goals, resource objectives, and performance targets (for a complete description of adaptive management program performance goals, resource objectives, and performance targets, see Chapter 2, Alternatives, of this document).

Figure 4.1-1. Comparison of the Effectiveness of Adaptive Management Research and Monitoring Program in Meeting Resource Performance Targets for No Action Alternative1-Scenario 1, Alternative 2, and Alternative 3.



The evaluation of the adaptive management program considers, in the discussion below, three research and monitoring topics from Schedule L-1 to illustrate differences among Alternatives 1, 2, and 3. The three environmental topics considered include temperature, large woody debris (LWD), and sediment. The topics selected represent current high priorities within the Cooperative Monitoring, Evaluation, and Research (CMER) Committee's effectiveness and validation monitoring program. This program includes projects designed to test the effectiveness of management prescriptions in meeting established performance goals, resource objectives, and performance targets as well as projects designed to validate existing performance targets.

In addition to the effectiveness and validation monitoring issues referenced above, the evaluation also considers the effects of the alternatives on three other Adaptive Management research and monitoring programs: extensive monitoring, intensive monitoring, and rule implementation tool development. These three programs are designed to track the status and trends of key environmental elements (extensive monitoring), to evaluate the effectiveness of management prescriptions in preventing cumulative watershed effects (intensive monitoring), and to develop technology-based tools that facilitate implementation of the Washington Forest Practices Rules and the Forest Practices Regulatory Program in general (rule implementation tool development).

The following paragraphs describe the level of adaptive management program support likely provided under each alternative and the expected effects on habitat conditions.

4.1.5.2 Evaluation of Alternatives

<u>Overview of Effects</u>

No Action Alternative 1-Scenario 1

Under No Action Alternative 1-Scenario 1, the adaptive management program would follow its current format and structure (WAC 222-12-045; subsection 2.3.2.2, Washington Forest Practices Rules and Program – Specific Description). However, the effectiveness of the program would likely be low (although slightly higher than under No Action Alternative 1-Scenario 2) as a result of not receiving the anticipated regulatory certainty provided by ESA take authorization. This reduction would be in the form of decreased participation by stakeholders from status quo, particularly commercial timber landowners to whom the regulatory certainty is a priority, and a resulting reduction in contributed resources and funding for implementation. Funding levels affect the amount, pace, and rigor of adaptive management research projects.

Currently, CMER has high priority research and monitoring projects identified, and work is underway in several areas (FPHCP Appendix H). Under No Action Alternative 1-Scenario 1, funding at levels below projections would cause a re-prioritization of research and monitoring. Projects would probably be delayed or not conducted as a result of less participation and less funding. A reasonable assumption is that only the highest priority effectiveness and validation projects and/or rule implementation tool projects would proceed, and the timeline for completion would be extended. Also, it is likely that little if any extensive and intensive monitoring would be conducted under this alternative.

Relative to No Action Alternative 1-Scenario 2, the adaptive management program under No Action Alternative 1-Scenario 1 is expected to have a slightly higher level of effectiveness because of a moderate amount of stakeholder participation and support (i.e., by those *not* relying on Federal assurances to provide regulatory certainty). Commercial timber landowners are not assumed to be a part of the collaboration under No Action Alternative 1-Scenario 1 because of the lack of the anticipated regulatory certainty provided by Federal assurances. Landowner contributions of technical expertise, forest sites for research, access, and support for funding could not be assumed.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the adaptive management program would be required to follow the format that was in the rules in effect on January 1, 1999. Regulations at that time required DNR to report to the Washington Forest Practices Board on opportunities to modify the regulations when baseline data, monitoring, evaluation or the use of interdisciplinary teams showed that such adaptive management would better meet the purposes and policies of the Forest Practices Act.

Although the same stakeholders that had embarked upon the FFR effort by 1999 would be involved under No Action Alternative 1-Scenario 2, the level of collaboration and support under this scenario is expected to be less than that found under No Action Alternative 1-Scenario 1. This scenario assumes that: 1) federal assurances are not provided, and 2) that the regulations “roll back” to those in effect on January 1, 1999. As a result, neither landowners nor public resource advocates would have gained benefits anticipated through FFR. Even though still required by the rules, support for the adaptive management program would be limited by the collaborators. Advocacy for public funding of collaborative adaptive management would be minimal. In addition, the pre-1999 adaptive management program included much less specific statutory and regulatory direction about the purpose of the program. It is reasonable to assume that the program would suffer from that lack of direction, and agreement would be more difficult to reach on how to spend very limited resources, compared with current conditions.

Alternative 2

Under Alternative 2, the adaptive management program would continue to follow its current format and structure (WAC 222-12-045; subsection 2.3.2.2, Washington Forest Practices Rules and Program – Specific Description). Receiving ESA take authorization through Section 10 of the ESA would provide the full extent of the regulatory certainty anticipated by FFR collaborators. As a result, Alternative 2 anticipates robust participation and support for the adaptive management program by collaborators, thereby achieving the full potential of its effectiveness. Under this alternative, it is expected that the program would continue to receive funding at anticipated levels and address scientific uncertainties at the anticipated pace and with anticipated rigor (FPHCP Appendix H).

Effectiveness of the adaptive management program under this alternative would be higher than under No Action Alternative 1-Scenario 1and substantially higher than under No Action Alternative 1-Scenario 2. Effectiveness would be the highest relative to all other alternatives.

Alternative 3

Under Alternative 3, the adaptive management program would continue to follow its current format and structure (WAC 222-12-045; subsection 2.3.2.2, Washington Forest Practices Rules and Program – Specific Description). However, the regulatory stability afforded by ESA Section 4(d) coverage is only related to species addressed in the 4(d) rules, and coverage can be modified by the Services through their rule-making authority. As a result, participation and support by those relying on regulatory certainty would be moderate compared to No Action Alternative 1-Scenario 1 (where effectiveness would be "low") and No Action Alternative 1-Scenario 2 (where effectiveness would be the "lowest"). A reasonable assumption would be that several more effectiveness and validation projects and/or rule tool projects (i.e., projects that facilitate implementation of the rules) might be funded than under No Action Alternative 1-Scenario 1 (directly related to only those few species covered by the 4(d) rule), or that an intensive monitoring project could be done under Alternative 3 that could not be done under No Action Alternative 1-Scenario 1. Again, the timelines for accomplishing these projects would likely be longer than under Alternative 2 due to less funding and fewer people willing to participate.

Alternative 4

Under Alternative 4, the adaptive management program would be managed directly by the Washington Forest Practices Board with no input from the collaborative, consensus-based TFW/FFR Policy Group that exists under No Action Alternative 1-Scenario 1. The Washington Forest Practices Board would take direct control over all effectiveness and validation monitoring and determine the need for any research projects relevant to forest practices. The DNR, on behalf of the Washington Forest Practices Board, would either conduct or contract for the research dependent upon available funding. In the absence of the TFW/FFR Policy Group, a new stakeholder advisory committee would be established that does not work on a consensus basis and whose membership is approved by the Washington Forest Practices Board. Proposals for changes to the rules that are supported by a simple majority, and even a minority, of the advisory committee may be brought before the Washington Forest Practices Board for review and decision.

Because Alternative 4 would implement a set of management prescriptions that are not consistent with the recommendations of the FFR, this alternative would effectively negate the FFR and the current Forest Practices Regulatory Program. This would result in a decrease in public funding for implementation of the FFR and a decrease in the collaboration and participation among stakeholders, particularly landowner participation, in the adaptive management program.

Alternative 4 is expected to result in a low level of adaptive management program support, although that support is not necessary under this alternative for implementation of the program. This is because the adaptive management program under this alternative is directed by the Washington Forest Practices Board. The effectiveness of the adaptive management program is expected to be low because research priorities are not currently established, long-term funding sources unknown, and outcomes (in terms of improvements in regulations) uncertain. Further, under Alternative 4 it is unlikely that stakeholders would reach consensus before the Washington Forest Practices Board on priorities, funding, or other attributes of the program.

It should be noted that under Alternative 4 there is less biological uncertainty associated with the effectiveness of the protection measures initially and, therefore, less need for an adaptive management program, regardless of its effectiveness. However, the level of uncertainty would be expected to increase over time as a result of implementing the more restrictive protection measures. The results would likely include an increase in the rate of forestland conversion, an increase in the incidence of forest health problems, and an increased in the likelihood of wildfire. Such consequences would be expected to offset some of the resource benefits associated with the more restrictive protection measures.

Detailed Effects Analysis

The varying levels of support for the adaptive management program described above have implications for the protection of fish and target amphibians, and for doing so at the least possible economic cost. The primary purpose of any adaptive management program is to provide credible, scientifically sound information to facilitate rule changes to meet established goals, objectives, and targets. Under the adaptive management program included in the No Action Alternative 1, Alternative 2 and Alternative 3, adequate program support is essential to ensure an effective adaptive management program and, therefore, proper resource protection. Alternative 4 does not require the same level of participation and support to function, but may lack priority-setting and funding necessary to assess regulatory prescription effectiveness where forestland conversion, forest health, and wildfire issues may pose a problem.

The information generated through adaptive management typically describes the degree to which management prescriptions affect a particular environmental element. For example, a monitoring project may evaluate the effect of Riparian Management Zone (RMZ) prescriptions on stream water temperatures. The environmental element (in this case temperature), in turn affects the quality and/or quantity of habitat for a particular species (e.g., bull trout). In the absence of adaptive management, it is difficult to accurately assess the degree to which management prescriptions maintain or alter environmental elements which, in turn, affect covered species.

This subsection describes the expected effects of the alternatives on several key environmental elements from an adaptive management standpoint. The evaluation focuses on current research and monitoring priorities related to temperature, LWD, and sediment to illustrate by example how varying levels of support for an adaptive management program may affect these environmental elements, and ultimately, habitat for fish and target amphibians. Later in this chapter, the reader may use these examples to assess how varying levels of support and, therefore, effectiveness of the adaptive management program would affect other resource attributes over time.

Temperature

Schedule L-1 of the FFR includes 11 different research and monitoring issues related to water temperature (FPHCP Appendix B). The issues include both effectiveness and validation monitoring topics. One effectiveness monitoring topic is listed as:

Test the cumulative effect (at basin scale) of the westside Type N smart buffers in meeting temperature targets (page 124, FFR).

"Smart buffers" refers to the initial Type N_p buffering strategy described under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 where RMZs are required along

50 percent of the length of Type N_p stream reaches and including all sensitive sites. "Temperature targets" refers to the State water quality standards for water temperature. This Schedule L-1 issue, referred to as the "Type N_p Buffer Effectiveness" project, will be used to describe how varying levels of adaptive management program effectiveness under the different alternatives may affect water temperature and habitat conditions for fish and target amphibians.

Implementation of the Type N_p Buffer Effectiveness project would provide information regarding the degree to which the Type N_p buffer strategy affects water temperatures both within Type N_p stream reaches and at the upstream end of the fish-bearing network. The results would have important implications for the protection of water quality and fish (particularly bull trout) and amphibian habitat. If the results affirm the effectiveness of the initial buffer strategy, it is unlikely any modifications to the rules would be necessary. If, however, the results indicate the buffer strategy is ineffective or only partially effective, policymakers would at the conclusion of the study have the information necessary to modify the rules to better ensure water temperature standards were met. In this instance, scientists responsible for the monitoring could recommend the most effective way to modify the management prescriptions to meet temperature targets. Finally, if the study was not implemented at all, policy makers would gain no information that would help resolve uncertainties and address any adverse effects. In fact, policy makers may not be aware that adverse impacts were occurring.

Under No Action Alternative 1-Scenario 1, improvements to the rules rely on the collaborative adaptive management program adopted by the Washington Forest Practices Board. Because the effectiveness of the adaptive management program in this scenario is low (See discussion above), improvements would be delayed and uncertain. The potential exists under Scenario 1 that the project would not be funded or pursued at all. If the buffer strategy is ineffective or only partially effective, resource impacts could be significant if the protection measures are ineffective. Policymakers would not gain for some time, if at all, the information with which to improve the regulations.

The outcome under No Action Alternative 1-Scenario 2 would be similar to that in Scenario 1. However, even greater resource impact is possible because the buffering strategy for Type 4 streams under the January 1, 1999 Washington Forest Practices Rules was less protective than the current rules, and the adaptive management program under this alternative is degraded further from that in Scenario 1. Under No Action Alternative 1-Scenario 2, the Type N_p Buffer Effectiveness project would need to be re-defined given the different buffering strategies of the rules. Further, it is possible that the research would not be conducted at all because under this scenario the adaptive management program is without support as a result of the absence of stakeholder participation, support, and funding.

Under Alternative 2, adaptive management would receive a high level of support, both in terms of public funding and stakeholder participation as a result of the regulatory certainty provided by federal assurances. It is highly likely that the Type N_p Buffer Effectiveness project would be pursued as a high priority within the adaptive management program, even as other priority research projects derived from Schedule L-1 are pursued (FPHCP Appendix B, Schedule L-1; FPHCP Appendix H).

In cases where monitoring results indicated the buffer strategy was ineffective or partially effective, Alternative 2 would result in substantially fewer temperature impacts to covered species than under either scenario of No Action Alternative 1 because: 1) adequate program funding and participation would result in timely project implementation, 2) timely project implementation would produce results in the shortest time frame, 3) adequate program support would ensure a comprehensive project scope (i.e., a broad distribution of study sites across space and time), and 4) the collaborative nature of the project would ensure prompt and serious consideration by the Washington Forest Practices Board of recommendations of TFW/FFR Policy Group.

Under Alternative 3, the adaptive management program would be required to maintain the format and structure as adopted by the Washington Forest Practices Board, the same as under both scenarios of No Action Alternative 1. The adaptive management program would have adequate stakeholder support as a result of the level of regulatory certainty offered under the ESA Section 4(d) rules. Program funding and participation under Alternative 3 would be moderate, resulting in the adaptive management program achieving moderate effectiveness in the amount, pace, and rigor of research projects relative to No Action Alternative 1. In cases where the initial Type N_p buffer strategy was ineffective or only partially effective in meeting temperature targets, the adaptive management program under Alternative 3 would provide feedback to decision-makers more-promptly than under either scenario in No Action Alternative 1 (but delayed relative to Alternative 2).

The scope of a project addressing temperature targets under Alternative 3 would be superior to the scope of efforts under No Action Alternative 1. However, it should be noted that the scope would be limited to effects on threatened species covered by the specific ESA Section 4(d) rules, likely not including amphibians or fish species not currently listed under the ESA and those listed species not covered by a Section 4(d) rule. As a result, the scope of a project would also be limited relative to the scope likely available under Alternative 2.

Under Alternative 4, adaptive management would not rely on the support of stakeholders, but rather be directed by the Washington Forest Practices Board subject to available State funds. Project implementation and scope would be determined by the Washington Forest Practices Board, also subject to available financial resources. Given the higher levels of protection for Type N_p waters under Alternative 4, the likelihood of negative temperature effects is lower compared to either scenario of No Action Alternative 1. This somewhat mitigates the potential effects relative to No Action Alternative 1 that could occur if the Washington Forest Practices Board did not address the uncertainty through adaptive management, or did so slowly. The priority for such a project may increase over time as the effects of increased forestland conversion, forest health issues, and wildfire affect broad, landscape-level resource protection in some watersheds. Lack of funding or the inability to establish priorities for adaptive management could affect the Washington Forest Practices Board's response to such emerging issues.

The effects of the alternatives on a single effectiveness monitoring project have been described above. In addition to effectiveness monitoring, the adaptive management program also includes temperature-related extensive and intensive monitoring projects and projects that involve the development of temperature-related rule implementation tools. The effects of the alternatives on these adaptive management sub-programs are expected to follow the same trends as described for effectiveness monitoring: Under No Action Alternative 1-Scenario 1, projects would likely be delayed, lack scope, and lack rigor relative to status quo and other alternatives. Under No Action Alternative 1-Scenario 2, it is likely that the projects simply would not be pursued. Projects are likely to be funded and implemented in a timely manner under Alternative 2, particularly compared to both scenarios under No Action Alternative 1. Under Alternative 3, projects are more likely to be implemented than under No Action Alternative 1, but less likely than under Alternative 2. Under Alternative 4, project implementation would be subject to the priority setting of the Washington Forest Practices Board and available funding. While the need for a robust and comprehensive adaptive management program may be less at the outset due to less resource protection uncertainty, that need likely increases over time, and the Washington Forest Practices Board would need to prioritize limited resources to areas of highest uncertainty. The lack of funding under Alternative 4 would likely limit the Washington Forest Practices Board's ability to respond with a robust and rigorous monitoring program.

Large Woody Debris

Schedule L-1 of the FFR includes a validation monitoring topic listed as:

Validate the Desired Future Condition targets within two years of report (page 126, FFR).

The "desired future condition" (DFC) targets refer to the basal area (See Glossary) targets that apply to Type S and F RMZs under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. This Schedule L-1 issue, referred to as the DFC Validation project, will be used to describe how varying levels of adaptive management program effectiveness under the different alternatives may affect LWD recruitment and habitat conditions for fish and target amphibians. Because there is a level of uncertainty with regard to the accuracy of current RMZ basal area targets, the DFC Validation project would be a high priority within the adaptive management program.

Implementation of the DFC Validation project would provide information regarding the degree to which current basal area targets reflect basal areas in natural, unmanaged stands. The results would have implications for LWD recruitment, for fish and amphibian habitat, and potentially for increased economic gain. If the results validate the existing targets, it is unlikely any modifications to the rules would be necessary. If, however, the results indicate the targets are not representative of natural, unmanaged stands, policymakers would have the information necessary to modify the targets.

Scientists responsible for monitoring could explain the most effective way to modify management prescriptions to meet performance targets. Finally, if the study was not implemented at all, policy makers would gain no information to would help resolve uncertainties and to address any adverse effects, whether they are related to resources or economics.

The adaptive management program under No Action Alternative 1-Scenario 1 would have a low level of effectiveness relative to other alternatives (although slightly higher than under No Action Alternative 1-Scenario 2). Because the effectiveness of the adaptive management program under this scenario would be low, improvements would be delayed and uncertain. The potential exists under Scenario 1 that the project would not be funded or pursued at all. If, in fact, the basal area targets are incorrect policymakers would not gain for some time, if at all, the information with which to improve the regulations.

Because No Action Alternative 1-Scenario 2 does not use basal area targets for riparian management, the DFC Validation project would not be necessary under this scenario. However, some form of monitoring would be necessary to evaluate the effectiveness of the January 1, 1999 Washington Forest Practices Rules RMZ leave tree requirements in providing adequate habitat. Because the RMZ leave tree requirements under this alternative are unlikely to provide adequate LWD recruitment, such monitoring would provide important information for policymakers when considering rule modifications. The low level of support for adaptive management under No Action Alternative 1-Scenario 2 would likely delay or limit the scope of any monitoring effort, if one was developed. Because Scenario 2 involves the “roll back” of regulations to those in effect on January 1, 1999 and a less functional adaptive management program, it also presents the highest likelihood for adverse resource effects relative to all alternatives.

Under Alternative 2, adaptive management would receive a high level of support, both in terms of public funding and stakeholder participation. It is highly likely under Alternative 2 that the DFC Validation project would be pursued. In cases where monitoring results indicated existing targets were incorrect, this Alternative would result in the fewest adverse habitat impacts among all alternatives, particularly relative to both scenarios in the No Action Alternative 1. This is the case because: 1) adequate program funding and participation would result in relatively rapid project implementation, 2) relatively rapid project implementation would produce results in the shortest time frame, 3) adequate program support would ensure a comprehensive project scope (i.e., a broad distribution of study sites across space and time), and 4) the collaborative nature of the adaptive management program would ensure serious and timely consideration of TFW/FFR Policy Group recommendations by the Washington Forest Practices Board.

Under Alternative 3, the adaptive management program would be required to maintain the format and structure as adopted by the Washington Forest Practices Board, the same as under No Action Alternative 1-Scenario 1 and Alternative 2. The adaptive management program under Alternative 3 would likely receive moderate stakeholder support as a result of the level of regulatory certainty offered under the ESA Section 4(d) rules. Program funding and participation under Alternative 3 would be moderate, resulting in the adaptive management program achieving moderate effectiveness in the amount, pace, and rigor of research projects relative to No Action Alternative 1. In cases where the basal area targets were found to be incorrect, the adaptive management program under Alternative 3 would provide feedback to decision-makers more-promptly than under either scenario in No Action Alternative 1 (but with a delay in project implementation relative to status quo or Alternative 2). Alternative 3 includes the potential of delay or a limit on the scope of the project due to funding constraints that are derived from the more-limited support as a result of the more-limited regulatory certainty provided by federal assurances under ESA Section 4(d). If the scope were limited, the potential exists that the forthcoming data would not be persuasive to decision-makers or that it would require a limitation on the applicability of the results. Both outcomes could mean that regulations would be improved relative to the scenarios under the No Action Alternative, but less effectively than under Alternative 2. Adverse resource effects due to insufficient LWD inputs would occur until regulations were improved, but the improvements would occur more rapidly than under No Action Alternative 1.

Under Alternative 4, RMZs are treated as no-harvest areas. Therefore, the DFC Validation project may not be necessary. Some form of effectiveness monitoring would be required if the Washington Forest Practices Board elected to evaluate the effectiveness of management prescriptions in providing adequate habitat. However, the greater degree of riparian protection offered by Alternative 4 increases the likelihood that management prescriptions directed at wood recruitment may be effective and may mitigate the need for such monitoring relative to No Action Alternative 1-Scenarios 1 and 2. However, without an adaptive management strategy, it would be difficult to determine whether a no-harvest buffer achieves or exceeds the desired habitat conditions in supplying large wood for recruitment. Also, the economic impact of such buffers would likely lead to increased conversion of forestlands to other uses. Also, no-harvest buffers may increase the incidence of forest health problems and wildfire. The ability of the Washington Forest Practices Board to monitor the effects of these other factors in the future would be limited under Alternative 4.

Sediment

Schedule L-1 of the FFR includes six different research and monitoring issues related to sediment. The issues include both effectiveness and validation monitoring topics. One effectiveness monitoring topic is listed as:

Determine the effectiveness of road maintenance BMPs (best management practices) on a site- and subbasin-scale in meeting road sediment targets (page 127, FFR).

This Schedule L-1 issue, referred to as the Roads BMP Effectiveness project, will be used to describe how varying levels of adaptive management program effectiveness under the different alternatives may affect road sediment delivery and habitat conditions for fish and target amphibians over time.

Implementation of the Roads BMP Effectiveness project would provide information regarding the degree to which implementation of specific sediment-reduction measures (via road maintenance and abandonment plans [RMAPs]) are effective in meeting established performance targets. The results have important implications for the protection of water quality and fish and amphibian habitat in both non-fish-bearing and fish-bearing waters. If the results affirm the effectiveness of the road BMPs, it is unlikely any modifications to the rules would be necessary. If, however, the results indicate some or all BMPs are ineffective or only partially effective, policymakers would have the information necessary to modify the rules and Board Manual guidance to better ensure the performance targets were met. Scientists responsible for the monitoring could explain how the management prescriptions could be modified to meet the road sediment targets. It is also possible that the study would not be implemented at all. In such an instance, policy makers would gain no information that would help resolve uncertainties and address any adverse effects.

The adaptive management program under No Action Alternative 1-Scenario 1 has a low level of effectiveness relative to other alternatives (although slightly higher than under No Action Alternative 1-Scenario 2). Since the effectiveness of the adaptive management program under this scenario is low, improvements would be delayed and uncertain. The potential exists under Scenario 1 that the project would not be funded or pursued. Resource impacts would be significant if, in fact, the specific sediment-reduction efforts are ineffective or only partially effective in providing ecological functions because policymakers would not gain for some time, if at all, the information with which to improve the regulations.

The adaptive management program under No Action Alternative 1-Scenario 2 has the lowest effectiveness of all alternatives. The low level of support for adaptive management under No Action Alternative 1-Scenario 2 would likely delay or limit the scope of any effectiveness monitoring effort. There is a high likelihood that the project would not be pursued at all. Because Scenario 2 involves: 1) no federal assurances, 2) the likely “roll back” of regulations to those in effect on January 1, 1999, and 3) a less functional adaptive management program, it presents the highest likelihood of adverse resource effects relative to Scenario 1 and all other alternatives.

Under Alternative 2, adaptive management would receive a high level of support, both in terms of public funding and stakeholder participation. The likelihood of timely project implementation would be highest under Alternative 2 relative to No Action Alternative 1 (and all other alternatives) because this alternative would receive broad financial and stakeholder support compared to the other alternatives.

In cases where monitoring results indicated the BMPs were ineffective or partially effective, this Alternative would result in the fewest sediment-related impacts to covered species and their habitat relative to the No Action Alternative 1 and other alternatives because: 1) adequate program funding and participation would result in relatively rapid project implementation, 2) relatively rapid project implementation would produce results in the shortest time frame, 3) adequate program support would ensure a comprehensive project scope (i.e., a broad distribution of study sites across space and time), and 4) the collaborative nature of the adaptive management program would ensure serious and timely consideration of the recommendations by the Washington Forest Practices Board.

Under Alternative 3, the adaptive management program is expected to maintain the same format and structure as under both scenarios of No Action Alternative 1 (as adopted by the Washington Forest Practices Board). Alternative 3 would likely receive moderate stakeholder support as a result of the regulatory certainty offered under the ESA Section 4(d) rules over that provided by No Action Alternative 1 (but less than Alternative 2). Program funding and participation under Alternative 3 would be moderate, resulting in the adaptive management program achieving moderate effectiveness. In cases where all or some road BMPs were ineffective or only partially effective in meeting performance targets, the adaptive management program under Alternative 3 would provide feedback to decision-makers more-promptly than under either scenario in No Action Alternative 1 (but with a delay in project implementation relative to status quo or Alternative 2). As with the No Action Alternative 1, Alternative 3 includes the possibility that the Road BMP Effectiveness project would not occur at all. Alternative 3 also includes the potential of a limit on the scope of the project due to reduced funding relative to status quo. If such were to occur, it would likely limit the applicability of the results or result in providing data that was insufficient to be persuasive. These outcomes could result in a delay or failure to improve regulations, resulting in resource impacts from on-going sediment-reduction measures that would not meet expectations (if the measures were found by the project to be inadequate).

Under Alternative 4, some form of effectiveness monitoring would be required if the Washington Forest Practices Board elected to evaluate the effectiveness of road BMPs in reducing sediment. However, given the accelerated RMAP implementation schedule and the cap on road densities under Alternative 4, the likelihood of sediment effects is lower compared to Scenario 1 of No Action Alternative 1 and significantly lower compared to Scenario 2. This somewhat mitigates the potential effects relative to No Action Alternative 1 that could occur if the Washington Forest Practices Board failed to pursue the uncertainty associated with the BMPs through adaptive management, or did so slowly. However, the economic impact of more restrictive regulations would likely lead to increased conversion of forestlands to other uses. Also, no-harvest buffers may increase the incidence of forest health problems and wildfire. These unintended consequences of Alternative 4 could affect the rate of fine sediment inputs to streams, and the ability of the Washington Forest Practices Board to monitor the effects of these other factors in the future would be limited under Alternative 4.

Summary

The preceding subsection provided illustrations of potential effects as a result of the various levels of effectiveness in the adaptive management program under each of the alternatives. As shown in Table S-1 in the Summary, this effectiveness would be low for No Action Alternative 1-Scenario 1, lowest for No Action Alternative 1-Scenario 2, high for Alternative 2, and moderate for Alternative 3. The likelihood of resource impacts under Alternative 4 is low at the outset, and therefore the need for a robust and comprehensive adaptive management program is initially reduced. However, unintended consequences of more restrictive protection measures likely increases the likelihood of negative resource impacts over time, and the Washington Forest Practices Board's ability to respond appropriately would likely be limited due to lack of priorities and secure, long-term funding. The follow subsections of this Chapter focus on an assessment of the effects on various resources of the regulatory provisions of each alternative. Often the analysis is presented in three groupings of alternatives: No Action Alternative 1-Scenario 2 (regulations in effect on January 1, 1999); Alternative 4 (more restrictive regulations); and No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 (existing, FFR-based regulations). As described above, the effectiveness of the adaptive management program provides further distinctions among these alternatives, particularly among the three alternatives within the grouping based on existing, FFR-based regulations. To avoid repetition, the remainder of this chapter does not restate the potential impact on resource effects over time of various levels of adaptive management effectiveness. Rather, it is suggested that the reviewer continue to consider the previous analysis of adaptive management when assessing the information on resource effects as described in the remainder of this chapter.

4.2 LAND OWNERSHIP AND USE

4.2.1 Introduction

The alternatives considered in this EIS would not directly affect land ownership; however, they would modify the level of restrictions on land use to varying degrees. These changes in restrictions may indirectly change land ownership by creating incentives to convert land from forest management to other land uses. Large timber companies have stated that long-term regulatory certainty and stability are also key factors in retaining forestlands. Changing regulations or other potential restrictions have increased the costs and uncertainty attendant upon investments in timber acquisitions and harvest activities (Forests and Fish Report 1999 [FPHCP Appendix B]; NMFS and USFWS 2003; See also individual scoping comment letters). Potentially affected private forestland owners include non-industrial private forests and small forest landowners, who harvest annual average volumes of 2 million board feet or less, as well as large timber companies with extensive land holdings throughout the State.

4.2.2 Evaluation Criteria

The alternatives being evaluated in this FEIS would directly affect only State, city, county, and private forestlands being managed for timber production in Washington State. No effects on land ownership and use are expected relative to Federal or tribal lands, or on State lands that are not being managed for timber production (e.g., State parks and wildlife areas), or on non-forestlands (e.g., agricultural lands). Therefore, the effects analysis and the evaluation criteria discussed below relate to these State, city, county, and private forestlands.

Land use would be directly affected within riparian corridors. Each of the alternatives would restrict land use within these corridors to varying degrees. In addition, riparian area restrictions could indirectly affect uses on adjacent or nearby non-riparian areas that are owned or managed by the same landowner or agency. Therefore, the primary evaluation criteria for potential land use effects are the type of riparian land use restrictions associated with each alternative and the amount of land area affected by the restrictions.

Ultimately, the degree of land use restrictions (both amount and type) could result in changes in ownership and conversion to other land uses. Therefore, a second evaluation criterion for land ownership and use is the degree to which the restriction of land uses ultimately affects land ownership and conversion to a land use that is not consistent with forest management.

4.2.3 Evaluation of Alternatives

The effects of the alternatives on land ownership and use are discussed in this subsection. In reading this discussion, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1, no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices

Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on land ownership and use are likely to fall somewhere between these two scenarios.

4.2.3.1 Direct Restrictions on Forest Land Use

Overview of Effects

Total western Washington RMZ area on private, city, and county lands would be approximately 631,000 acres under No Action Alternative 1-Scenario 2; 1,322,000 acres under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3; and 2,695,000 acres under Alternative 4. These figures represent about 10 percent, 21 percent, and 43 percent of all private, city, and county forestlands in western Washington, respectively (Note that State forestlands in western Washington are already ~~are~~ subject to an HCP, see subsection 1.1.2, Washington State's Habitat Conservation Plan, footnote 1).

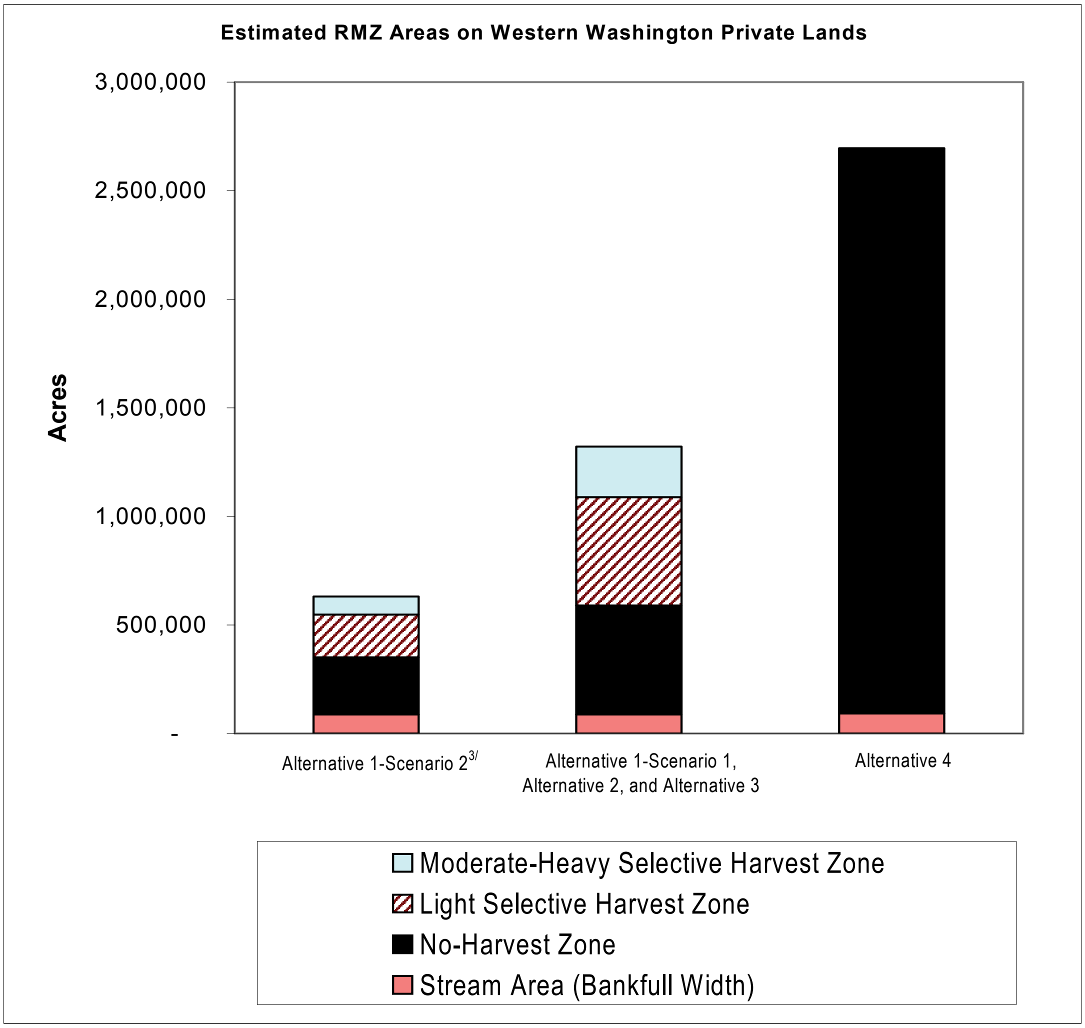
In eastern Washington, the total forestland area within RMZs on State and private, city, and county lands would be approximately 196,000 acres under No Action Alternative 1-Scenario 2; 374,000 acres under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3; and 871,000 acres under Alternative 4. These figures represent about 6 percent, 11 percent, and 26 percent of all State, private, city, and county forestlands in eastern Washington, respectively.

Effects Analysis

The primary direct effect of the alternatives on land ownership and use is the amount of land that is restricted from timber harvest within RMZs. Figures 4.2-1 and 4.2-2 display the estimated amount of land where timber harvest would likely be reduced because of RMZ restrictions under each alternative for western Washington and eastern Washington, respectively (See DEIS Appendix B for a description of the methods used to estimate these acres). State forestlands in western Washington are excluded from these figures because they are covered under an existing Habitat Conservation Plan (Washington DNR 1997d).

The no-harvest zone (i.e., the most restrictive land use zone) represents the entire RMZ area for Alternative 4 and somewhat less than half of the total RMZ area for the grouping of alternatives, which includes No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. Under No Action Alternative 1-Scenario 2, a no-harvest zone is not required but may occur in some instances according to the "shade rule" in Section 1 of the Washington Forest Practices Board Manual (FPHCP Appendix F).

Figure 4.2-1. Estimated RMZ Areas (acres) on Private Lands[1/] in Western Washington[2/] by Alternative (note that private lands include city and county-owned lands).

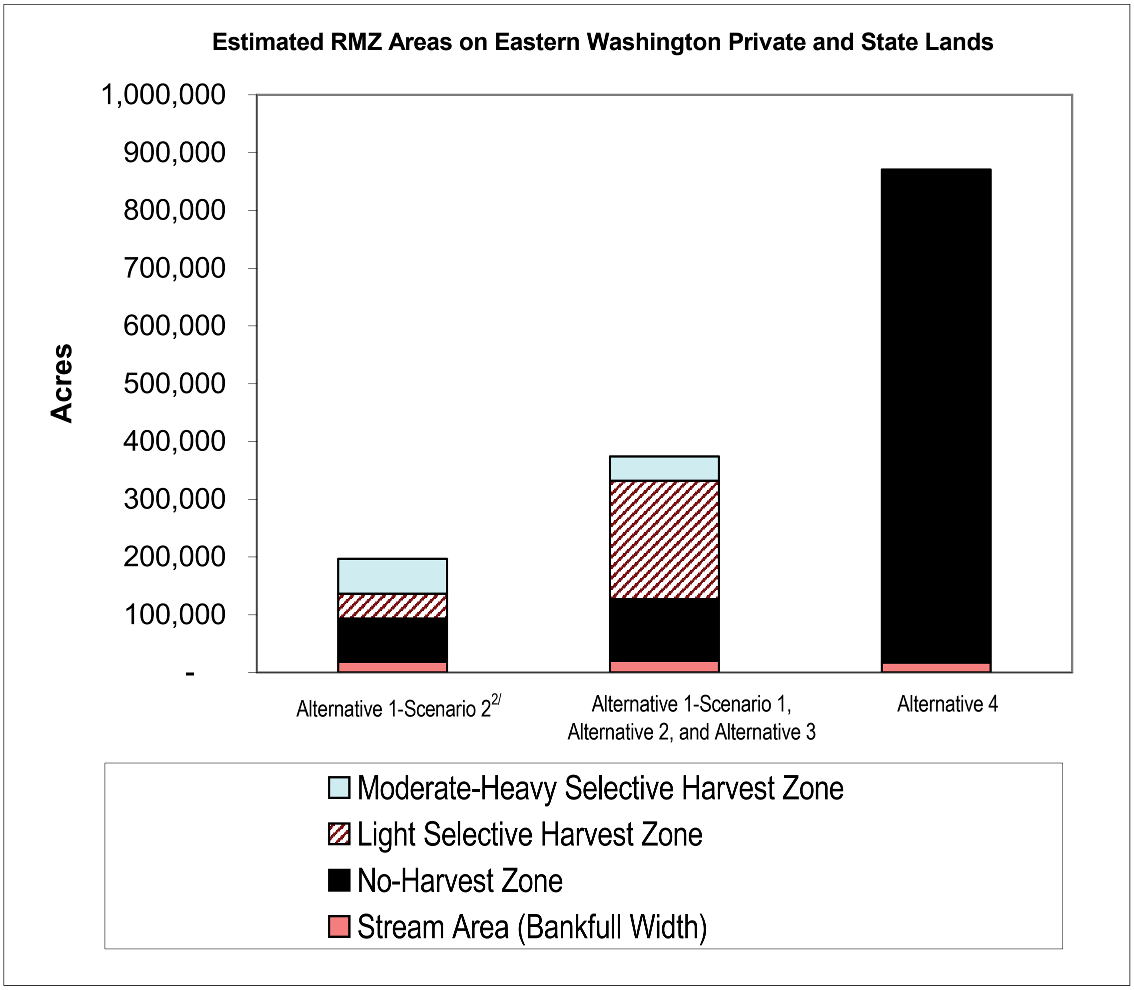


[1/] Total private forestlands in Western Washington cover approximately 6,289,000 acres.

[2/] State forestlands in western Washington are excluded from these figures because they are covered under an existing Habitat Conservation Plan (Washington DNR 1997d)).

[3/] Under No Action Alternative 1-Scenario 2, the rules in effect on January 1, 1999, do not require a no-harvest zone, however, for modeling purposes, a no-harvest zone was estimated to allow for comparison to the other alternatives that do require a no-harvest zone.

Figure 4.2-2. Estimated RMZ Areas (acres) on State and Private Lands[1/] in Eastern Washington by Alternative (note that private lands include city and county-owned lands).



[1/] Total private forestlands in eastern Washington cover approximately 3,365,000 acres.

[2/] Under No Action Alternative 1-Scenario 2, the rules in effect on January 1, 1999, do not require a no-harvest zone, however, for modeling purposes, a no-harvest zone was estimated to allow for comparison to the other alternatives that do require a no-harvest zone.

4.2.3.2 Forestland Conversion

Overview of Effects

The existing forest practices regulations were adopted "on the assumption that federal assurances . . . will be obtained" by June 30, 2005 (subsection 1.3.2, Washington State Legislative Directive Regarding Federal Assurances). As a result, the existing rate of private forestland conversion is, in part, occurring under a level of expectation that regulatory certainty will be provided by federal assurances (subsection 3.2.4, Forestland Conversion, for a general description of current and historic conversion in Washington) and is considered for purposes of analysis to be status quo. Under No Action Alternative 1-Scenario 1, those regulatory assurances would not be forthcoming, and the regulations adopted in anticipation of assurances would still remain in effect. As a result, the rate of conversion under No Action Alternative 1-Scenario 1 would likely increase from status quo.

Like Scenario 1, No Action Alternative 1-Scenario 2 includes no federal assurances (and, therefore, no anticipated regulatory certainty), but the Forest Practices Regulatory Program is "rolled back" to the rules in effect on January 1, 1999. This reduction in restrictions on harvest would likely result in an increase in the value of private forestlands for timber production and, therefore, the rate of conversion of private forestlands to other uses would be similar to the status quo, and less than under No Action Alternative 1-Scenario 1.

The Forest Practices Regulatory Program under Alternative 2 would be the same as No Action Alternative 1-Scenario 1 and more restrictive than No Action Alternative 1 Scenario 2. However, Alternative 2 would also provide the greatest degree of regulatory certainty and public funding available for landowner incentive/assistance programs and is consistent with the expectations inherent under the status quo. With confirmation of federal assurances and funding for landowner incentive/assistance programs under Alternative 2, it is likely that conversion rates would drop slightly from the status quo. These conversion rates would be slightly lower than under No Action Alternative 1-Scenario 1, but higher than under No Action Alternative 1-Scenario 2.

Alternative 3 provides more regulatory certainty than under No Action Alternative 1. As a result, conversion rates under Alternative 3 are anticipated to be lower than under No Action Alternative 1-Scenario 1, even though the initial Forest Practices Regulatory Program under these two alternatives is the same. However, conversion rates under Alternative 3 would be higher than under No Action Alternative 1-Scenario 2 because of the more-restrictive regulations under Alternative 3.

Alternative 4 would likely present the highest rate of conversion among all alternatives because its restrictive regulations would significantly reduce anticipated economic return to landowners from timber management, particularly small forest landowners. This is true even though federal assurances are provided under this alternative.

Effects Analysis

Many of the aquatic habitat functions described later in Chapter 4 relating to sediment, water quality, hydrology, and riparian processes, and particularly wood recruitment, would likely be adversely affected by substantial increases in land use conversion. While these effects would tend to be at the site scale, watershed scale effects could occur in basins with high densities of small landowners and/or in basins in close proximity to rapidly growing urban areas. Conversion of forestland to more intense land uses (e.g., agriculture, residential development) typically is followed by altered hydrologic regimes, diminished water quality, and reduced riparian function for aquatic species and other riparian–dependent wildlife.

THE FOLLOWING NEW TEXT REFLECTS PUBLIC COMMENTS ON THE DEIS

The problems stemming from forestland conversion and watershed urbanization have long been known and examined. Studies examining associations between watershed development and aquatic system conditions have been conducted since the late 1970s. In nearly every watershed where these studies have occurred, the quality and quantity of aquatic habitat are negatively associated with the percent of effective impervious area in a watershed (Schueler 1994; King County 1994; May 1996; Thurston County 1998). Likewise, hydrologic analysis has shown dramatic shifts in stream hydrographs to sharper peak flows and longer durations as urban development progresses in a watershed. Such hydrologic shifts can have adverse effects on aquatic species and habitats that evolved under forested conditions (Booth and Jackson 1997; Booth et al. 2002~~Booth et al. 1997 and 2002~~). Although stormwater management standards are fairly modern requirements, they have become more stringent over the last several years as evidence of the ineffectiveness of structural stormwater management solutions has accumulated.

Recent basin planning efforts in King, Thurston, and other western Washington counties and cities have taken a different approach and turned to examining non-structural solutions for minimizing the adverse effects of stormwater run-off and watershed urbanization (King County 1994; Thurston County 1998). These planning efforts found that using structural solutions (e.g., detention facilities, high-flow bypasses) to manage the increased runoff resulting from watershed urbanization were not meeting acceptable criteria, even in watersheds that contained suburban and rural zoning densities. Hydrologic modeling indicated that build-out conditions in these watersheds would result in unacceptable shifts in stream hydrographs, even if current stormwater drainage design standards were increased (e.g., doubling the size of detention ponds and cutting release rates in half). The alternatives to structural solutions in these situations are land use and zoning requirements. Under the Growth Management Act, local jurisdictions have the authority to set local land-use policy. Hydrologic modeling has indicated that retaining 60 to 70 percent forest cover in urbanizing watersheds is often more effective at maintaining existing stream hydrographs under build-out conditions than doubling stormwater management requirements (King County 1994; Thurston County 1998). Therefore, an underlying assumption of this analysis is that alternatives that minimize and mitigate forestland conversion would be beneficial to aquatic habitat.

END OF NEW TEXT

Limitations on land use resulting from RMZ restrictions may affect the rate of conversion of affected forestlands to other uses (subsection 3.2.4, Forestland Conversion, for a general description of current and historic conversion in Washington). Zobrist (2003) conducted 10 case studies of small, non-industrial private forest landowners in western Washington (six in Lewis County and four in Grays Harbor County) under the current Washington Forest Practices Rules, which would be the same initial rules as under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. These case studies were conducted to help better understand the economic impacts of these rules on small landowners and the economic implications of these impacts. One of the implications considered was the possibility that these rules would lead to an increase in the rate of conversion of forestland to other non-forested uses.

The results of these case studies indicated that some small landowners could potentially incur substantial economic losses under these alternatives, with the severity of potential impacts varying by landowner. This analysis considered several different harvest scenarios, including no riparian harvest, harvest in the outer zone only, and harvest in both the inner and outer zones, and compared forest and land values under each scenario with the January 1, 1999 Washington Forest Practices Rules, which would be the same as under No Action Alternative 1-Scenario 2. Economic losses were greatest under the no riparian harvest scenario compared to the scenarios that involved partial harvesting in the riparian zone. Harvesting in the outer zone reduced economic losses compared to the no riparian harvest scenario. Harvesting in both the inner and outer zones further reduced economic losses in some of the case studies, but the incremental benefit of harvesting in the inner zone was relatively small (Zobrist 2003).

The case study analysis found that the land value for timber management would be completely lost in no-harvest areas, such as the core zone and parts of the inner zone, as these acres could no longer be used for commercial management (Zobrist 2003). Further, if buffer restrictions resulted in a large portion of a given property being taken out of timber production, it could make the entire property unprofitable, because the production base available to cover fixed production costs would be much smaller. Also, buffer restrictions may fragment properties, separating unrestricted areas from one another and making management unfeasible in these areas, as well as those areas within the RMZ (Zobrist 2003).

The Forestry Riparian Easement Program, which is part of the current Washington Forest Practices Rules, is designed to mitigate the economic costs of the riparian rules on small forest landowners by compensating them directly for a portion of timber volume losses due to the RMZ restrictions. Zobrist (2003) concluded that this program can be very effective at mitigating losses, especially when harvest takes place in the riparian zone. However, he also identified a number of shortcomings. First, if participation is high, the cost will far exceed present funding levels, and it is unlikely that the majority of small landowners will enjoy the benefits of the program. Second, the program only compensates for currently standing timber. Thus, it does not compensate for the loss in land value due to riparian acreage that can no longer be used for forest management (Zobrist 2003).

The current Washington Forest Practices Rules allow for alternate plans to the current Washington Forest Practices Rules. Applicants can propose harvest prescriptions, including placement of LWD and uneven buffer widths that may be approved by Washington DNR if the alternate plan provides protection to public resources that is equivalent to that provided in the specific buffer prescriptions under the current Washington Forest Practices Rules. Alternate plan templates for small forest landowners to meet this objective are being considered for overstocked forest stand rehabilitation and conversion of certain hardwood-dominated stands to conifer-dominated stands. Alternate plans offer an incentive to retain forestland. Other small forest landowners are working with the Services to develop a programmatic HCP covering over 100,000 acres in Lewis County. If approved, the HCP in Lewis County, or others like it, should help to reduce the rate of conversions in those areas.

Substantial decreases in land value imply that it would not be economically viable for small landowners to continue to use their property for forest management, which could motivate land use conversion, particularly to residential development (Zobrist 2003). Non-industrial private forestlands in western Washington tend to interface with urbanizing areas, and conversion of these lands is a growing concern. A study conducted by Washington DNR, for example, found that non-industrial private forestlands were converted to non-forest use between 1979 and 1989 at a rate of almost 100 acres per day (Washington DNR 1998). This conversion figure is, however, for land converted from primary forestland to some other purpose. This does not always mean conversion to another land use, such as residential development or agriculture; it could mean conversion to smaller or less dense parcels of forestland. The majority of the conversion identified in this report occurred in western Washington, with much of the conversion occurring within urban growth area boundaries and on the fringes of the suburban/rural interface (Washington DNR 1998).

Conversion information available from Washington DNR's Forest Practices Application Review System database indicates that 53,821 acres were converted from forestland to other uses between 1997 and 2003 (Table 3-12).

The primary areas where conversion is taking place are in the Puget Sound Region and along the I-90 corridor. A study conducted by The Wilderness Society assessed changes in forest cover in King, Pierce, and Kittitas Counties from 1985 to 1999 based on Landsat imagery (Thomson et al. 2003). This study identified approximately 96,000 acres that had been converted from forest to urban development during that period in the three-county analysis area.

The results of Zobrist's (2003) case study analysis suggest that the rate of non-industrial private forestland conversion would likely increase under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 relative to No Action Alternative 1-Scenario 2. Forestland conversion would likely be the lowest under No Action Alternative 1-

Scenario 2 because of the less-restrictive RMZ rules in effect on January 1, 1999. No Action Alternative 1-Scenario 1 would result in reduced funding for landowner incentive and assistance programs, such as the Forestry Riparian Easement Program because of a lack of regulatory certainty leading to a lack in public funding for such programs. As a result, comparing these three alternatives, small landowner mitigation, viewed in terms of financial compensation, would be lowest under No Action Alternative 1-Scenario 1, higher under Alternative 3, and highest under Alternative 2. This effect would likely result in a lower rate of conversion under Alternative 2 and higher rates under No Action Alternative 1-Scenario 1 and Alternative 3.

RMZ restrictions would be substantially higher under Alternative 4 relative to all other alternatives (Figure 4.2-1). Thus, it can be concluded (based on the findings of Zobrist 2003) that the economic viability for forest landowners, especially small forest landowners, would be lower under Alternative 4, and the rate of forestland conversion could be substantially higher than under any of the other alternatives. These types of effects would be particularly likely to occur in the South Puget Sound and West Puget Sound Regions, as well as the North Puget Sound and lower Columbia Regions, where substantial urban development pressures exist and non-industrial private forestlands are often located along the urban-wildland interface. However, county regulations and restrictions, the proximity of properties to urban areas, the current real estate market, and other factors would contribute to how fast conversion could take place under any alternative.

~~Many of the aquatic habitat functions described in the following subsections on sediment, water quality, hydrology, and riparian processes, particularly wood recruitment, would likely be affected adversely by substantial increases in land use conversion. While these effects would tend to be at the site scale, watershed scale effects could occur in basins with high densities of small landowners and/or in basins in close proximity to rapidly growing urban areas. Conversion of forestland to more intense land uses (e.g., agriculture, residential development) typically is followed by altered hydrologic regimes, diminished water quality, and reduced riparian function for aquatic species and other riparian dependent wildlife.~~

The restrictions proposed under each alternative only apply to private forestlands in western Washington and private and State forestlands in eastern Washington. As a result, none of the alternatives are expected to have a direct effect on Federal, tribal, other State-managed, or agricultural lands. Reductions in land available for harvest or increases in conversion from forestland to other uses on the lands managed under these alternatives could increase demand for timber from other land ownerships or encourage conversion on other nearby lands, but these effects are expected to be minor.

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4.3 AIR QUALITY

4.3.1 Introduction

There would be only minor differences among the alternatives in terms of effects on air quality. Timber harvest-associated traffic on logging roads would add dust to the air, and prescribed burning and wildfires would add smoke under all alternatives. The dust and smoke could produce eye and respiratory discomfort to people working, living, or recreating in the area. Air pollution from dust would be partially mitigated by dust abatement measures under all alternatives. All alternatives would comply with Federal air quality standards, the Washington Visibility State Implementation Plan (Washington Department of Ecology 1999a), which regulates (among other pollutants) emissions from prescribed burning, and the State Smoke Management Plan (Washington DNR 1998i), which would mitigate any adverse effects from silvicultural burning.

4.3.2 Evaluation Criteria

None of the rules under any of the alternatives would significantly affect the amount of burning that takes place or the amount of traffic on logging roads. A general indicator of the amount of activity that produces air emissions is the amount of land taken out of forest management over the long term. Thus, in the following evaluation, the amount of RMZ area (particularly no-harvest area) is used as a general indicator of the differences in activity levels among the alternatives.

4.3.3 Evaluation of Alternatives

This subsection addresses the effects of the alternatives on air quality. In reading this subsection it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1, no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the forest practices program in a way that is difficult to predict. Therefore, two scenarios (Alternative 1-Scenario 1 and Alternative 1-Scenario 2), which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined to represent the No Action Alternative (subsection 2.3.1, No Action Alternative 1 (No Action)). The effects of No Action are displayed for both of these endpoints in the following paragraph, the actual effects of No Action on air quality are likely to fall somewhere between these two scenarios.

No Action Alternative 1-Scenario 1 (and Alternative 2 and Alternative 3) would have harvest levels consistent with the status quo. Dust levels under these three alternatives, therefore, are likely to be similar to current levels. No Action Alternative 1-Scenario 2 is projected to result in more harvest over the long term than the status quo (and more than other alternatives) because it would require substantially fewer trees be left in RMZs (Figures 4.2-1 and 4.2-2). In areas where more miles of road are used and/or there is more truck traffic compared to the status quo, there is the potential for increases in dust under No Action Alternative 1-Scenario 2 than from levels under No Action Alternative

1-Scenario 1. The same is true for Alternatives 2 and 3 relative to No Action Alternative 1-Scenario 2.

Alternative 4 is projected to result in the lowest harvest level because of the large no-harvest RMZs. Therefore, Alternative 4 would have a lower potential to generate dust than either No Action Alternative 1-Scenario 1 or Scenario 2.

Air pollution from dust under all alternatives would be mitigated by dust abatement measures required by Washington Forest Practices Board road maintenance standards and State Department of Labor and Industries safety standards for dust. These include using gravel road surface material, applying chemical dust suppressants, or applying water to the road surface.

The use of prescribed burning (both broadcast burning and pile and burn) to prepare a site for planting is expected to be similar under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. Levels of prescribed burning would be slightly higher under No Action Alternative 1-Scenario 2 than No Action Alternative 1-Scenario 1. Because of reduced harvest activity under Alternative 4, prescribed burning would be slightly lower than under either scenario of the No Action Alternative 1.

Compared to the status quo, little or no additional adverse effects on air quality are anticipated due to prescribed burning for site preparation under any of the proposed alternatives. Per WAC 222-30-100, slash burning is strictly regulated under the Washington State Smoke Management Plan (Washington DNR 1998i) and would require a permit from the Washington DNR. Prescribed burning for both slash disposal and to reduce wildfires would occur in eastern Washington. Fewer acres of prescribed burning would likely occur in western Washington due to the cool and wet weather patterns that generally prevail and the restrictions on burning that may affect urban areas.

Air pollution from wildfire is also expected to be greater on the eastside of the State than on the westside because of the drier conditions east of the Cascade Mountains. No Action Alternative 1-Scenario 2 would result in the lowest likelihood of wildfire among all alternatives because there would be smaller riparian buffer areas and some tree removal would be allowed, resulting in low fuel loads. This alternative would be less likely to violate air quality standards due to wildfire compared to the status quo.

No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) has a riparian buffer larger than No Action Alternative 1-Scenario 2 and would allow partial tree removal in portions of the buffers. This would result in higher levels of fuel than No Action Alternative 1-Scenario 2. The likelihood of wildfire associated with this alternative (and Alternatives 2 and 3), and the likelihood of violating air quality standards, would be similar to the status quo.

The likelihood of wildfire is expected to be slightly higher under Alternative 4 than either scenario of No Action Alternative 1, due to the wider unmanaged riparian buffers, which would result in greater fuel buildup in riparian corridors compared to other alternatives. Unmanaged stands tend to have higher amounts of both down and standing dead fuel and a wide range of tree sizes, ranging from seedlings and saplings to mid-canopy trees to upper canopy trees. This creates a “ladder effect” that allows fire to move from the ground to the upper canopy. The likelihood of wildfire under Alternative 4 may result in a slightly greater affect on air quality standards compared to the status quo.

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4.4 GEOLOGY, SOILS, AND EROSIONAL PROCESSES

In this subsection, the effects of the alternatives are divided into two main areas: surface erosion and mass wasting. Differences in climate, topography, geology, and resulting soil characteristics among and within regions of the State will lead to differences in overall susceptibility to surface erosion and mass wasting. The Washington Forest Practices Rules apply statewide, with some differences between eastern and western Washington. In general, higher frequencies of mass wasting and lower surface erosion rates occur in western Washington relative to eastern Washington forestlands due to differences in climate, topography, geology, and soil permeability (subsection 3.4, Geology, Soils, and Erosional Processes). The Regional Summaries (DEIS Appendix A) describe differences in geology and soil types, which vary by region and are summarized in the affected environment discussion of subsection 3.4 (Geology, Soils, and Erosional Processes).

4.4.1 Surface Erosion

The major sources of surface erosion on forestlands due to forest management are erosion from road surfaces and hill-slope erosion following harvest, as discussed in subsection 3.4.2 (Erosion). The evaluation criteria for these sources are described below.

4.4.1.1 Surface Erosion Evaluation Criteria

Road Surface Erosion

Road surface erosion is affected by road construction methods, road use, road maintenance, road abandonment, and drainage, as discussed in subsection 3.4.2.2 (Forest Practices Effects on Erosion and Sedimentation). The criterion for evaluating this chronic source of erosion sediment is a qualitative assessment of how well the Washington Forest Practices Rules that are pertinent to road management (i.e., planning, construction, use, maintenance, drainage, and abandonment) would control road-related sediment production and delivery to streams under each alternative.

Chapter 222-24-050 through 052 of the WAC (also found in Washington Forest Practices Board 2002) describe the reasoning, schedule, and requirements for road maintenance and abandonment of forest roads, including RMAPs under the current Washington Forest Practices Rules. RMAPs are required analyses and plans to be submitted by forest landowners to Washington DNR. The purpose of the RMAP program is to evaluate and prioritize the maintenance and abandonment of forest roads by addressing roads in most need of these actions first, as demonstrated by a well-defined set of maintenance and abandonment criteria designed to protect surface waters from sediment input, and resources from road-related mass wasting events. The need for improvement of road maintenance and abandonment practices over the January 1, 1999 Washington Forest Practices Rule is described in Rashin et al. (1999).

Hillslope Erosion Related to Timber Harvest

Timber harvest activities often lead to increased soil disturbance, potentially increasing delivery of fine sediments to stream channels. Factors influencing the delivery of excessive sediment to streams as a result of timber harvest are discussed in subsection 3.4.2.2 (Forest Practices Effects on Erosion and Sedimentation).

Evaluation criteria for hillslope erosion are compared using an equivalent buffer area index. The equivalent buffer area index is similar in concept to the equivalent road area analysis of McGurk and Fong (1995) and the non-point source risk assessment of Lull et al. (1995), and represents a relative measure of the protection of streams from fine sediment derived from hillslope erosion (DEIS Appendix B). The ability of buffers to capture fine sediment is largely dependent on their width, slope, and the management practices within the buffer strip. Buffer-strip width is the most common parameter used for evaluating the ability of a management option to minimize fine sediment delivery to streams. Recommended buffer widths for sediment removal vary widely, ranging from about 10 feet for removing coarse fractions (sand) to 400 feet for fine fractions (clay). Studies of forested watersheds often recommend buffers of approximately 100 feet for this purpose (Johnson and Ryba 1992). Spence et al. (1996) also reviewed the literature on buffer widths for sediment filtration. Although Spence et al. (1996) and his colleagues gave no definitive width, they concluded that on gentle slopes 100 feet might be sufficient, while on steep slopes 300 feet may be necessary for sediment filtration. The Forest Ecosystem Management Assessment Team (FEMAT) (1993) buffer width for sediment filtration is one site potential tree height (See Glossary), or approximately 170 feet in western Washington for Site Class II forestland. For management purposes, a fixed width rather than one based on site potential tree height is more appropriate, since sediment movement is unrelated to the latter. Site potential tree height was used by FEMAT (1993) as a surrogate for using fixed width because of the relationship between site potential tree height and soil stability given by tree roots (the bigger the site potential tree height, the wider the root system and the greater the width). Rashin et al. (1999) recommended a 10 meter (33-foot) buffer as effective at reducing timber harvest–related surface erosion from entering the drainage network.

For this FEIS, the equivalent buffer area index was evaluated for a 30-foot and a 200-foot RMZ width, for all alternatives, representing a lower end and upper end RMZ prescription. The lower end RMZ width of 30 feet was chosen to be consistent with the recommendation of Rashin et al. (1999). The higher end buffer was chosen to represent the upper end of recommendations and the widest buffers being considered under any of the alternatives.

The equivalent buffer area index values are expressed as a percentage that is normalized based on the assumption that complete protection is provided by a 30-foot no-harvest buffer for the 30-foot equivalent buffer area index and that complete protection is provided by a 200-foot no-harvest buffer for the 200-foot equivalent buffer area index.

Regardless of the equivalent buffer area index width chosen to analyze hillslope erosion, in forestlands on steep terrain, it should be noted that riparian buffers do not provide full protection from upslope sedimentation that originates from roads, unless all road drainage is directed to the forest floor. This is generally not possible, and considerable suspended sediment may be transported to fish-bearing streams via non-fish-bearing streams where roads bisect the non-fish-bearing riparian buffers and streams. Best Management Practices (BMPs) for road placement and construction, as well as RMAPs and Watershed Analysis are meant to address this issue. Effectiveness of road construction techniques and recommended BMPs for prevention of sediment-related water quality impacts over the January 1, 1999 Washington Forest Practices Rules is discussed in more detail in Rashin et al. (1999).

4.4.1.2 Evaluation of Alternatives

The effects of the alternatives on road surface and hillslope erosion are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative, no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1) to represent the No-Action Alternative. The effects of No Action are discussed for both of these endpoints in the following paragraphs, but the actual outcome and the actual effects of No Action on road surface erosion and hillslope erosion are likely to fall between these two scenarios.

<u>Road Surface Erosion</u>

Overview of Effects

The effects of the alternatives on road-related surface erosion and sediment delivery are analyzed in this subsection. It is important to note that, from a historical perspective, road-related surface erosion and sediment delivery to streams has been substantially reduced over time because of improvements in road construction methods, the frequency of maintenance, and the implementation of BMPs (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). The following paragraphs address the likelihood of increased sediment delivery by alternative.

Overall, No Action Alternative 1-Scenario 2 would result in the highest likelihood of fine sediment delivery to streams over the long term, primarily because the eventual rules, under this scenario, would not be outcome-based and would lack the needed flexibility for site-specific situations. In addition, RMAPs would generally not be required, and rules and BMPs that address road drainage would be less protective than for the other alternatives. However, the probability of sediment delivery would be substantially reduced in those areas where Watershed Analysis was performed.

No Action Alternative 1-Scenario 1 (and Alternative 2 and Alternative 3) would reduce road-related sediment from delivering to streams, relative to No Action Alternative 1-Scenario 2, due to~~:~~ 1) improved BMPs, 2) implementation of RMAPs, and 3) an outcome-based and enforceable policy statement that requires resource protection within a 15-year period for large landowners that represent <u>more than half of</u> the ~~majority of~~ covered lands.

The probability of sediment delivery under Alternatives 2 and 3 and No Action Alternative 1-Scenario 1 is expected to be similar since Washington Forest Practices Rules are the same among these alternatives. Alternative 4 would result in a low likelihood of road-generated sediment delivery to streams over the short term and long term when compared to either scenario under the No Action Alternative 1. This outcome would be due to the no net increase restriction on road densities and the shorter timeframe for completion of RMAPs and their implementation.

Detailed Effects Analysis

A detailed analysis of the alternatives is presented in the following subsections.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the January 1, 1999 Washington Forest Practices Rules would be in effect. These rules were intended to control the rate of sediment delivery to streams based on implementation of BMPs. Among the alternatives considered, No Action Alternative 1-Scenario 2 is the only one that would not require RMAPs for most forestlands over the long term. In general, the highest likelihood for sediment delivery to streams from roads would occur under this alternative. Rashin et al. (1999) evaluated the January 1, 1999 Washington Forest Practices Rules and came to a similar conclusion (although the evaluation took place prior to January 1, 1999, the rules evaluated were the same as those in effect on January 1, 1999). However, where Watershed Analysis had been applied, prescriptions were developed to reduce surface erosion for areas where there was a high vulnerability to a public resource, such as fisheries or water quality. Without gaining incidental take authorization under ITPs or ESA Section 4(d) rules, Watershed Analysis, which has decreased since the current Washington Forest Practices Rules were implemented, may be applied more frequently by forest landowners to gain greater certainty in their ability to harvest.

A road maintenance survey was conducted by Washington DNR on 379 miles of State and private forest roads across Washington State. The unpublished draft document concluded that the January 1, 1999 Washington Forest Practices Rules are subjective and inadequate because they do not establish an acceptable limit on how much sediment delivery constitutes resource damage. The delivery of fine sediment from road surfaces to streams is addressed by the rules with statements such as "minimize erosion" or "not conducive to accelerated erosion;" however, the rules do not directly address the desired outcome, which is to avoid resource damage. In addition, the rules do not offer a standard process for landowners and regulators to assess or identify successes and failures relating to resource protection, which can lead to varying compliance expectations throughout the State for landowners, regulators, and the public. The draft report by Washington DNR on road maintenance concluded that the January 1, 1999 Washington Forest Practices Rules emphasize the use of culverts and ditches as the primary means of addressing hydrologic issues, but do not adequately address sediment production. The results of the survey showed that approximately 65 percent of the surveyed roads had direct delivery of sediment to streams (Washington DNR, unpublished draft report, 1999).

In addition, the rules under No Action Alternative 1-Scenario 2 do not result in a landscape-level approach to sediment reduction. RMAPs, which are required under the current rules (and No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4), are a landscape-level or ownership-wide assessment, and would not be mandatory under No Action Alternative 1-Scenario 2 unless Washington DNR assessments indicate an ongoing problem; in this situation, road plans would be required on a case-by-case basis. The rules under No Action Alternative 1-Scenario 2 do not have any specific guidelines or assessment tools in the Washington Forest Practices Board Manual as to when these plans are required. The draft report by Washington DNR on road maintenance concluded that RMAPs appear to assist landowners in identifying and addressing most issues that have the potential to cause resource damage and are effective at providing better protection for public resources; however, surface erosion appeared to be a problem in some areas that had an RMAP (Washington DNR, unpublished draft report, 1999).

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Under these alternatives, the current rules pertaining to forest roads would remain in effect, including RMAP rules. Watershed Analysis would be undertaken less frequently than under No Action Alternative 1-Scenario 2. The approach of the rules under these alternatives (i.e., the current Washington Forest Practices Rules) is specifically designed to reduce road-generated sediment. For new roads, all ditch relief culverts are required to drain onto the forest floor in such a way that no sediment reaches a stream. Research has shown that sediment from relief culverts can travel overland for 100 feet (or more) under certain conditions (Duncan et. al. 1987). Therefore, under these alternatives, the performance-based Washington Forest Practices Board Manual guidance would result in placement of culverts where necessary to minimize sediment delivery to streams. Other conditions, such as slope and soil texture, can make the culvert-to-stream distance even greater.

RMAPs for entire ownerships would be required by 2006 from large landowners. The plans would require the inventory and assessment of all forest roads, including orphan roads. Further, the rules under these alternatives specify that all upgrades to roads must be completed, and new maintenance standards applied to all roads built after 1974, by the end of 2016. Priorities in the rules place activities and locations with the highest potential benefit to fish and water quality early in the maintenance and abandonment schedule. Washington DNR provides guidance and tools necessary for landowners to complete the RMAPs.

Small forest landowners would be required to submit a ~~c~~Checklist ~~type of~~ RMAP with their forest practices application/notification~~s~~ for timber harvest/salvage to include forest roads used in the forest practices application/notification. The 20-acre exempt landowner does not have to submit an RMAP or Checklist RMAP ~~-checklist~~. However, regardless of ownership category or use, ~~covered under the forest practices activities in the application. Roads used or proposed for use, as timber haul routes~~all forest roads must be maintained in a condition that prevents damage to public resources.

RMAPs represent a landscape-level approach that includes prioritization of problem sediment areas and an implementation schedule that would reduce the delivery of chronic sediment to streams. Abandonment plans would prioritize roads for abandonment that would exempt them from future maintenance. This would also result in further reduction of surface erosion from roads and sediment delivery to streams.

Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, the current RMAP rules (WAC 222-24-010(1)) to protect water quality and aquatic and riparian habitats do not explicitly include or recommend tools such as monitoring to measure the effects of roads on the resources. However, the current Washington Forest Practice Rules require annual reviews and meetings with large forest landowners on their road plans, which constitute an informal assessment of the plan's effectiveness. These processes would continue under these alternatives.

Alternative 4

Alternative 4 would substantially reduce road sediment delivery to streams relative to No Action Alternative 1-Scenario 2. There would also be some reduction in road sediment delivery to streams under Alternative 4 compared to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. This is primarily due to the requirement under Alternative 4 of no net increase in forest road densities on State and private timberlands. In addition, Alternative 4 would require the time frame for completion of road maintenance and abandonment plans to be 5 years shorter than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. All landowners would have to submit RMAPs. There would be no difference between the RMAP requirements for small landowners and large landowners as under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Road upgrades and road abandonment in a shorter time period would reduce the total quantity of sediment generated by surface erosion compared to the other alternatives.

Hillslope Erosion

Overview of Effects

A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative in the following subsections. It is important to note that from an historical perspective, hillslope erosion and sediment delivery to streams has been substantially reduced over time due to the implementation of buffers and improved felling, yarding, transport techniques, and BMP implementation (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation).

No Action Alternative 1-Scenario 1 (and Alternative 2 and Alternative 3) would provide full protection for Type S and F streams relative to sediment delivery resulting from hillslope erosion. However, Type N_P and N_S streams would not be fully protected due to narrower buffers along these streams. Even so, relative to No Action Alternative 1-

Scenario 2, No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would result in a low likelihood of sediment delivery from hillslope erosion due to implementation of Equipment Limitation Zones.

No Action Alternative 1-Scenario 2 would result in nearly full protection of hillslope erosion from directly reaching Type 1, 2, and 3 waters. The lack of RMZs along Type 4 and 5 streams would result in a high likelihood of hillslope erosion delivering sediment to these waters. No Action Alternative 1-Scenario 2 represents a return to the January 1, 1999 Washington Forest Practices Rules that were less protective with respect to hillslope erosion than the current Washington Forest Practices Rules. Increased sediment input would be expected under this alternative relative to No Action Alternative 1-Scenario 1 (as well as Alternatives 2, 3, and 4), unless Watershed Analysis is widely and consistently applied.

Alternative 4 would provide full protection of all streams from timber harvest-related hillslope erosion. Alternative 4 would result in greater protection than either scenario of No Action Alternative 1.

Detailed Effects Analysis

Results of the sediment equivalent buffer area index calculations are presented for both western and eastern Washington streams in Figure 4.4-1 for a 30-foot distance from the streambank and in Figure 4.4-2 for a 200-foot distance from the streambank. For ease of comparison, results are presented for all streams, for fish-bearing streams only, and for perennial and seasonal non-fish-bearing streams. It should be noted that the sediment equivalent buffer area index values are expressed as percentages with 100 percent equal to complete protection. The sediment equivalent buffer area index for the 30-foot width assumes that complete protection is provided by a 30-foot no-harvest buffer and the sediment equivalent buffer area index for the 200-foot width assumes that complete protection is provided by a 200-foot no-harvest buffer.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the likelihood of sediment delivery to streams would be high along Type 4 and 5 streams, which would not have established RMZs. Because Type 4 and 5 streams are the most abundant stream types on the landscape (DEIS Appendix B), the likelihood of sediment delivery from harvest-related practices would be high.

The sediment equivalent buffer area index indicates the least protection of streams from hillslope erosion for No Action Alternative 1-Scenario 2 because of the lack of riparian buffers necessary to filter harvest-related surface erosion, particularly along non-fish-bearing streams. Sedimentation effects would be short-term and would persist until sites become re-vegetated. For western Washington streams, No Action Alternative 1-Scenario 2 would provide a sediment equivalent buffer area index of 78 percent assuming a 30-foot width is required for full protection, and 65 percent assuming a 200-foot width is required. For eastern Washington streams, the sediment equivalent buffer area index is estimated at 86 percent for the 30-foot full-protection assumption, and at 67 percent for the 200-foot assumption (Figures 4.4-1 and 4.4-2). These values are separate from the discussion of which total buffer widths are most appropriate, and are simply a method to compare alternatives in terms of filtering effectiveness across given buffer widths on various stream types.

In a study on the effectiveness of the January 1, 1999 Washington Forest Practices Rules at preventing sediment delivery, Rashin et al. (1999) concluded that streamside buffers in place at the time were effective at preventing sediment delivery to Type 1-3 streams. Along Type 4 and 5 streams, which were not buffered, physical impacts included extensive fine sediment deposition and other streambed changes such as increased streambed mobility, burial of substrates by logging slash, and loss of pre-existing LWD. Rashin et al. (1999) concluded that the no-harvest buffers in place at the time were generally effective in preventing sediment delivery, except where flow was channelized. Most erosion features that were identified as delivering sediment occurred within 30 feet of a stream. However, they concluded that many of the BMPs and rules were ineffective, particularly where no RMZs were in place, as was the case prior to 1999 for Type 4 and 5 streams. In another study, Pentec (1991) concluded that the lack of RMZs and associated BMPs on Type 4 and 5 streams was a fundamental flaw in the January 1, 1999 Washington Forest Practices Rules.

The likelihood of sediment delivery to Type 4, Type 5, and other larger streams would be high under No Action Alternative 1-Scenario 2. It should also be noted that the likelihood would be increased for all streams with Channel Migration Zones in this alternative because the rules under this alternative do not include Channel Migration Zone protection as do the current Washington Forest Practices Rules (i.e., No Action Alternative 1-Scenario 1 and Alternatives 2 and 3).

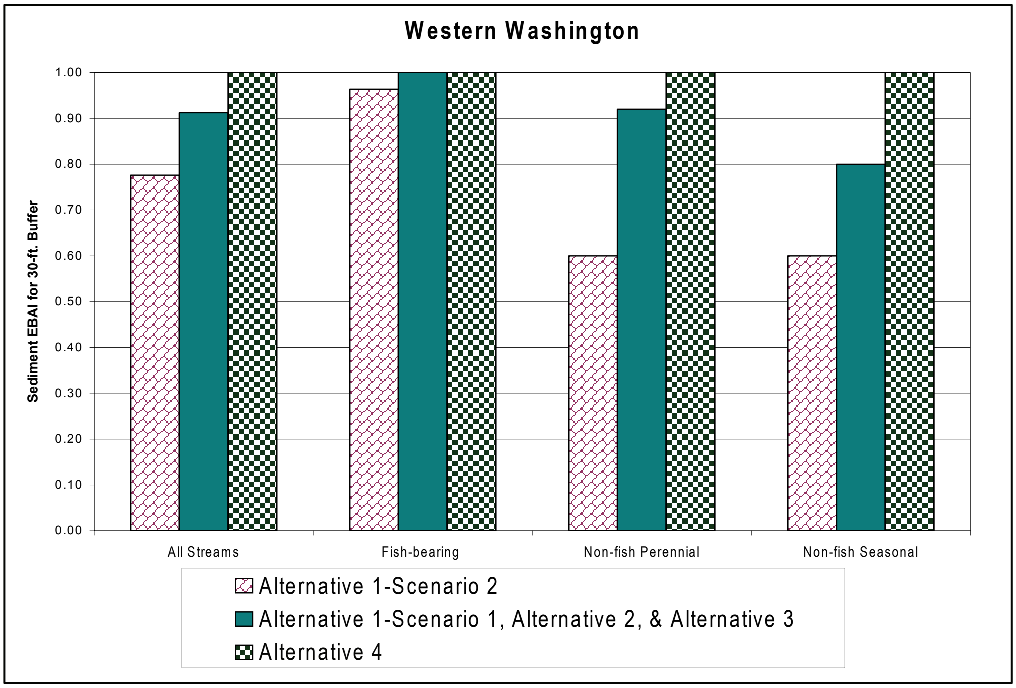
No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Under this group of alternatives (i.e., current rules), the no-harvest portion of RMZs for Type S and F streams (a minimum of 50 feet on the westside and 30 feet on the eastside) would meet or exceed the 30-foot buffer criterion described above under No Action Alternative 1- Scenario 2. Full protection of hillslope erosion would exist along Type S and F streams.

A 30-foot Equipment Limitation Zone would continue to be applied to each side of all Type N_p and N_s streams. Landowners would continue to be required to mitigate (e.g., grass seeding, mulching, or installation of water bars) for the disturbance of more than 10 percent of the soil within any as a result of the use of ground-based equipment, skid-trails, stream-crossings (other than road crossings), or partial (as opposed to fully suspended) suspension of logs during yarding. These Equipment Limitation Zones would

Figure 4.4-1. Equivalent Buffer Area Index (EBAI) for Sediment Summed for all Streams, Fish-Bearing Streams, Perennial Non-fish Streams, and Seasonal Non-fish Streams, by Alternative Normalized by Assuming 100 Percent Protection is Provided by a 30-foot No-Harvest Buffer Width.



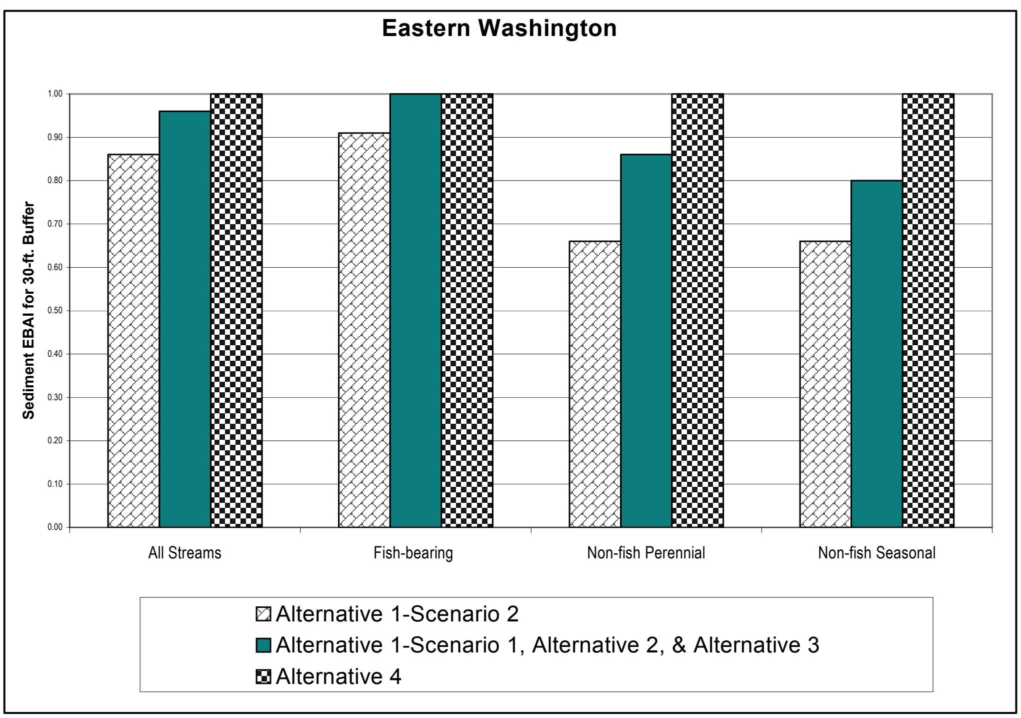
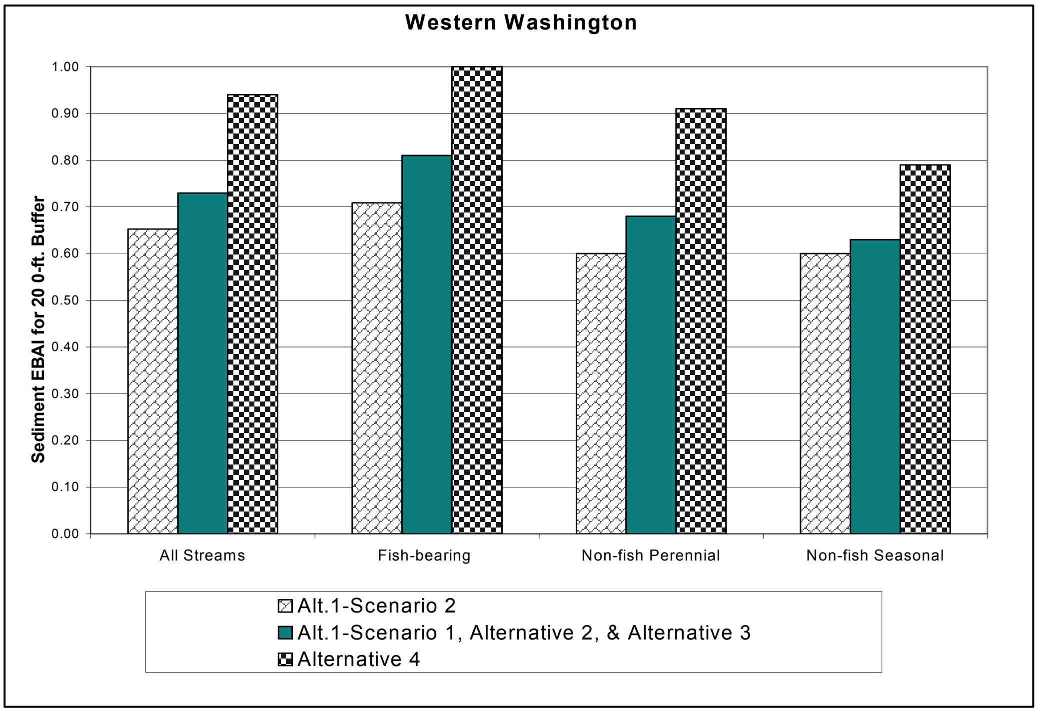
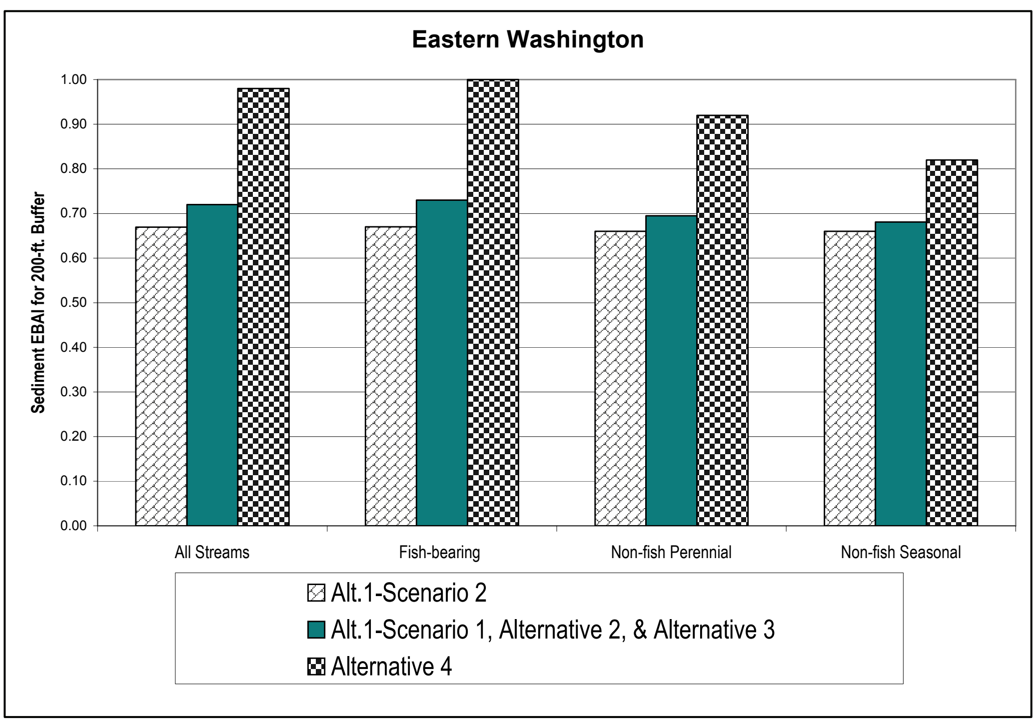


Figure 4.4-2. Equivalent Buffer Area Index (EBAI) for Sediment Summed for all Streams, Fish-Bearing Streams, Perennial Non-fish Streams, and Seasonal Non-fish Streams, by Alternative Normalized by Assuming 100 Percent Protection is Provided by a 200-foot No-Harvest Buffer Width.





continue to reduce the amount of timber harvest-generated surface erosion and subsequent delivery to the stream network.

A minimum of 50 percent of the N_P streams in western Washington would receive 50-foot no-harvest buffers, which exceeds the 30-foot sediment filtration criterion recommended by Rashin et al. (1999). In addition, sensitive sites, such as headwater springs, headwall seeps, side-slope seeps, and Type N_p confluences, are protected by 56-foot radius buffers where no harvest is allowed. In practice, approximately 70 percent or more of N_P streams are receiving these buffers, due to unstable slopes and sensitive area buffers, according to Washington DNR field staff observations.

The no-harvest buffers along many of the N_P streams, and the 30-foot Equipment Limitation Zone along the other Type N_p streams and N_S streams should continue to prevent hillslope sediment from entering streams.

Along Type N_P streams on the eastside, if a landowner were to choose the clearcut option, at least 60 percent of the Type N_p stream length would receive a 50-foot no-harvest buffer. If the partial cut option were to be chosen, a 50-foot selective harvest buffer would be required along the entire length of the Type N_p stream. In cases where harvest would be allowed within the RMZ, the effectiveness of the buffer in filtering sediment would be compromised, but the Equipment Limitation Zone mitigation requirements should reduce any hillslope erosion from entering streams.

The sediment equivalent buffer area index for effective riparian sediment filtration shows that these alternatives, including No Action Alternative 1-Scenario 1, would have a much greater buffering effect for sediment filtration, compared to No Action Alternative 1-Scenario 2. The estimated equivalent buffer area index values are 91 percent for the westside and 96 percent for the eastside assuming a 30-foot width is required for full protection, and 73 percent for the westside and 72 percent for the eastside assuming a 200-foot width is required for full protection (Figures 4.4-1 and 4.4-2). However, these alternatives do not provide full protection of timber harvest-related surface erosion, specifically along Type N_P and N_S streams that do not have 50-foot no-harvest buffers. Sediment equivalent buffer area index values for these streams are estimated at 80 percent for the 30-foot full-protection assumption and between 63 and 68 percent for the 200-foot full-protection assumption.

Alternative 4

The no-harvest buffers on all stream types under Alternative 4 far exceed the 30-foot buffer criterion recommended by Rashin et al. (1999). Therefore, all streams would be fully protected from hillslope erosion delivery of sediment under the 30-foot full-protection assumption when compared to either scenario of No Action Alternative 1. The sediment equivalent buffer area index under the 200-foot full-protection assumption is estimated at 94 percent for westside streams and 98 percent for eastside streams for this alternative (Figures 4.4-1 and 4.4-2).

4.4.2 Mass Wasting

Mass wasting is a natural occurrence; however, forest road construction and timber harvest have been shown in a variety of studies to significantly increase the frequency and magnitude of mass wasting events in potentially unstable areas (subsection 3.4.2, Erosion). The Washington Forest Practices Rules are designed to reduce the frequency and magnitude of debris flows, but when they occur, they also ensure that large, whole trees are available for recruitment to non-fish and fish-bearing streams.

In the past three decades, a greater level of understanding, greater restrictions on harvest, and more requirements for mitigation related to potentially unstable areas has substantially decreased landslide frequency from historical levels (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation; DEIS Appendix A).

4.4.2.1 Mass Wasting Evaluation Criteria

Whether or not a particular slope will fail at any given time is dependent on a variety of variables, including precipitation rate and quantity; soil moisture; hydrology; slope aspect, length, and curvature; the internal strength of the slope material, (Coates 1990; Dragovich et al. 1993a), and root strength of vegetation (Harp et al. 1997; Schmidt et al. 2001; Roering et al. 2003). Disturbances, including timber harvest and road building, that compact or weaken slope material, change the hydrology of the slope, or undercut marginally stable slopes can trigger mass wasting events (Rollerson et al. ~~1973~~1997; Swanson and Dyrness 1975; Amaranthus et al. 1985; Dragovich et al. 1993b; Gerstel 1996). Increased levels of planning and analysis can reduce the likelihood of landslides by identifying and avoiding potentially unstable landforms, as can minimizing disturbance from harvest activities in these areas (Gerstel 1994; Rashin et al. 1999; Dhakal and Sidle 2003). The likelihood of management-related mass wasting is discussed separately in relation to forest roads, timber harvest, and streambank stability.

To achieve avoidance of unstable areas and protection from road-related landslides, there are three factors that must be considered when assessing the effectiveness of a given strategy or alternative for minimizing mass wasting: 1) to what degree do the rules adequately define unstable slopes and landforms across the landscape (i.e., how good are the definitions), 2) what mechanisms are in place to ensure unstable slopes and landforms are detected during the forest practices application review process (i.e., screening tools and training programs), and 3) how effective are the rule procedures or prescriptions in minimizing mass wasting (i.e., level of avoidance or mitigation required by the rules based on adequate definitions and screening processes)? The factors required for meeting these criteria are evaluated below with respect to both road- and harvest-related mass wasting.

<u>Road-related Landslides</u>

The potential for road-related landslides depends on both the location of roads in relation to unstable areas and on how the roads are designed, built, and maintained (Rashin et al. 1999; USDA Forest Service 2001). Therefore, additional evaluation criteria for this episodic source of sediment impacts are: 1) the degree to which unstable slopes would be avoided under each alternative, and 2) the degree of protection from road-related landslides provided by the Washington Forest Practices Rules.

Chapter 222-24-050 through 052 of the WAC (See also Washington Forest Practices Board 2002) describe the reasoning, schedule, and requirements for road maintenance and abandonment for forest roads, including RMAPs, which are currently required analyses and plans to be submitted by forest landowners to Washington DNR. The purpose of the RMAP program is to evaluate and prioritize the maintenance and abandonment of forest roads by addressing roads in most need of these actions first, as demonstrated by a well-defined set of maintenance and abandonment criteria designed to protect surface waters from sediment input, and resources from road-related mass wasting events. The need for improvement of road maintenance and abandonment practices over the requirements of the rules in effect on January 1, 1999, is described in Rashin et al. (1999).

Landslides Related to Timber Harvest

Mass wasting related to timber harvest is most likely to occur on steep slopes and specific landforms that are highly susceptible to mass failure. The initiation of landslides from management activities can occur in both riparian areas and upslope areas. The evaluation criterion for harvest-related landslides is based on the degree of protection provided to unstable areas under each alternative. This assessment considers the protection of unstable slopes upslope from RMZs that may buffer upslope landslides and landslides that may occur in RMZs.

Streambank Stability

The evaluation of timber harvest effects on streambank stability is based on RMZ widths and activities allowed within the RMZ that may affect root strength and thus streambank integrity. For this analysis, one-half of a tree crown diameter (which is in the range of 0.3 site potential tree height) is assumed to be a sufficient width for the maintenance of streambank stability. The rationale for the value of 0.3 site potential tree height is based on the curve for root strength on page V-27 of the FEMAT (1993) report. Consideration is also given to the composition of riparian species because of differences in the root morphology and relative root strength of conifers, deciduous trees, and shrubs. Bank stability is a relative term. Bank erosion is a natural process that on the one hand provides LWD and sediment for the benefit of aquatic ecosystems, while on the other hand, bank erosion beyond natural rates and durations may be detrimental to aquatic ecosystems (LWD overloading, channel shifting and bedload aggradation, changes in width/depth ratios, and possible increased stream temperatures). This subsection evaluates how the alternatives protect bank stability and integrity relative to natural conditions and processes.

4.4.2.2 Evaluation of Alternatives

The effects of the alternatives on road related landslides are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1, no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on road surface erosion and hillslope erosion are likely to fall between these two scenarios.

<u>Road Related Landslides</u>

Overview of Effects

The effects of the alternatives on road-related landslides and sediment delivery are analyzed in this subsection. There is no comprehensive statewide data available for historical or current management-related landslide frequency compared to natural levels. However, even the January 1, 1999 Washington Forest Practices Rules were much more protective of unstable slopes than historic rules (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation); therefore, it is likely that the frequency of road-related mass wasting events would be reduced under any of the alternatives, relative to historic conditions.

Compared to the No Action Alternative 1-Scenario 1, No Action Alternative 1-Scenario 2 would result in an increased likelihood of road-related landslides because: 1) under the January 1, 1999 Washington Forest Practices Rules the unstable slope screening process did not identify some unstable areas, 2) there were no comprehensive screening process required to identify unstable areas on all forestlands, 3) the rules and BMPs that address road drainage were inadequate, and 4) while forest landowners would continue to be required to do road maintenance, there would be no requirements for RMAPs and schedule for completion of road repairs.

No Action Alternative 1-Scenario 1 (as well as Alternative 2 and Alternative 3) would result in a continued low to moderate likelihood of road-related landslides because: 1) the unstable slope screening process under the current Washington Forest Practices Rules is more refined and relies on a more complete and specific set of definitions and requirements for evaluating the potential for landslides than under the January 1, 1999 Washington Forest Practices Rules, 2) the Washington Forest Practices Rules and BMPs that address road drainage are substantially strengthened over the January 1, 1999 Washington Forest Practices Rules, 3) RMAPs are required for forestland owners, and 4) training programs for identifying potentially unstable slopes are being implemented by Washington DNR. Compared to No Action Alternative 1-Scenario 2, this group of alternatives has a lower likelihood of road-related mass wasting.

Alternative 4 would result in the lowest likelihood of road-related landslides relative to either scenario of the No Action Alternative 1 because: 1) there would be no net increases in roads, 2) the rules and BMPs that address road drainage would be more protective than the current Washington Forest Practices Rules, 3) RMAPs would be required in the shortest timeframe, and 4) there would be a broader set of definitions of potentially unstable slopes than under the other alternatives.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, it is assumed that the January 1, 1999 Washington Forest Practices Rules would govern forest practices. No Action Alternative 1-Scenario 2 would be the least protective of the alternatives in terms of avoidance of unstable slopes. As discussed above under Road Surface Erosion, RMAPs would not be required over the long term under No Action Alternative 1-Scenario 2. The construction of roads on potentially unstable slopes increases the probability of road-related failures (Swanson et al. 1987). The mechanisms for identifying potentially unstable slopes and landforms were not comprehensive under the January 1, 1999 Washington Forest Practices Rules, and definitions were incomplete. The likelihood of not identifying potentially unstable slopes due to inadequate screening would be high under this alternative. However, under this scenario, Watershed Analysis may be conducted more frequently than under the current Washington Forest Practices Rules and may reduce the potential for road building on unstable slopes. Watershed Analysis is effective at identifying unstable slopes, and at defining suitable prescriptions that would minimize the potential of failure due to roads, when it is applied.

Landforms with a high potential for mass wasting would most likely be identified in forest practices applications, or in subsequent reviews, and classified as Class IV-Special. A Class IV-Special forest practices application covers practices where there is a potential for substantial impact to the environment such as aquatic habitat, water quality, and cultural resources.

The January 1, 1999 Washington Forest Practices Rules also have few specific guidelines that directly address road-related mass wasting issues such as road drainage. Road-related landslides can be caused by road drainage problems such as plugged culverts and inadequately spaced cross drains and/or road construction on potentially unstable slopes (Rashin et al. 1999; USDA Forest Service 2001). Problems can result from inadequate construction and maintenance. The rules under No Action Alternative 1-Scenario 2 require culverts and bridges to pass a 50-year flow event. Cross drains are only required every 600 to 1,000 feet depending on road gradient. Rashin et al. (1999) concluded that the most common drainage problems that caused resource damage to streams were undersized culverts and inadequate cross drain spacing; the most common maintenance related drainage problem was the maintenance of functional inlets (i.e., the drains from roadside ditches that divert water under the road through a culvert).

In addition, the January 1, 1999 Washington Forest Practices Rules do not address drainage onto unstable slopes. Road drainage onto unstable areas can initiate mass wasting and the drainage onto unstable areas may not be identified when a forest practices application is reviewed; thus, a road built on stable ground may drain water onto potentially unstable areas. The drainage of water onto steep slopes can increase the likelihood of slope failure (USDA Forest Service 2001). Where Watershed Analysis is conducted, the prescriptions for mass wasting could address and reduce the likelihood of road-related landslides.

Studies by Toth (1991) and Oregon Department of Forestry (1999a) found that newer roads (younger than 10 years old) experienced a lower rate of mass wasting than older roads. Because there is no requirement under No Action Alternative 1-Scenario 2 to upgrade roads to current construction standards unless a public resource has been damaged or there is a potential for damage to a public resource, the thousands of miles of older roads (both active and inactive) and orphan roads that currently exist in statewide forests could continue to fail over time and likely deliver large quantities of sediment to the drainage network. If active or inactive roads are damaging public resources, the Washington DNR would have the authority to require the repair of these roads under this alternative.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would provide more protection and result in a lower likelihood of road-related landslides than under No Action Alternative 1-Scenario 2. The identification and definitions of potentially unstable slopes and landforms have improved substantially in the current rules (which would be in place under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3), compared with the January 1, 1999 Washington Forest Practices Rules (which would be in place over the long term under No Action Alternative 1-Scenario 2). All Forest Practices applications would be screened for potentially unstable slopes and landforms. Field verification requirements and qualifications of personnel who may field verify and design mitigation are codified under the current Washington Forest Practices Rules (WAC 222-10-030, 222-16-050(1)(d); Washington Forest Practices Board Manual 2000, Section 16) and would continue to be in effect. The Washington DNR has implemented a training program for identification of potentially unstable slopes and landforms and this would continue; however, there is a high likelihood that funding would not be adequate to continue the training program under No Action Alternative 1-Scenario 1 and may not be adequate under Alternative 3.

As would be the case under any of the alternatives, new roads built on potentially unstable slopes would require greater scrutiny if the forest practices application is processed as a Class IV-Special. Class IV-Special applications currently require a specific Washington State Environmental Policy Act (SEPA) review including a site evaluation by a qualified expert and a detailed mitigation plan. However, a more refined screening method would be used to identify potentially unstable slopes during forest practices application reviews so that these slopes are more likely to be identified. This more refined screening process would reduce the likelihood of road construction on high hazard mass wasting areas and reduce the potential of failure on slopes and landforms with a high potential for failure. As under the current rules (No Action Alternative 1-Scenario 1 and Alternatives 2 and 3), roads would often be located away from unstable slopes to avoid resource impacts, minimize forest practices application approval time for road building, and reduce the costs associated with building on unstable areas.

Road drainage rules under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would reduce over time drainage-related road failures such as plugged culverts, particularly relative to No Action Alternative 1-Scenario 2. More specific BMPs currently exist in the Washington Forest Practices Board Manual (Scenario 1) that address road drainage than under the January 1, 1999 Washington Forest Practices Rules (Scenario 2). Some of these include: outsloping roads so runoff drains onto slopes, more frequent cross-drain spacing, and installation of new culverts that can pass a 100-year flow event. Maintenance BMPs include removing debris from culvert outlets and inlets after major storm events and preventative ditch maintenance.

While under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) the Washington Forest Practices Rules and Board Manual do not explicitly consider that roads located on stable slopes may drain onto potentially unstable slopes (e.g., a ridge-top road that drains water onto convergent headwalls) without initiating a Class IV-Special application, the Washington DNR can use conditioning authority to screen for unstable slopes, thus helping to mitigate for this potential impact.

Under No Action Alternative1-Scenario 1 (and Alternatives 2 and 3), existing culverts would be replaced unless they meet the following three requirements: 1) pose “little risk to public resources,” 2) “have been properly maintained,” and 3) are “capable of passing fish” (WAC 222-24-050). The Washington Forest Practices Rules regarding RMAPs are intended to prevent failure of existing culverts by requiring maintenance and replacement of culverts that pose a substantial threat to public resources. Many culverts exist on Type N_p and N_s streams. If damage to public resources is imminent, DNR can require that the existing culvert must be replaced sooner, rather than at the end of its lifespan.

The current Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) require large forest landowners to upgrade all roads on their ownership to current construction standards by 2016 (WAC 222-24-050). RMAPs would describe the landowner’s intended strategies to improve all roads to current construction standards set forth in WAC Chapter 222-24. The current rules are consistent with standards studied by Toth (1991) and Oregon Department of Forestry (1999a), which demonstrate that they have a much lower rate of mass wasting (e.g., failure) than older roads constructed under older standards.

Small forest landowners are required to address road-related problems at the time they submit a forest practices application to the DNR. Culvert repairs are prioritized within a watershed so that the repairs that provide the greatest benefits to aquatic resources are fixed first and generally based on available public funding.

Under No Action Alternative 1-Scenario 1 (and Alternative 2 and 3), the implementation of RMAPs for large landowners would substantially reduce the likelihood of road-related landslides compared to No Action Alternative 1-Scenario 2. Orphan roads would be inventoried and assessed. After the inventory and assessment, an evaluation would be made to determine the scope of the problem presented by the orphan roads, and if cost-sharing would be needed to repair the orphan roads problems. Where orphan roads are abandoned, further reduction of potential mass failure of roads, sediment delivery to streams, and potential debris torrent initiation would occur. No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would preserve the existing process for RMAPs, assessment of orphan roads, and maintain current rules protecting potentially unstable slopes.

Alternative 4

Under Alternative 4, the likelihood of road-related mass wasting would be lower than either scenario under No Action Alternative 1. Alternative 4 includes a "no net increase" rule for forest roads within a basin. The "no net increase" in roads on a per unit area basis would reduce the probability of failure because fewer additional roads would be constructed, and some roads would be eliminated. Whenever a new road is proposed, an equivalent amount of road on the same property or the same basin would have to be abandoned using the abandonment guidelines in the current Washington Forest Practices Rules. Alternative 4 also has an even more conservative approach to unstable landforms than the current rules: all slopes greater than 80 percent are considered high hazard. Rules would require no-harvest on these slopes in addition to a 50-foot no-harvest buffer around high hazard slopes. Also, activities on slopes greater than 50 percent would trigger the SEPA review process and be classified as a Class IV–special forest practices application. Additionally, Alternative 4 would not have different requirements for RMAPs for small landowners and would require that RMAPs be implemented by 2011, rather than 2016, and would not have a 20-acre parcel exemption.

The shorter time period for RMAPs, which include orphan roads, decreases the likelihood of mass wasting because the potential for failure of older roads would be reduced by five years. Roads on stable slopes that drain onto potentially unstable slopes would not be classified as Class IV-Special applications, resulting in the same likelihood of mass wasting from this impact as under No Action Alternative 1-Scenario 1. Alternative 4 would result in an overall reduction of road-related sediment from entering the drainage network.

Landslides Related to Timber Harvest

Overview of Effects

This subsection evaluates the alternatives in terms of the likelihood of timber harvest-related landslides. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative, in the following subsections.

There are no comprehensive statewide data available for historical or current landslide frequency due to timber harvest compared to natural levels. However, the January 1, 1999 Washington Forest Practices Rules were much more protective of unstable slopes than historic rules (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and

Sedimentation); therefore, it is likely that the frequency of timber harvest-related mass wasting events would be reduced under any of the alternatives relative to historic conditions.

No Action Alternative 1-Scenario 2 would result in a return to January 1, 1999 Washington Forest Practices Rules. As such, the likelihood of harvest-related landslides and damage to public resources (including surface water quality and habitat) would increase from the status quo, be higher than under No Action Alternative 1-Scenario 1, and be highest relative to all other alternatives because: 1) under the January 1, 1999 Washington Forest Practices Rules the unstable slope screening process did not identify some unstable areas, and 2) there would be no comprehensive screening process required to identify unstable areas on all forestlands. Additionally, No Action Alternative 1-Scenario 2 would result in an increased likelihood of harvest-related landslides delivering to streams relative to the other alternatives, primarily due to the low frequency of RMZ protection along steep Type 4 and 5 streams.

No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would provide the same current levels of protection and more protection than under No Action Alternative 1-Scenario 2 because: 1) the unstable slope screening process would be more refined and rely on a more complete and specific set of definitions and requirements for the evaluation of landslides than under the January 1, 1999 Washington Forest Practices Rules, and 2) training programs for identification of potentially unstable slopes would be implemented by the Washington DNR (although funding for this training may disappear over time under No Action Alternative 1-Scenario 1 and may be reduced over time under Alternative 3). While No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would provide greater protection for sediment delivery relative to No Action Alternative 1-Scenario 2, this group of alternatives would still result in a slight to moderate likelihood of harvest-related landslides delivering to streams.

Alternative 4 would provide the greatest protection for potentially unstable slopes and landforms compared to either scenario of No Action Alternative 1, because: 1) there would be a broader set of definitions of potentially unstable slopes, and 2) the amount of protection and buffered area would increase on and around potentially unstable areas. Thus, Alternative 4 would likely have a lower rate of harvest-related landslides relative to either scenario of the No Action Alternative 1.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, some landforms with a high potential for mass wasting would most likely be identified during processing of the forest practices application. However, there would be little incidental protection of potentially high hazard slopes because there would be no RMZs for Type 4 and 5 waters, which constitute approximately 50 to 60 percent of all streams on the landscape (DEIS Appendix B). RMZs of fish-bearing typed waters (Type 1, 2, and 3) provide some incidental protection of areas with a high mass wasting potential; however, short-term losses to windthrow may impair the effectiveness of these buffers by reducing stand density and causing soil disturbance, and therefore reducing the filtering capacity of the buffer in the short term.

Under No Action Alternative 1-Scenario 2, the only protection provided for small tributary junctions and steep channel gradients would be if they triggered a Class IV-Special application based on the likelihood of being unstable and having a potential to substantially impact a public resource. Because these areas receive no specific protection under the January 1, 1999 Washington Forest Practices Rules, there is a moderate likelihood of debris torrents. The steep small tributary streams tend to be first- and second-order streams that would be Type 4 and 5 waters (See Glossary). Except for very limited situations, these streams have no buffers to protect them from management activities.

Once a debris flow is initiated, RMZs along high order streams may act to reduce channel impacts. The streams most susceptible to riparian damage by channelized debris flows tend to have gradients greater than 20 percent (Coho and Burges 1991). On the westside, most streams with gradients greater than 20 percent are Type 4 and 5 waters (DEIS Appendix B); these streams would receive no riparian buffers that might help mitigate impacts from channelized debris flows under No Action Alternative 1-Scenario 2. Lower gradient streams (Types 1-3) would receive some protection from debris flow impacts and sediment input. An assumption of a “fencing effect” on landslide “runout,” deposition, and sedimentation is based on the observations of Johnson et al. (2000) of landslides that occurred immediately following a single storm event of more than 300 landslides on Prince of Wales Island, Alaska. A “fencing effect” results from standing riparian trees that serve as roughness elements, which slow the landslide travel rate and reduce the travel distance (i.e., “runout”). Landslides studied that started and remained in old-growth forests were more likely to split or remain unchannelized, contained more woody debris, and had less erosion and more deposition along the runout zone compared to landslides that occurred in clearcuts without riparian buffers. The authors estimated that more fine sediment would migrate further down tributary channels to mainstem channels as a result of less woody debris and depositional features along the runout path.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Relative to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would provide more specific definitions of potentially unstable slopes and landforms. Under this group of alternatives, all forest practices applications would be screened for potentially unstable slopes and landforms. Field verification requirements and qualifications of personnel who may field verify and design mitigation would remain codified (WAC 222-10-030, 222-16-050(1)(d); Washington Forest Practices Board Manual 2000, Section 16), and the Washington DNR would continue implementing a training program for identification of potentially unstable slopes and landforms (although funding for this training may disappear over time under No Action

Alternative 1-Scenario 1 and may be reduced over time under Alternative 3). As would be the case under any of this group of alternatives, new roads built on potentially unstable slopes would require greater scrutiny if the forest practices application is processed as a Class IV-Special. Class IV-Special applications currently require a specific SEPA review including a site evaluation by a qualified expert and a detailed mitigation plan. A more refined screening method would be used to identify potentially unstable slopes during forest practices application reviews so that these slopes are more likely to be identified. This more refined screening process would account for regional and local variations in soils, geology, and topography. Because of the screening tools that trigger Class IV-Special (e.g., the slope morphology model (SMORPH), improved definitions in the Washington Forest Practices Board manual, as well as review of the application by qualified Washington DNR personnel familiar with the landslide hazards in the area) it would be more likely that potentially unstable slopes would be identified, and more applications would be classified as Class IV-Special by the Washington DNR. As a result, more landowners would modify their applications to avoid unstable slopes and thereby avoid the requirements of a Class IV-Special application.

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), areas of high susceptibility to debris torrents (i.e., steep tributary channels) would receive greater protection than under No Action Alternative 1-Scenario 2. If the areas of high susceptibility are on specific high hazard landforms and have the potential to deliver sediment to a public resource or threaten public safety, the forest practice would be a Class-IV Special, and mitigation would be necessary for the management activity to occur. Also, sensitive areas such as headwall and sideslope seeps, springs, and Type N_p confluences would receive a 56-foot radius no-harvest buffer in western Washington and a 50-foot no-harvest buffer in eastern Washington. Seasonal non-fish-bearing streams (Type N_s), as well as the unbuffered portions of perennial streams (Type N_p) would continue to receive protection from Equipment Limitation Zones. Management activities are allowed in Equipment Limitation Zones, but with specific mitigation requirements for any soil disturbance greater than 10 percent of the Equipment Limitation Zone area. Local buffer effectiveness may be impaired in some cases due to short-term losses to windthrow. There is still a low to moderate likelihood of debris torrents initiation because of potential for management activity in areas of susceptibility.

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), approximately 75 percent of streams less than 20 percent gradient would have Type S and F buffers, and 25 percent would have Type N buffers (DEIS Appendix B). These buffers would provide some, but not necessarily full protection in the form of a fencing effect for debris torrents, and may be subject to short-term losses to windthrow. As a result, these alternatives would have a slight to moderate likelihood of harvest-related landslides delivering to streams.

Alternative 4

Under Alternative 4, potentially high hazard areas identified during forest practices application review would automatically trigger a Class IV-special classification, would be treated as a no-harvest area, and would be protected by a 50-foot no-harvest buffer around the perimeter of the unstable slope or landform. Alternative 4 provides the most protection from mass wasting and delivery of sediment to streams due to timber harvest relative to both scenarios in No Action Alternative 1. Alternative 4 also anticipates further rule development for areas of moderate potential slope instability.

The no-harvest RMZs under Alternative 4 would protect steep stream channel junctions. This would probably reduce the frequency and downstream impacts of debris torrents. Also, under Alternative 4, no timber harvest or road activity is permitted on high hazard slopes. Incidental protection of steep tributary junctions would also be provided if the tributary junction areas are considered high hazard mass wasting areas. Streams with channel gradients of 20 to 30 percent would receive 100-foot buffers, and streams with gradients greater than 30 percent would receive 70-foot buffers. Further, Channel Disturbance Zone buffers would be retained along steep streams that have a high potential for channelized landslides. These buffers should provide partial protection for streams from potential sediment inputs. Because buffer widths are wider under Alternative 4, they are more likely to be windfirm and thus more likely to function without short-term losses to blowdown.

Streambank Stability

Overview of Effects

The effects of the alternatives on streambank stability are based on RMZ widths and activities allowed within the RMZ, or the stream channel that may affect root strength and, thus, streambank integrity are summarized here and analyzed in more detail in the following subsections.

No Action Alternative 1-Scenario 2 would generally provide protection for bank stability and integrity along Type 1, 2, and 3 streams. However, bank stability would not be protected along Type 4 and 5 streams; therefore, increased high bank instability is likely along these small streams. Because of the amount of historic logging to streambanks, it is likely that ~~even~~ this alternative would result in an improvement in bank stability relative to historic conditions in riparian zones of the State.

No Action Alternative 1-Scenario 1, (and Alternatives 2 and 3) would also protect bank stability along fish-bearing streams and many non-fish-bearing streams, except along those non-fish-bearing streams that lack RMZs. Felling and yarding activities that occur in and across these steam channels would further compromise bank stability in non-fish-bearing streams lacking RMZs. However, some protection would be provided by Equipment Limitation Zones. This group of alternatives would be expected to provide more protection for bank stability than No Action Alternative-Scenario 2.

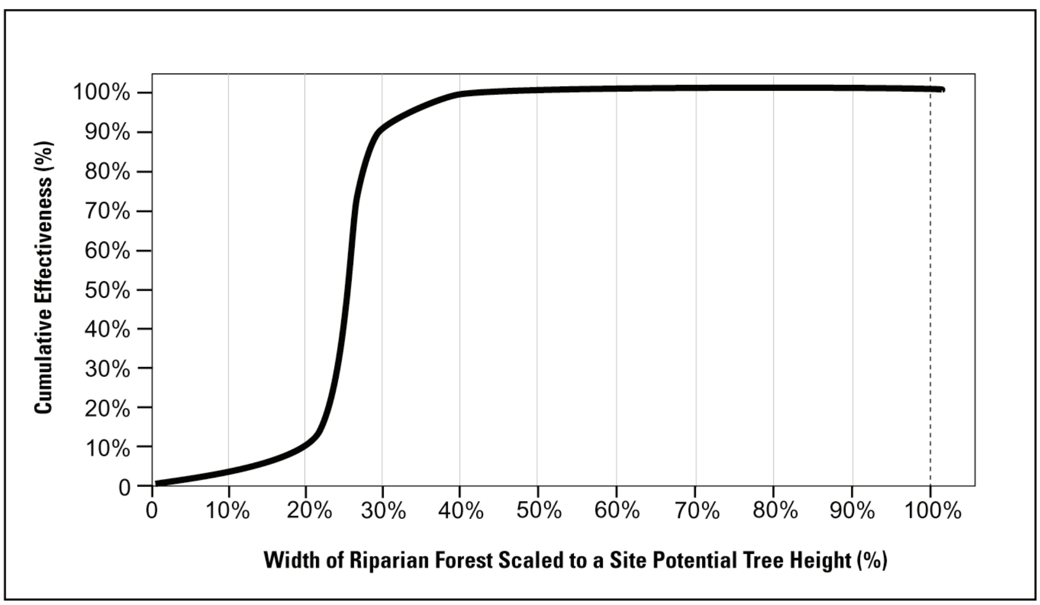
Alternative 4 would fully protect bank stability along all streams by requiring no-harvest riparian buffer zones of at least 70 feet along all streams. Under Alternative 4, bank stability protection would be expected to be substantially more than under No Action Alternative 1-Scenario 2, and somewhat more than under No Action Alternative 1-Scenario 1.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

In western Washington, No Action Alternative 1-Scenario 2 (January 1, 1999 Washington Forest Practices Rules) would fully maintain streambank stability based on the RMZ buffer widths for Type 1, 2, and 3 streams when the maximum RMZ widths are implemented and no harvest occurs within the RMZ. However, the minimum RMZ width of 25 feet does not meet the one-half crown diameter (0.3 site potential tree height) required for complete maintenance of streambank stability as described by FEMAT (1993, p. V-27) (Figure 4.4-3). For each stream type, RMZ width can vary depending on the extent of wetland vegetation and the width needed to meet shade requirements, from a minimum of 25 feet to a maximum of 200 feet (Figures 2-1 and 2-2). In cases where shade requirements are met, selective harvest could occur adjacent to the stream channel, compromising rooting strength and increasing the likelihood of impacts to the streambank. However, a greater number of leave trees are provided in RMZs along less stable stream channels (i.e., gravel/cobble channels) and this aspect may slightly reduce the likelihood of negative effects. For streams that do not meet the established criterion of one-half crown diameter (0.3 site potential tree height), combined with the selective harvest prescriptions, the likelihood of reducing root strength and, therefore, streambank stability, would increase. This is because January 1, 1999 rules offered only minimal streambank protection by requiring operators to avoid disturbance of brush, stumps, and trees that display large root systems embedded in the bank in the RMZ core zone for Type S and F waters, and RMZs for Type Np waters.

Figure 4.4-3. Percent Effectiveness of Root Strength in Relation to the Distance from the Stream Channel.



Source: FEMAT 1993

In eastern Washington, streambank stability would be fully maintained along Type 1, 2, and 3 streams when the maximum and average RMZ widths are implemented. Site class I would require a wider RMZ to provide a sufficient width buffer to maintain streambank stability. However, minimum RMZ widths of 30 feet would fully maintain streambank stability for all other site classes (Figure 4.4-3). In both western and eastern Washington, the possibility of harvest activity within the RMZ under No Action Alternative 1-Scenario 2 leaves the possibility that root strength would be compromised and the streambank potentially damaged. However, selective harvest does maintain some streambank integrity through root strength and minimizes further streambank damage relative to clearcutting, as would the requirement to avoid disturbing brush and stumps, including their root systems (WAC 222-30-030).

The greatest potential for adverse effects is for Type 4 and 5 streams that would have no leave tree requirements, and where timber harvest and yarding could occur adjacent to, in, and across the stream. For Type 4 and 5 waters, RMZs would not be required except for site-specific conditions and, in this case, would not exceed 25 feet. Therefore, RMZs under the January 1, 1999 Washington Forest Practices Rules for Type 4 and 5 streams would not meet the one-half crown diameter (0.3 site potential tree height) required for complete protection as described in FEMAT (1993, pV-27). Type 4 and 5 streams are small, tend to be moderately or highly confined, and have less erosive power; therefore, they do not necessarily require expansive buffers for streambank stability maintenance. However, Type 4 and 5 streams are susceptible to other processes such as mass wasting and peak flows, which could affect streambank stability. The lack of an RMZ along most of these smaller streams means that Type 4 and 5 waters would receive no streambank stability protection. Further, streambank stability could be severely compromised when felling and yarding are allowed in, or across, Type 4 and 5 streams and when logging slash is allowed to remain in streams following logging.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), existing forest practices rules would continue. Under these rules all Type S and F streams would have RMZ widths that exceed the width recommended by FEMAT (1993, p. V-26) for full maintenance of streambank stability. On the westside, the 50-foot no-harvest zone adjacent to the streambank (or Channel Migration Zone) combined with the selective harvest inner zone under Management Option 1 (as described in Chapter 2, for F and S streams, calls for thinning from below in the inner zone and 20 riparian leave trees per acre in the outer zone), should provide sufficient rooting strength to fully maintain streambank stability. Additional protection due to the no-harvest floor adjacent to the 50-foot no-harvest zone under Management Option 2 would provide even greater maintenance of streambank stability (as described in Chapter 2, for S and F streams, enough Riparian Leave Trees must be left in the inner zone to meet the Stand

Requirements, plus an additional 20 Riparian Leave Trees per acre in the outer zone. If the no-harvest restriction in the core zone results in conditions that would exceed the Stand Requirements, fewer trees may be left in the outer zone). On the eastside, the 30-foot no-harvest zone adjacent to the streambank (or Channel Migration Zone) combined with the selective harvest inner zone should fully maintain streambank stability. Overall, these three alternatives would provide substantially more protection of streambank integrity than No Action Alternative 1-Scenario 2 along Type S and F streams.

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), at least 50 percent of a Type N_p streams' length would receive a 50-foot RMZ (DEIS Appendix B); and these segments would have most of the protection required to maintain bank stability, according to FEMAT (1993). In addition, Type N_p streams are much smaller, tend to be moderately or highly confined, and have less erosive power than Type S or F streams, therefore, they do not necessarily require extensive buffers to maintain streambank stability. For other segments of Type N_p streams and for all N_s streams, no RMZ would be provided except in cases where trees are retained for the protection of unstable slopes. However, all Type N streams would receive some protection because of the 30-foot Equipment Limitation Zones that would be implemented. These zones would provide substantially more protection than conditions under No Action Alternative 1-Scenario 2. However, as under No Action Alternative 1-Scenario 2, the lack of an RMZ restricting timber harvest on these smaller streams means that some Type N_p and all N_s streams would not receive complete bank stability protection.

Alternative 4

Under Alternative 4, the RMZ width and no-harvest requirements in the RMZs would meet or exceed the current recommendations in the literature (0.3 site potential tree height no-harvest buffers) for full maintenance of streambank stability on most streams. According to FEMAT (1993), all streams on both the east and westside would be completely protected (Figures 2-1 and 2-2). In addition, where there are small channels that have potential slope stability issues, Channel Disturbance Zone buffers would provide additional protection (Table 2-15). Thus, under Alternative 4, greater bank stability protection would be expected compared to No Action Alternative 1-Scenario 2, and somewhat more than under No Action Alternative 1-Scenario 1.

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4.5 WATER RESOURCES

Water resources include groundwater and surface water resources. Water occurring in the hyporheic zone, defined as the zone of mixing between groundwater and surface water along a stream system, is also discussed in this subsection, as it can contribute to either surface water or ground water quality or quantity. It is also discussed in subsection 4.8 (Fish and Fish Habitat) as a habitat component.

4.5.1 Surface Water Quality

Effects on surface water quality are discussed in terms of effects on temperature, sediment and turbidity, dissolved oxygen concentration, level of contamination by pesticides (insecticides, herbicides, and fungicides), and nutrient concentrations.

4.5.1.1 Evaluation Criteria

Temperature

Many factors can influence stream temperature, such as shade, air temperature, groundwater inflow, channel width, ratios of channel width to channel depth, and watershed conditions (Brosofske et al. 1997; Johnson and Jones 2000; Bartholow 2002; MacDonald et al. 2003; Sridhar et al. 2004; Curry et al. 2004). Forest practices can reduce canopy cover near streams, which can lead to an increase in solar radiation and increased stream temperatures along unshaded reaches (FEMAT 1993; Brosofske et al. 1997). Temperatures in small streams were documented by Johnson and Jones (2000) in a paired basin study to return to pre-harvest conditions after 15 years following harvest, regardless of the presence of riparian buffers.

The amount of temperature increase due to lack of shade and the downstream impacts of surface water warming from upstream areas depends on the combined effects of watershed and stream surface and subsurface hydrologic conditions (Johnson and Jones 2000; Curry et al. 2004), but the effect of increased solar radiation due to a lack of riparian buffer can be demonstrated and modeled to be a significant local and downstream factor affecting stream temperatures, especially with respect to increases in daily temperature maxima (FEMAT 1993; Johnson and Jones 2000; Bartholow 2002; Sridhar et al. 2004). Water temperature total maximum daily loads (TMDLs) developed for streams and rivers in Washington have predicted that it will take between 50 and 80 years, depending on location and type of riparian vegetation, to achieve natural temperature conditions that existed prior to timber harvest (Personal Communication, Laurie Mann, Environmental Protection Agency, September 13, 2004).

The evaluation criterion for stream water temperature is the retention of streamside shade during and after timber harvest activities to ensure no temperature increase from increased solar radiation. For comparison the conservative approach of measuring the alternatives against the potential for change in short wave solar radiation is taken because changes in solar radiation have been demonstrated to be a primary factor controlling changes in stream temperature following harvest, even though it may not be the only factor (forestry or non-forestry related) affecting changes in stream temperature for a given watershed or reach (Johnson and Jones 2000; Bartholow 2002). A no-harvest buffer width of 0.75 site potential tree height is used as the criterion to evaluate the effectiveness of RMZs to maintain shade for streams greater than 5 feet in width, based on the shading curve from FEMAT (1993, p V-27). For streams less than 5 feet in width, the analysis will consider this factor plus the protection of seeps, springs, other sensitive sites, and stream-adjacent unstable slopes.

Incidental protection of hyporheic zones on large streams with alluvial channels and active Channel Migration Zones may protect stream temperatures in these reaches in addition to shade protection for surface waters. Conduction between substrate and soil materials near streams has been inferred to account for a portion of the energy input to surface waters (Johnson and Jones 2000).

Sediment and Turbidity

The evaluation criterion for sediment-related water quality parameters is the overall reduction in sediment delivery to streams from management activities, meaning the degree to which the alternatives would reduce sediment delivery from existing forestry-related sources and minimize sediment delivery from future forestry-related sources. Reduction in sediment delivery to surface waters could be achieved by reduction in chronic erosion sources such as surface erosion and episodic sediment deposition (i.e., mass wasting) associated with timber harvest (Dhakal and Sidle 2003); and road construction, road use, road maintenance, and road abandonment (Rashin et al. 1999).

Turbidity, an optical measure of water clarity, is affected by the amount of fine suspended sediment in water, but can also be related to the amount of organic acids (tannins), and other organic materials that might be dissolved in water, causing lowered water clarity even under undisturbed watershed conditions. Therefore, for the purposes of regulation, allowable turbidity changes are relative to background. For the purposes of this analysis, turbidity would be considered together with suspended and bedload sediment.

Dissolved Oxygen and Nutrients

Fish can be adversely affected by decreases in dissolved oxygen, as discussed in subsection 3.8.3.8 (Dissolved Oxygen). The evaluation criteria for dissolved oxygen focuses on how well each of the alternatives protect water resources from decreases in dissolved oxygen that would be harmful to fish (subsection 3.8, Fish and Fish Habitat). The analysis is based on an assessment of relative effects on stream temperature and excess nutrient input as a function of proposed buffer widths under each alternative. Temperature has a direct physical effect on the concentration of dissolved oxygen in water (Washington Department of Ecology 2002c). Dissolved oxygen concentration decreases as temperature increases up to the boiling point of water at 1 bar of pressure. ~~The thermodynamic explanation for this phenomenon is that gases have negative entropies of solvation, meaning that gases become more ordered (due to loss of volume) when dissolved in water than in a gaseous phase (Levine 1995).~~

Stream complexity and flow circulation are also relevant factors contributing to dissolved oxygen. Nutrients such as those derived from leaf and needle litter in surface waters and dissolved nutrients from hyporheic zones are beneficial to fish, as discussed in subsection

3.8.3.5 (The Aquatic Food Chain). However, excess nutrients due to wind drift or runoff from application of fertilizers may lead to adverse effects in terms of overproduction of stream organisms (e.g., algae) and consequent short-term decreases in dissolved oxygen (subsection 3.8, Fish and Fish Habitat). Dissolved oxygen can be decreased by fine sediment input as well, if the fine sediment contains nutrient material, as discussed in subsection 3.8 (Fish and Fish Habitat). In general, buffers for harvest activities and fertilizer application should decrease the likelihood of low dissolved oxygen concentrations in surface waters due to either reduced shade or increased nutrient input by protecting riparian and hyporheic zone functions, filtering sediment, and providing for re-areation through instream LWD (FEMAT 1993; CH2MHill 2000). The buffers for fertilizer application would not change under any alternative because fertilizer application rules are unchanged in the January 1, 1999 Washington Forest Practices Rules and the current Washington Forest Practices Rules.

Incidental protection of hyporheic zones on large streams with alluvial channels and active Channel Migration Zones may help protect stream dissolved oxygen and nutrient chemistry in these reaches from changes in the adjacent non-buffered areas (Naiman and Bilby 1998). However, no explicit protection is given to hyporheic zones under any of the alternatives.

Pesticides (Insecticides, Herbicides, and Fungicides)

The evaluation of forest pesticide applications focuses on how well each of the alternatives would protect water resources from pesticide contamination (e.g., spray drift, runoff, erosion, seepage to groundwater). In addition, the evaluation criteria take into account how well the alternatives would protect riparian plants from damage caused by pesticide applications. Finally, the criteria consider the potential impacts to fish and aquatic life resulting from contamination of water resources in subsection 4.8 (Fish and Fish Habitat). Note: The reader is reminded that forest chemical activities are not included as a proposed covered activity in the State's application for incidental take authorization under Alternative 2, Alternative 3, and Alternative 4.

Several other laws and regulations, aside from the Washington Forest Practices Rules in WAC 222-50, govern the application of pesticides. All alternatives are subject to forest practices WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment), which helps determine if the forest practices application is a Class IV-Special. This preliminary process addresses the available information on the toxicity of the specific pesticide and the potential impacts of the proposed applications. If under WAC 222-16-070 the forest practice is found to be a Class IV-Special, additional environmental precautions and SEPA review may be required. Additionally, the Environmental Protection Agency (EPA) regulates the labeling, availability, and use of pesticides and other forest chemicals.

An important consideration for this FEIS is that the Washington Forest Practices Rules are not the single means of environmental protection for pesticide applications. The analysis presented in this FEIS focuses on an evaluation of each alternative with the purpose of making qualitative comparisons among the alternatives, with the caveat that regulations developed by Federal and State agencies may require wider buffers for individual chemicals than Washington Forest Practices Rules do, or may further restrict the use of certain chemicals (including pesticides and pesticide additives) for silvicultural purposes. Regulations are continually being developed by EPA in consultation with the Washington Department of Fish and Wildlife (WDFW), NMFS, and USFWS as new pesticides and pesticide additives come on the market. The effectiveness of particular pesticide buffers in preventing surface water contamination may be a result of site conditions or weather conditions at time of application. Therefore, a "fully functional" pesticide buffer cannot be defined for all current and future pesticide products.

In general, pesticide applications on forestlands are currently infrequent. On westside State-managed lands, for example, pesticide application rates are reported as one to two applications every 40 to 60 years (Washington DNR 2004c). Modern pesticide products are generally designed to break down rapidly or bind to soil materials. Therefore, the short term impact of spills, overspray, or erosion is considered to be more likely than the long-term impact from pesticide applications on forestlands adjacent to surface water or groundwater.

4.5.1.2 Evaluation of Alternatives

The effects of the alternatives on water quality parameters are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1 no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1). The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on water quality are likely to fall between these two scenarios.

The increased protection of riparian vegetation by requiring buffers during harvest relative to historic timber practices has resulted in significantly improved riparian function (subsection 3.5.1, Surface Water Quality; DEIS Appendix A). Improvement over historical conditions for forested streams should generally continue or at least be maintained as riparian vegetation matures regardless of which of the alternatives is selected. However, the amount and rate of improvement, and short-term and long-term effects may be influenced by alternative, depending on the parameter.

Temperature

Overview of Effects

This subsection evaluates the degree to which the alternatives are likely to produce elevated stream temperatures. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative, in the following subsections.

No Action Alternative 1-Scenario 2 has a low to moderate likelihood of producing stream temperature increases along Type 1, 2, and 3 waters and a high likelihood along Type 4 and 5 waters. However, because of the current early-seral condition of most riparian areas on the lands covered by Washington Forest Practices Rules (subsections 3.7.1.6, Historic Protection of Riparian Areas, and 3.7.1.7, Current Condition of Riparian Areas), this alternative would likely result in some improvement in the average level of shade provided by riparian areas on covered lands over the long term.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 have a low likelihood of producing elevated water temperatures in Type S and F streams. There is a moderate to high likelihood of elevated water temperatures in Type N streams. The effect of temperature increases in non-fish-bearing streams on downstream fish-bearing streams is uncertain, and could be important in watersheds with a high degree of past harvest or already elevated stream temperature. Compared to current conditions, continued statewide improvement in shade retention, and therefore stream temperature protection, is expected under these alternatives, particularly within the bull trout overlay of eastern Washington where additional shade trees are required to be left in the RMZs (Washington Forest Practices Board 2001b, Section 1). Relative to No Action Alternative 1-Scenario 2, this group of alternatives has considerably higher levels of shade retention (particularly along Type N_p streams), and therefore have a lower likelihood of producing elevated stream temperatures.

Alternative 4 has a very low likelihood of stream temperature increases due to adequate shade along all streams; this alternative has the lowest uncertainty of adverse effects on stream temperature when compared to both scenarios of the No Action Alternative 1. Compared to current conditions, it would result in long-term improvement and retention of stream shade, and therefore, improvement in protection of stream temperatures.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2 (which would result in the January 1, 1999 Washington Forest Practices Rules), Type 1, 2, and 3 waters would generally receive adequate shade protection regardless of RMZ width. Within the RMZ, the shade rule, WAC 222-30-040, must be met before any harvest activity can occur within the RMZ. The shade rule is based upon elevation of the stream and the water quality classification of the stream (Class A or AA; Table 3-13). The shade rule reflects the fact that lower-elevation streams require more shade and higher elevations require less shade to meet water quality standards. The shade rule is meant to achieve State water quality standards. The shade rule limits harvest within RMZs by requiring specified levels of canopy closure over streams at different elevations. Tree retention requirements within RMZs at lower elevations tend to be greater than at higher elevations.

On the westside, the minimum RMZ width of 25 feet on Type 2 and 3 waters (some Type 1 waters have much wider buffers due to Shoreline Management Act requirements) does not meet the 0.75 site potential tree height required for complete shade protection for any site class (FEMAT 1993, pp V-27 through V-28). However, the shade rule is applied to the maximum RMZ width. Therefore, water temperature protection is substantially increased over the minimum RMZ width. For each stream type, RMZ buffer widths can vary between the minimum and maximum values of 25 feet and 100 feet (Figures 2-1 and 2-2) (Chapter 2, Alternatives). For Type 4 and 5 waters, RMZs are generally not required under most conditions and, under No Action Alternative 1-Scenario 2, would not exceed 25 feet. Therefore, RMZs for Type 4 and 5 streams do not meet the 0.75 site potential tree height required for adequate shade retention. This is important because Type 4 and Type 5 waters comprise a large portion of the drainage network (DEIS Appendix B).

On the eastside under No Action Alternative 1-Scenario 2, most RMZ widths along Type 1, 2, and 3 streams do not meet the 0.75 site potential tree height criterion, except along some Type 1 streams where additional protection may occur due to Shoreline Management Act requirements. The few exceptions are primarily where maximum RMZs are applied to areas with low site class. However, minimum RMZ widths of 30 feet do not meet the 0.75 site potential tree height required for adequate shade retention for any site class (compare p. V-27 in FEMAT 1993 to Figures 2-1 and 2-2 in this document). Similar to the westside, the RMZ buffer width can vary between the minimum and maximum values of 30 feet to over 300 feet (Figures 2-1 and 2-2) (Chapter 2, Alternatives).

For Type 4 and 5 waters, RMZs are not required except for site-specific conditions and in this case would not exceed 25 feet. The lack of RMZs on Type 4 and 5 streams would not meet the 0.75 site potential tree height criterion for shade retention. However, shade may be provided to these streams from understory vegetation and slash. Caldwell et al. (1991) documented temperature increases in harvested Type 4 waters of 2°C to 8°C (3.6 to 14.4°F) on several westside streams. Although in many cases the water quality temperature criteria were met, the increases observed were still violations of the 2.8°C (5°F) increase allowed for non-point source activities. However, where a harvested Type 4 stream flows into a Type 3 stream, the temperature increases in the Type 3 stream were negligible approximately 150 meters downstream of the confluence (Caldwell et al. 1991). In addition, Zwienecki and Newton (1999) found that streams returned to background temperatures within 500 feet after accounting for a stream's natural downstream warming trend. However, No Action Alternative 1-Scenario 2 provides no protection of sensitive sites for Type 4 waters.

The shade provided by RMZs under No Action Alternative 1-Scenario 2 is further reduced as a result of allowable harvest within the RMZ. No Action Alternative 1-Scenario 2 would not meet the protection requirements for maintaining stream temperature along Type 1, 2, and 3 waters, resulting in a moderate likelihood of stream temperature increases as a result of reduced shade. Type 4 and 5 waters would have a high likelihood of stream temperature increase due to inadequate shade because there are no buffers along Type 4 and 5 streams.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action

Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Westside

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), the stream typing and associated prescriptions increase the retention of shade provided to the drainage network compared to No Action Alternative 1-Scenario 2, because more streams would receive some type of buffer. Under this group of alternatives, the nominal RMZ widths for Type S and F streams exceed the criteria to provide complete shade, using both 100-year and 250-year site potential tree heights (Table 4.7-1), but some level of harvest would be allowed within the inner and outer zones if the shade rule of maintaining adequate shade within 75 feet of the bankfull or Channel Migration Zone edge is met. Parcels that meet the 20-acre exemption must follow the shade rule that was in effect on January 1, 1999. The impact of these rule differences on 20-acre exempt parcels on westside stream temperatures is assumed to be negligible due to the small percentage of area impacted on westside lands (See Chapter 5, Cumulative Effects, for discussion of 20-acre exempt parcel impacts).

At least 50 percent of the length of Type N_p streams would receive a 50-foot no-harvest buffer (DEIS Appendix B). Seeps and other sensitive areas would also receive protection from forest practices with 50-foot no-harvest buffers. In western Washington, 56-foot radius no-harvest buffers are required at Type N_p confluences. In addition, where an N_p stream meets a Type F or S stream, a 50-foot no-harvest buffer would be required for the first 500 feet upstream of the confluence with the Type F or S stream. These buffers should provide some temperature protection within Type N_p channels. Additional buffering would occur where trees are retained on stream-adjacent unstable slopes. High hazard unstable slopes including channel heads, bedrock hollows, and inner gorges are commonly associated with Type N_p channels and are often treated as no-harvest areas. While difficult to quantify, unstable slopes buffering substantially increases stream shade and temperature protection along many Type N_p waters, particularly in western Washington where there is a higher frequency of unstable slopes and landforms. Some portions of unbuffered N_p channels are likely to exceed water quality standards for several years following harvest. There is a low to moderate likelihood of temperature increases at the downstream end of Type N_p stream reaches that would lack buffers.

Type N_S streams would not likely be adversely affected because these streams are typically dry during the warmest summer months when the waters are most vulnerable to warming. However, Type N_s streams that may have water present during this time may not have adequate shade from overstory trees to maintain stream temperature because no buffers are required along these streams. However, protection of unstable slopes adjacent to Type N_s waters would, in many cases, provide adequate shade for temperature control. However, the level of shade and length of channel protected would vary with the extent of unstable slopes and landforms. Shrubs and debris along the streams may provide adequate shade; but, because of this uncertainty, there is a high likelihood of water temperature increases in Type N_S streams where water is present during the summer months (i.e., July through September).

There are no data from the scientific literature conclusively demonstrating that the combination of a no-harvest zone with a selective harvest zone out to 0.75 site potential tree height will provide complete shade protection. In general, the no-harvest portions of RMZs and the implementation of the shade rule would provide a higher level of protection and increase shade in areas where applied compared to No Action Alternative 1-Scenario 2. Overall, the RMZ effectiveness to provide shade to Type S and F streams under this alternative would be high (subsection 4.7.1, Riparian Processes). RMZs along Type S and F waters are adequate to maintain shade; however, potential increases in water temperature may occur along Type N_s and N_p streams. The potential cumulative effects of temperature increases in Type N_p streams delivering to Type S and F streams is uncertain, but could be important in watersheds with a high degree of past harvest or a history of elevated temperatures. This is a priority research topic under the adaptive management program incorporated under these alternatives (subsection 4.10, Birds, Mammals, Other Wildlife, and Their Habitats).

Eastside

Under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), RMZ buffer widths would exceed the width recommended by FEMAT (1993) for full shade protection for Type S and F streams (Figure 4.7-3). Along Type S and F streams the 30-foot no-harvest zone adjacent to the streambank (or Channel Migration Zone) combined with the inner zone's selective harvest prescription (out to 0.75 site potential tree height) should adequately protect shade levels (subsection 4.7.1, Riparian Processes). In addition, within the bull trout overlay, the shade rule would require the retention of "all available shade" within 75 feet of the streambank (or Channel Migration Zone). The bull trout overlay includes watersheds in eastern Washington that contain bull trout habitat as identified on the WDFW's bull trout map (Washington Forest Practices Board 2000b, Section 1; WAC 222-16-010). The retention of shade within the bull trout overlay is likely to maintain water temperatures.

For Type N_P streams, sensitive sites would be buffered with either a partial cut buffer where adjacent harvest operations employ a partial cut strategy or a 50-foot no-harvest buffer where adjacent harvest operations employ a clearcut strategy. The 50-foot partial cut strategy RMZ would not provide complete protection of shade. However, these buffers should protect sensitive sites and provide some shade with understory vegetation to protect stream water temperatures. For the clearcut strategy, the 50 feet of no-harvest protection would only be provided on one-third of the N_p streams (DEIS Appendix B). Unstable slopes protection would supplement RMZ protection where these features are present along Type N_p waters. Although unquantified, such supplemental protection would likely be substantial in areas where there is a high frequency of unstable slopes and landforms.

A low to moderate likelihood of temperature increases exists for segments of unbuffered N_p streams. Stream temperatures that may increase in these reaches might be mitigated downstream when the water flows through an RMZ (Bartholow ~~2004~~2002) or if cooler groundwater or surface water enters the stream as discharge increases (Curry et al. ~~2004~~2002). However, channel type (e.g., alluvial versus bedrock), susceptibility to blowdown, stream aspect, and watershed properties or changes that would also affect groundwater and soil temperatures may also influence the efficacy of the RMZ rules downstream, or groundwater recharge temperatures (Brosofske et al. 1997; MacDdonald et al. 2003; Sridhar et al. 2004). Sensitive sites are also protected from harvest, which protect groundwater seeps and springs. Type N_s streams would not likely be adversely affected because these streams tend to be dry during the warmest summer months when the waters are most vulnerable to warming. However, Type N_s streams that may have water present during this time may lack adequate shade from overstory trees to maintain stream temperature because buffers are not required along these streams. Where stream-adjacent unstable slopes are present, shade is likely to be retained as a result of the no-harvest buffers typically retained to protect these features. Shrubs and debris in the streams may provide adequate shade; but, because of this uncertainty, a moderate to high likelihood of water temperature increases exists in N_s streams with flowing water during the summer months.

Alternative 4

In general under Alternative 4, for all streams on both the eastside and westside, most if not all shade would be retained (Figures 4.7-5 and 4.7-6). In general, the no-harvest RMZs would provide a higher level of shade retention than either scenario of No Action Alternative 1 thereby substantially reducing the likelihood of temperature increases.

<u>Sediment and Turbidity</u>

Overview of Effects

This subsection evaluates the alternatives in terms of the likelihood for sediment and turbidity effects on water quality. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative in the following subsections.

No Action Alternative 1-Scenario 2 would result in a high likelihood of sediment-related impacts to streams. However, because of the limited protective measures followed historically (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation*),* instream sediment and turbidity in forested watersheds would be expected to improve relative to current conditions under this alternative. Still, relative to No Action Alternative 1-Scenario 1 and all other alternatives, this alternative has the highest likelihood of sediment and turbidity impacts.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would result in a moderate likelihood of sediment delivery in the short term (next 10 years) and a low to moderate likelihood of sediment delivery in the long term; this conclusion has a moderate degree of uncertainty. Instream sediment and turbidity levels would be expected to continue to improve in the long term under this alternative as riparian buffers and current rules related to mass wasting and erosion are implemented. Relative to No Action Alternative 1-Scenario 2, these alternatives have a low likelihood of sediment and turbidity impacts. Alternative 4 would result in a moderate likelihood of sediment delivery in the short term (next 10 years) and a low likelihood of sediment delivery to streams in the long term; this conclusion has a moderate degree of uncertainty.

This alternative would be expected to result in the most rapid improvement to instream sediment and turbidity levels in forested watersheds as a result of forest practices over the long term. Alternative 4 would the lowest likelihood of sediment and turbidity impacts relative to No Action Alternative 1 and of all the other alternatives.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Based on the criteria presented in subsection 4.4 (Geology, Soils, and Erosional Processes), and this subsection, No Action Alternative 1-Scenario 2 would result in increased sediment delivery relative to No Action Alternative 1-Scenario 1 and all other alternatives due to reduced protection for potentially unstable slopes, a lack of RMAPS, and reduced buffer widths. Under No Action Alternative 1-Scenario 2, the Washington Forest Practices Board Manual would provide prescriptive-based BMPs, as required by the January 1, 1999 Washington Forest Practices Rules that were approved by the Washington Department of Ecology (Ecology). However, as multiple studies have shown, the implementation of past BMPs did not always reduce water quality-related impacts from sediments (Rashin et al. 1999). The slow rate at which road maintenance plans were completed under these rules indicated that this alternative would present a high likelihood of sediment delivery to streams. However, if Watershed Analysis were applied, there would be an effective mechanism for addressing road maintenance and abandonment in watersheds with identified sediment input and water quality problems.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, the cumulative effects of the implementation of RMAPs, BMPs, and specific road management, use, maintenance, and construction guidelines in the Washington Forest Practices Board Manual, RMZs, and Equipment Limitation Zones on all perennial and intermittent streams, and greater environmental review of practices on potentially unstable slopes should substantially reduce sediment delivery to streams compared to No Action Alternative 1-Scenario 2. As discussed above in subsection 4.4 (Geology, Soils, and Erosional Processes), the effect in sediment reduction would occur over time as RMAPs are implemented and completed by 2016. In addition, all these alternatives would result in less ground disturbance because of no-harvest RMZs and/or Equipment Limitation Zones than under No Action Alternative 1-Scenario 2.

Alternative 4

Under Alternative 4, sediment reductions would be greater overall and would occur in a shorter timeframe than under either scenario of No Action Alternative 1. As discussed in subsection 4.4 (Geology, Soils, and Erosional Processes), a shorter timeframe for implementation of RMAPs, the no-net-increase rule for forest roads, and the more rapid road maintenance and abandonment of orphan roads would reduce sediment delivery to streams to a greater degree than No Action Alternative 1-Scenario 1 and Scenario 2. Additionally, increased no-harvest buffer widths would provide greater protection to surface waters, as shown in subsection 4.4.1 (Surface Erosion).

Dissolved Oxygen and Nutrients

In general, wide buffers would offer greater protection for dissolved oxygen levels due to cooler stream temperatures, additional wood recruitment, and reduced sediment and nutrient inputs to streams (Beschta et al. 1997; Washington Department of Ecology 2002c).

Based on the previous discussions of temperature and sediment, none of the alternatives are expected to result in major long-term effects on dissolved oxygen or nutrient concentrations in streams. Although short-term influences, such as algal blooms, from large inputs of organic material (fertilizer spills, runoff, or severe blowdown in riparian zones) might occur, they would be relatively independent of the alternatives considered. The 1998 303(d) listings suggest that forestry effects on dissolved oxygen were more limited than temperature effects (Washington DNR 2004c).

No Action Alternative 1-Scenario 2 has the highest likelihood of producing dissolved oxygen and nutrient impacts of all of the alternatives because it requires the narrowest buffers (See equivalent buffer area index discussion in subsections 3.4 and 4.4, Geology, Soils and Sedimentation) and the lowest shade retention of all of the alternatives considered.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would offer more protection for dissolved oxygen and nutrients than No Action Alternative 1-Scenario 2 due to wider, more extensive buffers.

Alternative 4 would have the lowest likelihood of producing dissolved oxygen and nutrient impacts relative to either scenario of the No Action Alternative due to high levels of riparian protection and reduced sediment inputs.

Pesticides (Insecticides, Herbicides, and Fungicides)

Overview of Effects

This subsection evaluates the alternatives in terms of the likelihood for negative effects on water quality from pesticide application. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative in the following subsections.

Based on required buffer widths, No Action Alternative 1-Scenario 2 is assumed to have a low to moderate likelihood of short-term negative water quality effects from improperly applied pesticides, spills, or input to streams due to erosion. Relative to all other alternatives however, this alternative would have the highest likelihood of water quality impacts from pesticides.

Additional requirements targeting the protection of surface waters under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, would result in a continued, reduced likelihood of impacts to surface water and groundwater (through a reduction in exchange with contaminated surface water).

Increased buffer widths required for hand applications of pesticides near surface waters under Alternative 4 means this alternative has a much lower likelihood of surface water contamination compared with No Action Alternative 1-Scenario 2, and a slightly lower likelihood of contamination compared with No Action Alternative 1-Scenario 1.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Hand application of pesticides within the RMZ would not result in direct entry into surface waters. However, application of highly persistent pesticides, or pesticides with high mobility, could result in measurable surface water contamination through localized erosion or storm runoff. The overall impact would be situation- and chemical-specific, depending on the specific chemical properties as well as the timing, duration, and extent of contamination. In general, because of the slow surface and subsurface runoff from forested lands and the relatively infrequent pesticide applications, most pesticide applications in the RMZ are not expected to result in ~~meaningful impacts on~~ measurable degradation of water quality.

In the January 1, 1999 Washington Forest Practices Rules, a 50-foot buffer required for aerial applications on all Type 1, 2, and 3 waters and flowing portions of Type 4 and 5 waters does not provide sufficient protection to prevent pesticides from entering surface waters. Wind conditions favoring atmospheric drift toward surface water could result in a direct application of pesticides to the surface water. No Action Alternative 1-Scenario 2 does not include any special provisions or modifications for pesticide application based on weather conditions or equipment (e.g., wind speed, application height, nozzle type, or droplet size). Variations in wind conditions, droplet size, air shear (a function of nozzle angle and air speed), nozzle height, and boom length all have a significant influence on pesticide spray drift (Spray Drift Task Force 1997; Washington Department of Ecology 1993a). By not accounting for these variations, No Action Alternative 1-Scenario 2 poses a higher likelihood of surface water contamination caused by spray drift, adverse weather, or inappropriate equipment selection and use than No Action Alternative 1-Scenario 1. Although the entry of pesticides into surface waters does not necessarily result in meaningful impacts (e.g., very low levels of pesticide contamination may not even be measurable), Ecology (1993a) found a 50-foot buffer to be partially effective to ineffective at meeting applicable water quality standards, Forest Practices Rule requirements, and certain product label restrictions.

In addition, the application of pesticides to dry portions of Type 4 and 5 waters and other ponds and sloughs could result in high instream concentrations if future runoff returns flow to the dry streams (Washington Department of Ecology 1993a). Research has shown instances where applications over dry channels resulted in very high instream concentrations of chemicals. The results were generally temporary but important enough to cause adverse impacts on water quality and aquatic organisms (Neary and Michael 1996; Washington Department of Ecology 1993a). Because none of the alternatives provide any greater protection of dry streambeds, the impacts would be the same under all alternatives.

When applying pesticides using power equipment from the ground, the 25-foot buffer required for all typed waters (excluding dry Type 4 and 5 waters) and all Type A and B wetlands should adequately protect surface waters from receiving significant pesticide overspray. However, as with the hand and aerial applications, the 25-foot buffer does not provide a high level of protection from highly mobile or highly persistent pesticides that may be transported to surface waters through erosion or storm runoff. However, slow runoff from forested lands, the relatively infrequent application of pesticides, and the generally low toxicity of most pesticides are likely to limit surface water contamination. Hand application of pesticides within Wetland Management Zones should not result in meaningful impacts to surface waters, provided that those pesticides are only applied to specific targets and the required application rates are not exceeded.

Any leaks, drips, and spills of pesticides could contaminate forest soils. The potential impacts of an accidental spill are highly dependent on the effectiveness of the required containment and cleanup procedures. If effective safety and cleanup measures are not implemented and contaminated soils erode, the contaminants could be passed to downstream waters.

Finally, possible impacts on surface waters could occur through contaminated groundwater flow to surface waters. The extent of these impacts is difficult to predict but depends on the degree of groundwater contamination, the volume of water exchanged, the length of time between groundwater contamination and contact with surface water, and the persistence and mobility of the pesticide in question.

Overall, pesticide applications under No Action Alternative 1-Scenario 2 would have a moderate likelihood of surface water contamination and may result in impacts on surface waters, primarily for newer products that have not had buffer determinations made by EPA, and for which a 50-foot buffer may not be adequate (Washington Forest Practices Board 2001a, Appendix J).

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Compared to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 contain additional requirements targeting the protection of water resources from pesticide applications. These alternatives include implementation of BMPs designed to "eliminate the direct entry of pesticides to water (defined as the entry of medium to large droplets), while minimizing off-target drift" in aerial application of pesticides (Washington DNR 1999). By recommending variable buffer widths for aerial applications depending on water type, environmental conditions, and the method of application, No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would result in a lower likelihood of water quality impacts compared to No Action Alternative 1-Scenario 2. Specifically, by adjusting the buffer widths to suit wind conditions, nozzle types, and application heights during aerial application of pesticides, these alternatives would reduce the pesticide drift into surface waters compared to No Action Alternative 1-Scenario 2 (Washington Department of Ecology 1993a). Buffer widths specified for these alternatives also are correlated with the critical management or habitat zones identified for each water type. Therefore, No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would also minimize impacts within the RMZs identified for each water type. Moreover, these alternatives recommend using the maximum applicable buffer width in situations where the recommended buffer width and recommended offset from surface waters are different.

Under this group of alternatives, restrictions on ground applications of pesticides with power or hand equipment provide for greater protection of Type S or F waters compared to No Action Alternative 1-Scenario 2. Specifically, ground application with power equipment would not be permitted within the core and inner zones of Type S and F waters, and hand applications would not be allowed within the core zones of Type S or F waters (unless prescribed to meet specific localized requirements). These buffers can total to 100 feet or more for RMZs on Site Class II (Figures 2-1 and 2-2). These increased buffer widths afforded by these alternatives would result in a lower likelihood of drift and erosive transport of pesticides than under No Action Alternative 1-Scenario 2.

Overall, the increased attention given to the required buffer widths under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would reduce the likelihood of surface water impacts compared to No Action Alternative 1-Scenario 2. However, because this group of alternatives still allow for pesticide application over dry segments of some watercourses, some contamination of surface waters is possible if flow returns to the stream soon after the application. Likewise, even with the increased buffer width for most surface waters, these alternatives could allow low levels of pesticides to reach surface waters either directly or through storm water runoff, soil erosion, and sediment transport. Nevertheless, the net impacts would be less than those expected under No Action Alternative 1-Scenario 2.

Alternative 4

Alternative 4 is nearly identical to No Action Alternative 1-Scenario 1with the exception of three main additions. Under Alternative 4, plants with cultural value would be protected from forest pesticides, hand application of forest pesticides would be prohibited within 50 feet of all typed waters, and forest pesticide applications needed to restore RMZ functions would require an alternate plan. Therefore, surface water impacts from pesticide applications under Alternative 4 are expected to be slightly less than under No Action Alternative 1-Scenario 1and considerably less than under No Action Alternative 1-Scenario 2.

The increased buffer required for hand applications near surface waters under Alternative 4 would greatly reduce the amount of pesticides that reach surface waters directly via spray drift compared to No Action Alternative 1-Scenario 2, and only slightly reduce the potential for contamination compared to No Action Alternative 1-Scenario 1. The recommended 50-foot buffer for hand applications is greater than that required under the scenarios of the No Action Alternative, with the exception of the core zone buffer on westside Type S and F streams required under No Action Alternative 1-Scenario 1 (westside core zone is 50 feet). In addition, alternative plans required for forest pesticide applications when restoring RMZs under Alternative 4 are expected to reduce the amount of pesticides that enter surface waters. However, as with all other alternatives, low levels of pesticides may reach surface waters through storm runoff, soil erosion, and sediment transport.

4.5.2 Surface Water Quantity

Surface water quantity is evaluated in terms of the effects of timber harvest activities on water yield, low flows, and peak flows. The effects of individual forest practices in general will contribute to short-term effects on water quantity that will improve over the course of a few years to a few decades following harvest, except for road-related effects.

4.5.2.1 Evaluation Criteria

Water Yield

An increase in overall annual water yield is generally not considered to adversely affect the beneficial uses of the stream system. However, differences between the alternatives and the No Action Alternative are evaluated qualitatively based on the literature. As discussed in subsection 3.5.2.1 (Water Yield (Annual)), timber harvest has been shown to increase water yields in the short term following timber harvest due to reduced evapotranspiration. As forests re-grow, these effects are reduced (subsection 3.5.2.1, Water Yield (Annual)). Further discussion is included under the subsection titled Peak Flows, below.

Low Flows

As discussed in subsection 3.5.2.2 (Low Flows), studies of low flows following timber harvest have shown that summer low flows in western Oregon and northern California have increased over pre-harvest levels for approximately 5 years following timber harvest. An increase in low flows during the summer months generally does not adversely affect the beneficial uses of the aquatic system. Small volumetric increases may provide improved habitat conditions (lower stream temperatures, increased instream wetted area, and volume) and increased aquatic productivity (subsection 3.5.2.2, Low Flows). Differences among the alternatives are evaluated qualitatively based on the literature.

Peak Flows

Peak flows are evaluated in terms of the effects of roads and the effects of timber harvest, as described below. Peak flow impacts are episodic, occurring during storm events.

Road Influence on Peak Flows

The FFR set an objective to "maintain surface and groundwater hydrologic regimes (magnitude, frequency, timing, and routing of stream flows) by disconnecting road drainage from the stream network, preventing increases in peak flows causing scour, and maintaining hydrologic continuity of wetlands" (FPHCP Appendix B). As discussed in subsection 3.5.2.7, (Management Influences on Peak Flows), two summaries of recent research studies on roads in forested areas demonstrate that roads can have significant effects on peak flows if roads are improperly constructed and if road drainage is connected to the stream network through improper construction or neglect (USDA Forest Service 2001; CMER 2004). A potential exists that road drainage may increase peak flow magnitudes, which would have greater impacts on first and second order drainages. This potential may be substantial in certain basins, and is based upon the road management and drainage criteria, and potential for decrease (e.g., abandonment) in roads under each alternative (further discussion of RMAPs and abandonment is included in subsection 3.4, Geology, Soils, and Erosional Processes).

Timber Harvest Influence on Peak Flows

Many studies have found a correlation between the hydrologic maturity of a basin, especially in the rain-on-snow zone (also known as the transient snow zone), and the potential for increased peak flows (subsection 3.5.2.7, Management Influence on Peak Flows). The evaluation criteria for timber harvest-related peak flows is how well the Washington Forest Practices Rules under each alternative would reduce the potential for large areas in the rain-on-snow zone of a basin to become hydrologically immature (e.g., early-seral stage). Although the effect of rain-on-snow events is most pronounced in the rain-on-snow zone, they can potentially occur at any elevation, depending on storm temperature and antecedent snow conditions. Therefore, the effects of timber harvest on peak flows in rain-dominated and snowmelt-dominated watersheds were also considered.

4.5.2.2 Evaluation of Alternatives

The effects of the alternatives on surface water quantity are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1 no ITPs or ESA Section 4(d) authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on water quality are likely to fall between these two scenarios.

<u>Water Yield</u>

The alternatives may be ranked in terms of their relative probability of increasing short-term annual water yield based on the total amount of harvest allowed. No Action Alternative 1-Scenario 2 would have the least restrictions on harvest area and would have the greatest probability among the alternatives of increasing short-term water yield for any given watershed as a result of timber harvest because it would assume the least acreage of buffered areas adjacent to surface water and wetland features. It would also be the least restrictive alternative in terms of harvest on potentially unstable slopes and road placement. No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would have similar probabilities of increasing water yield as a result of timber harvest as No Action

Alternative 1-Scenario 2, but would have a lower probability of increasing short-term annual water yield for a given watershed as a result of timber harvest. Alternative 4 would have the lowest probability among the alternatives of increasing water yield as a result of timber harvest because it has: 1) the greatest acreage of no-harvest buffers adjacent to surface water and wetland features, 2) a requirement that there be no net increase in roaded areas, and 3) the most conservative restrictions on areas that may be buffered due to potential slope instability.

Low Flows

A qualitative comparison of alternatives would yield identical conclusions to the discussion in subsection 4.5.2.1 (Evaluation Criteria), ranking No Action Alternative 1-Scenario 2 as having the greatest probability to increase low flows following harvest, followed by the group of No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. Alternative 4 would be least likely to increase low flows in the short term for a given watershed as a result of timber harvest.

Peak Flows

The discussion of alternatives based on peak flow effects is divided into effects from timber harvest and effects from roads.

Timber Harvest Influence on Peak Flows

Overview of Effects

This subsection evaluates the degree to which each alternative is likely to produce increases in peak flows due to timber harvest. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative, in the following subsections.

No Action Alternative 1-Scenario 2 has a moderate likelihood of peak flow increases. Under this alternative, peak flow effects would be addressed through Watershed Analysis or the rain-on-snow rule (See discussion about this rule under the Detailed Effects Analysis below).

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would have a slightly lower likelihood of peak flow effects relative to No Action Alternative 1-Scenario 2. Under these alternatives, forest landowners would have less incentive to conduct Watershed Analyses, which includes an assessment of peak flow impacts. Rain-on-snow peak flow impacts would continue to be addressed through the rain-on-snow rule under these alternatives.

Alternative 4 would provide the lowest likelihood of harvest-related peak flow impacts relative to all other alternatives because the rules would directly address the cumulative hydrologic maturity in rain-on-snow zones.

Detailed Effects Analysis

<u>No Action Alternative 1-Scenario 2</u>. The Washington Forest Practices Rules in effect on January 1, 1999 address the effects of timber harvest on peak flows in two ways. First, the rules authorize the Washington DNR to condition the size of clearcuts in the "significant" (WAC 222-22-100(2)) rain-on-snow zone where peak flows can potentially result in material damage to public resources. This rule is commonly referred to as the "rain-on-snow" rule. Second, harvest-related effects on rain-on-snow-generated peak flows are addressed as part of Watershed Analysis. In Watershed Analysis, the hydrologic change module assesses the sensitivity of sub-basins within a Watershed Administrative Unit to increased peak flows resulting from the effects of timber harvest on snow accumulation and melt during rain-on-snow precipitation events. However, Watershed Analysis has only been applied to a small percentage of the State and is voluntary for private landowners. Lack of Federal ESA assurances under this alternative may increase the frequency and rate at which Watershed Analyses are conducted.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would result in an increase in the level of tree retention across the landscape relative to No Action Alternative 1-Scenario 2 due to additional protections associated with RMZs, Channel Migration Zones, sensitive sites, and unstable slopes. Also, the rain-on-snow rule and Watershed Analysis would address the effects of harvest on rain-on-snow-generated peak flows under these alternatives. Watershed Analysis would be required of the Washington DNR to the extent that funding is available and landowners voluntarily participate. No new Watershed Analyses have been initiated since the Forest and Fish rules were implemented in 2000, and none are anticipated for the near future. Although it is part of the current Washington Forest Practices Rules, it remains unfunded. Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, there would be less incentive to conduct Watershed Analysis. However, the results of past Watershed Analyses suggest that rain-on-snow peak flow impacts associated with timber harvest are very limited.

Management prescriptions to limit harvest-induced peak flow increases have been developed for only two of approximately 62 Watershed Administrative Units that have undergone analysis (Personal Communication, Jeff Grizzel, DNR, September 16, 2004). The likelihood of negative effects associated with timber-harvest induced peak flows could be slightly lower than under No Action Alternative 1-Scenario 2.

Alternative 4. Under Alternative 4, a new eastside hydrology module would be developed as part of Watershed Analysis and would be applied to eastside watersheds that undergo Watershed Analysis. As in the other alternatives, Watershed Analysis would remain mandatory for the Washington DNR depending on available funding, and voluntary for private landowners. In addition, a landscape rule would be applied to all forest practices applications to limit the amount of hydrologically immature (based upon crown closure) forest within rain-on-snow zones. The rule states that a minimum of two-thirds of lands by ownership, within the rain-on-snow zone of basins 1,000 acres or larger in size must be maintained in stands that are at least 25 years old. This alternative would provide the greatest protection among all alternatives, substantially more than No Action Alternative 1-Scenario 2, and more than No Action Alternative 1-Scenario 1, from potential management-related peak flows from rain-on-snow events.

Road Influence on Peak Flows

Overview of Effects

This subsection evaluates the alternatives in terms of the likelihood of road-induced peak flow increases. A summary comparison of the effects of the alternatives is provided in the next few paragraphs, and a detailed analysis of the effects is provided by alternative in the following subsections.

All alternatives would be expected to reduce road-induced peak flow increases through improved road construction, maintenance, and abandonment over historical conditions (DEIS Appendix A).

No Action Alternative 1-Scenario 2 would not encourage disconnection of road drainage from the stream network; therefore, there would be a moderate likelihood of road-induced peak flow increases. Further, the potential for an increase in road-influenced peak flows compared to current conditions would exist.

No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would reduce the potential for road-related peak flow increases because the Washington Forest Practices Rules would require that road drainage be disconnected from the stream network.

Alternative 4 would have a similar or lower likelihood of road-related peak flow increases relative to No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 because the more rapid implementation of RMAPs under this alternative would accelerate the disconnection of road drainage from stream networks.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2. Under No Action Alternative 1-Scenario 2, the road drainage BMPs included in the January 1, 1999 Washington Forest Practices Rules such as rolling grade dips, water bars, and grade dips at stream crossings would be encouraged and their use would be required if deemed necessary, but specifics are not given that make those requirements clear on when implementation is necessary. Because the January 1, 1999 Washington Forest Practices Rules do not explicitly require outsloping of roads, but do require ditching, relief culverts, and other BMPs that reduce the volume of surface water reaching streams, the implementation of these rules may have a greater effect in extending the drainage network and potentially influencing peak flows than would the rules under the other alternatives (subsection 4.1.2.5, Alternative Groupings).

Requirements for locating roads in the January 1, 1999 Washington Forest Practices Rules included the following requirements: stream crossings are required to be minimized, as well as road locations in RMZs, wetlands, Wetland Management Zones and narrow canyons. Except where crossings are necessary, roads shall not be located in natural channels or RMZs except where the Washington DNR determines the risk to public resources is too great to relocate the road.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3. Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, closer spacing of ditch relief culverts compared to No Action Alternative 1-Scenario 2 would be required, and outlets of ditch relief culverts would have to be located to allow the dispersal of water to the forest floor before reaching any stream. RMAPs would have to be implemented by 2016. These include abandonment of roads and the upgrade of all roads (except orphaned roads) to current construction standards, which includes drainage. The reduction in road surface drainage would reduce the potential of road influences on peak flows.

Requirements for locating roads are similar to No Action Alternative 1-Scenario 2. Stream crossings would be required to be minimized, and except for crossings, roads would be kept out of natural channels, Channel Migration Zones, RMZs, Equipment Limitation Zones, or sensitive sites, when there would be substantial damage to fish or wildlife habitat. Additionally, an interdisciplinary team would be required to review the placement of roads in such areas. These additional requirements and levels of review may prevent excessive hydrologic connection between new roads and streams in some areas.

Alternative 4. Under Alternative 4, road effects on peak flows would be similar to No Action Alternative 1-Scenario 1. In addition, there would be no net increase in roads allowed for large landowners. However, RMAPs would be implemented sooner than under No Action Alternative 1-Scenario 1 (10 years versus 15 years). The no-net increase in roads and similar drainage guidelines as under No Action Alternative 1-Scenario 1would likely reduce the impacts of roads on peak flows. The road effects on peak flows would be less compared to No Action Alternative 1-Scenario 2 because of the requirements for no-net increase in roads and the accelerated schedule for RMAPS.

4.5.3 Groundwater

4.5.3.1 Evaluation Criteria

Water Quality

The primary concerns for groundwater quality are the effects of forest practices on groundwater temperature and effects from pesticide applications or fertilization (CH2MHill 2000). These effects are qualitatively assessed under each alternative.

Studies of hyporheic zones (regions within the streambed and near streams where surface water and shallow groundwater mix at the reach scale (e.g., Naiman and Bilby 1998)), show complex flow patterns and locations of upwelling and downwelling of groundwater along alluvial channels. Colluvial and bedrock channels tend to have more limited hyporheic zones. Upwelling hyporheic waters are sought out by salmonids during spawning and rearing (subsection 4.8, Fish and Fish Habitat). Alterations to the hyporheic zone due to local decreases in groundwater input, disturbances to floodplains and channels by debris flows, timber harvest, or road building could potentially alter the hydrology of the hyporheic zone and associated surface waters and fish habitat. However, due to the complexity of hyporheic zone hydrology, even a qualitative evaluation of the proposed alternatives on this resource is somewhat speculative. An assumption is made that larger buffers and more conservative protections for the riparian zone would have a lower likelihood of disturbing groundwater hydrology and water quality of the hyporheic zone, which would also be beneficial to associated resources, such as fish and amphibians. The hyporheic zone resource is especially important for streams with Channel Migration Zones and broad floodplains (subsection 3.5, Water Resources).

Water Quantity

Timber harvest increases peak flows and water yield to surface water by decreasing infiltration rates and evapotranspiration within a watershed or landscape (Lewis et al. 2001). There are potentially competing effects on groundwater on a watershed or Water Resource Inventory Area (WRIA) scale: groundwater inputs to lower reaches of stream systems decrease over time due to a reduction in infiltration during storm events on a watershed or WRIA scale (Harr et al. 1979). Cumulative effects may increase the effects on aquifer systems where forestlands occur on recharge areas for groundwater. However, analysis at regional or statewide scales is speculative due to the complexity of groundwater hydrology and groundwater-surface water interactions. The differences among the alternatives in terms of the effects of forest practices on groundwater quantity are qualitatively assessed.

4.5.3.2 Evaluation of Alternatives

The effects of the alternatives on water quantity are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative 1, no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on water quantity are likely to fall between these two scenarios.

Water Quality

Overview of Effects

Because all alternatives are subject to specific provisions for the protection of groundwater having a high susceptibility for contamination (WAC 222-16-070), application of forest pesticides should not result in substantial impacts on groundwater and hyporheic zone water quality. Groundwater temperature is not discussed, except in terms of impacts to hyporheic zone upwelling areas. Effects on municipal or sole source aquifer temperatures from forestry are not anticipated to vary among alternatives, or to be substantial.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

No Action Alternative 1-Scenario 2 includes provisions to limit groundwater contamination resulting from forest pesticide applications. Groundwater protection is provided under WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment), where the Washington Forest Practices Rules require an evaluation of site-specific use of aerially applied pesticides or fertilizers. However, localized groundwater impacts could also occur through contaminated surface water recharge to groundwater. The extent of these impacts is difficult to predict but depends on the degree of contamination of the surface water, the volume of water exchanged, and the mobility and persistence of the chemical contaminant.

The likelihood that a given pesticide or fertilizer would impact a groundwater aquifer depends in part on geologic and hydrologic conditions that vary considerably across the State. Local conditions determine how rapidly groundwater moves, whether it is connected directly or indirectly to surface waters and how groundwater withdrawals affect surface waters, the depth of the water below the soil surface, and how effectively soils attenuate or filter out chemical contaminants (Environmental Protection Agency 1986). This complex interaction between soil and water makes it difficult to predict the likelihood and extent of groundwater contamination.

Because No Action Alternative 1-Scenario 2 would provide provisions for groundwater protection, application of forest pesticides and fertilizers should not result in substantial impacts to groundwater quality. However, groundwater impacts could occur in localized areas with particularly vulnerable aquifers and in areas where highly persistent and mobile pesticides are applied. Likewise, the application of forest pesticides and fertilizers to forested lands may contribute to cumulative effects on groundwater quality, the net effects of which are area- or site-specific and somewhat unpredictable. Additional details on the potential impacts to groundwater quality from pesticides and fertilizers are discussed in Appendix J of the recent Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a).

The widespread use of pesticides and fertilizers could lead to contamination of groundwater aquifers unless adequate protective measures are implemented. No Action Alternative 1-Scenario 2 does not include any specific provisions for the protection of aquifers, but does provide for the protection of groundwater having a high susceptibility for contamination. In general, No Action Alternative 1-Scenario 2 is not expected to result in substantial impacts on aquifers. To date, there are no data that indicate that forest pesticide applications under the January 1, 1999 Washington Forest Practices Rules (No Action Alternative 1-Scenario 2) resulted in substantial impacts to aquifers, therefore, no substantial impacts are expected to occur under this alternative. Application of forest pesticides and fertilizers, however, could contribute to cumulative impacts associated with contamination of aquifers. Appendix J in the Washington Forest Practices Board (2001) contains additional details on the potential for sole-source aquifer contamination from forest chemicals.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

Groundwater impacts associated with No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 are expected to be similar but slightly less than under No Action Alternative 1-Scenario 2. Direct impacts on groundwater from pesticide or fertilizer leaching to groundwater aquifers could potentially occur at the same rate under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 as with No Action Alternative 1-Scenario 2. However, because the increased buffer widths required under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would result in fewer surface water impacts, the likelihood that contaminated surface water would reach and contaminate groundwater (via water exchange with a susceptible aquifer or within the hyporheic zone) is also reduced.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 is expected to result in similar but slightly lower impacts on aquifers compared to No Action Alternative 1-Scenario 2. The increased buffer widths required for pesticide applications under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would result in slightly less impact on surface waters resulting in a reduction in the potential for the interaction of contaminated surface water with aquifers. Overall, impacts are expected to be similar to or slightly lower than those described for No Action Alternative 1-Scenario 2 (i.e., no substantial impacts).

Alternative 4

The potential groundwater impacts resulting from pesticide or fertilizer application under Alternative 4 are expected to be nearly identical to the impacts associated with No Action Alternative 1-Scenario 1, but lower than No Action Alternative 1-Scenario 2. The biggest difference is that the minor reduction in the potential for pesticide drift to surface waters during aerial application under Alternative 4 could result in a decrease in the level of pesticides reaching groundwater or hyporheic zones (through a reduction in the exchange with potentially contaminated surface waters, as discussed above); a slight decrease compared to No Action Alternative 1-Scenario 1 and more of a decrease compared to No Action Alternative 1-Scenario 2.

Alternative 4 is expected to result in similar but slightly lower impacts on aquifers compared to No Action Alternative 1-Scenario 1 and even less of an impact when compared to No Action Alternative 1-Scenario 2. The increased buffer widths required for pesticide and fertilizer applications under Alternative 4 may result in slightly less sole-source aquifer contamination, through a reduction in the potential for contaminated surface water to interact with and adversely impact groundwater.

Water Quantity

Overview of Effects

None of the alternatives are expected to measurably alter the availability of water to aquifers. Therefore, only effects to hyporheic zone water quantity are considered.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Based on the assumptions stated above, No Action Alternative 1-Scenario 2 would have the highest likelihood for adverse impacts to the hydrology of hyporheic zones due to the narrow buffers on streams, especially Type 1 and 2 streams, which would contain most of the alluvial channels with significant hyporheic zones. A mitigating factor for large streams (Type 1 or S) is the Shoreline Management Act that requires a 200-foot Shoreline Management Zone buffers on each side of these streams, and allows no more than 30 percent timber volume removal every 10 years. The Shoreline Management Act applies regardless of alternative.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would have a lower likelihood for adverse hyporheic zone impacts than No Action Alternative 1-Scenario 2 based on buffer width and the increased protection of riparian areas on all streams, particularly Type S and F streams. No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) all include protection of Channel Migration Zones, which also provides additional protection for hyporheic zones.

Alternative 4

Alternative 4 would offer the greatest protection concerning riparian areas, particularly on low-gradient streams that would be most likely to have extensive hyporheic zones in alluvial channels. The protection of hyporheic zones would be substantially greater under Alternative 4, and impacts would be less, compared to either scenario of No Action Alternative 1 because of the larger no-harvest riparian zones.

4.6 VEGETATION

This subsection considers the effects of the alternatives on forest vegetation, including the potential indirect effects that may result from an increased occurrence of fire. It also considers the potential effects to threatened and endangered plants and invasive weeds.

In reading this analysis, it should be remembered from Chapter 2 (Alternatives) hat under No Action Alternative 1 no ITPs or ESA Section 4(d) take authorization would be issued. This lack of action would likely affect the Forest Practices Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Washington Forest Practices Rules, have been defined (subsection 2.3.1, No Action Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on forest vegetation, threatened and endangered plants, and invasive weeds are likely to fall between these two scenarios.

4.6.1 Evaluation Criteria

Evaluation criteria used in this analysis include the amount of:

- Early-, mid-, and late-seral vegetation, both short term (next 10 years) and long term. This measure considers the differences in riparian buffer widths under each alternative.
- Landowner support for, and participation in, forest management programs. This measure considers the likelihood that investment in silvicultural treatments would be implemented to speed the development of complex forest structures under some alternatives.
- Area with a high potential for fire. This measure considers the amount of area with snags and standing trees surrounded by logging slash.
- Area with potential for adverse effects to existing threatened and endangered plants. This measure considers the amount of disturbance from timber harvest, including thinning, roads, and yarding corridors, as well as likely disturbance from windthrow.
- Area with increased exposure to invasive weeds. This measure considers the amount of disturbance from roads, skid trails, and regeneration harvest.

4.6.2 Forest Vegetation

4.6.2.1 Overview of Effects

Forest vegetation is shaped by both natural events and human activities, past, present, and future. Currently, available riparian vegetation data indicate that early- and mid-seral stands dominate State, county, city, and private forestlands in Washington; that is, the lands covered by the Washington Forest Practices Rules (covered lands) (Knutson and Naef 1997; Washington Forest Practices Board 2001a; McHenry et al. 1998; and Lunetta et al. 1997). The covered lands are expected to continue to support primarily early- and mid-seral vegetation for the foreseeable future, except within RMZs. Riparian buffers proposed under the alternatives would result in changes over time, depending on their width and prescriptions. The buffers proposed for the westside of the Cascades differ from those proposed for the eastside under No Action Alternative 1, both scenarios, and Alternatives 2 and 3. They would be the same for both sides of the Cascades under Alternative 4. Figures 4.2-1 and 4.2-2 graphically present~~s~~ ~~a summary of~~ the estimated RMZ acres by alternative for western (private, city, and county lands only) and eastern (private, city, county, and State lands) Washington, respectively, ~~under each of the alternatives,~~ and indicate~~s~~ the level of management or protection afforded different portions of these RMZs.

The covered lands include approximately 72 percent of the Sitka Spruce vegetation zone, 62 percent of the Western Hemlock zone, and 28 percent of the Grand fir/Douglas-fir and Ponderosa Pine zones (subsection 3.6.1, Forest Vegetation). The alternatives would have a greater effect on the Sitka Spruce and Western Hemlock zones than on forests in other vegetation zones. Only minor amounts of the other zones would be affected by the proposed alternatives.

Under all alternatives, westside State trust lands (approximately 1,390,000 acres) would continue to be managed under the State Trust Lands HCP, approximately 31 percent of which would be within RMZs (Washington DNR 2004c). These lands would not be affected by changes proposed in this analysis.

4.6.2.2 Detailed Effects Analysis

No Action Alternative 1-Scenario 2

No Action Alternative 1-Scenario 2 assumes that the Washington Forest Practices Rules that were in effect on January 1, 1999 would be implemented. Covered private, city, and county forestlands on the westside (approximately 6,289,000 acres) would be managed under the January 1, 1999 Washington Forest Practices Rules. Approximately 7 percent of these lands would be within the no-harvest or light selective harvest riparian zones (Figure 4.2-1). Another 1 percent would be in the moderate to heavy selective harvest zone (Figure 4.2-1). These buffers would initially retain mostly early to mid-seral forest characteristics; however, over ~~and, in~~ time, they would develop ~~into~~ late-seral forest characteristics. In total, almost 9 percent of the covered lands on the westside would develop late-seral forest characteristics over the long term~~, compared to approximately 1 percent now (Washington Forest Practices Board 2001a)~~. As the amount of acres in late-seral conditions increases, there would naturally be a corresponding decrease in early and mid-seral forest. (Note that State forestlands in western Washington are not included in these calculations because they are already subject to an HCP, see subsection 1.1.2, Washington State's Habitat Conservation Plan, footnote 1.)

Approximately 3 percent of the covered lands on the eastside (which include~~d~~ private, city, county, and State lands) would be within the no-harvest or light selective harvest riparian zones (Figure 4.2-2). Almost 2 percent would be in the moderate to heavy selective harvest zone (Figure 4.2-2). Initially, most of ~~T~~these buffers would retain early to mid-seral forest characteristics~~ and, in~~; however, over time, they would develop ~~into~~ late-seral forest characteristics. In total, approximately 5 percent of the covered lands on the eastside would develop ~~into~~ late-seral forest characteristics over the long term~~, compared to approximately 5 percent now (Washington Forest Practices Board 2001a)~~. Also, 50 percent of the area outside of the RMZ is likely to be managed using a selection harvest prescription (Personal Communication, Charlene Rodgers, Washington DNR, April 6, 2004) and may retain enough trees to develop some of the characteristics associated with mid- or late-seral forest.

Management under No Action Alternative 1-Scenario 2 may result in a reduction of landowner participation in non-regulatory programs and further reductions in silvicultural investments by private forest landowners and the State compared to the status quo (or No Action Alternative 1-Scenario 1). There would be substantially less land in protective stream buffers than under No Action Alternative 1-Scenario 1. Under this scenario, there would be little or no incentive to implement thinning and fertilization programs to speed the development of late-seral conditions in riparian areas. No Action Alternative 1-Scenario 2 would not likely increase the fire potential because the area with standing trees and snags adjacent to logging slash would not increase over current conditions.

No Action Alternative 1-Scenario 1

No Action Alternative 1-Scenario 1 assumes that current Washington Forest Practices Rules would continue to be implemented. Covered private, city, and county forestlands on the westside (approximately 6,289,000 acres) would continue to be managed under the current Washington Forest Practices Rules. Approximately 16 percent of these lands would be within the no-harvest or light selective harvest riparian zones (RMZ core zone or inner zone, respectively) (Figures 4.2-1). Another 4 percent would be in the moderate to heavy selective harvest zone (RMZ outer zone) (Figure 4.2-1). Most of ~~T~~these buffers would retain early- to mid-seral forest characteristics~~ and, in~~; however, over time, they would develop ~~into~~ late-seral ~~stands~~characteristics. In total, approximately 20 percent of the covered lands on the westside would develop late-seral characteristics over the long term~~, compared to approximately 1 percent under current conditions (Washington Forest Practices Board 2001a)~~. As the amount of acres in late-seral conditions increases, there would naturally be a corresponding decrease in early- and mid-seral forest.

About 3,365,000 acres of covered lands exist on the eastside of the Cascades (including private, city, county, and State forestlands). Approximately 9 percent of these lands would be within the no-harvest or light selective harvest riparian zones (Figure 4.2-2). Another 1 percent would be in the moderate to heavy selective harvest zone (Figure 4.2-2). These buffers would retain early to mid-seral forest characteristics~~ and, in~~; however, over time, they would develop ~~into~~ late-seral ~~forest~~characteristics. In total, ~~approximately 9~~almost 11 percent of the covered lands on the eastside would develop late-seral characteristics over the long term~~, compared to approximately 5 percent at present (Washington Forest Practices Board 2001a)~~. There would be a small corresponding decrease in early- and mid-seral forest. Also, 50 percent of the area outside of the RMZ would likely be managed using a selection harvest prescription (Personal Communication, Charlene Rodgers, Washington DNR , May 2004) and may retain enough trees to develop some of the characteristics associated with mid- or late-seral forest.

In general, No Action Alternative 1-Scenario 1 would likely result in substantially reduced silvicultural investments by private forest landowners and the State. Less thinning and fertilization would likely delay development of late-seral conditions in riparian areas. This alternative may increase the short-term fire potential slightly by increasing the area with standing trees and snags adjacent to logging slash. Also, No Action Alternative 1-Scenario 1 would "feather" the edges of riparian buffers by allowing moderate to heavy selective harvest in the outer zone of the buffer, light selective harvest in the inner zone, and no harvest in the core zone (Note: there is no outer, inner, or core zone equivalent under No Action Alternative 1-Scenario 2).

Alternative 2

Under Alternative 2, riparian buffer areas on covered lands would be similar to those described under No Action Alternative 1-Scenario 1 but substantially more protective than under No Action Alternative 1-Scenario 2. In addition, implementation and participation in non-regulatory programs by all parties is expected to continue at a high rate, leading to increased investment in silvicultural activities, such as thinning, designed to speed development of late-seral conditions in riparian areas and on some upland lands owned by the State. Alternative 2 may result in a short-term increase in fires as compared to No Action Alternative 1-Scenario 1 because of the expected increase in thinning, which would increase the area with standing trees and snags intermixed with slash (from thinning). However, over the longer-term, thinning, particularly in eastern Washington, would reduce dangerous fuel loads in riparian buffers that would accumulate over time. Additionally, as under No Action Alternative 1-Scenario 1, Alternative 2 would "feather" the edges of buffer areas by allowing moderate to heavy selective harvest in the outer zone of the buffer, light selective harvest in the inner zone, and no harvest in the core zone.

Alternative 3

Under Alternative 3, riparian buffer areas on covered lands would be similar to those described under No Action Alternative 1-Scenario 1 but substantially more protective than under No Action Alternative 1-Scenario 2. In addition, implementation and participation in non-regulatory programs by all parties is expected to continue at a moderate rate but higher than under No Action Alternative 1-Scenario 1. Investment in silvicultural activities designed to speed development of late-seral conditions in riparian areas and on some uplands owned by the State is, therefore, expected to be more than under No Action Alternative 1-Scenario 1 (but less than under Alternative 2). As under No Action Alternative 1-Scenario 1, Alternative 3 would "feather" the edges of buffer areas by allowing moderate to heavy selective harvest in the outer zone of the buffer, light selective harvest in the inner zone, and no harvest in the core zone.

Alternative 4

Alternative 4 assumes that current Washington Forest Practices Rules would be repealed and that new, more protective, Washington Forest Practices Rules would be developed and implemented. Covered private, city, and county lands on the westside (approximately 6,289,300 acres) would be managed under more restrictive Washington

Forest Practices Rules. Nearly 41 percent of these lands would be within the no-harvest riparian zones (Figure 4.2-1). These buffers would initially retain early to mid-seral forest characteristics~~ and, in~~; however, over time, they would develop ~~into~~ late-seral ~~forest~~characteristics. Therefore, approximately 41 percent of the covered private, city, and county lands on the westside would develop late-seral characteristics over the long term~~, compared to less than 1 percent now (Washington Forest Practices Board 2001a)~~. As the amount of acres in late-seral conditions increases, there would naturally be a corresponding decrease in early and mid-seral forest.

Over 25 percent of the covered lands on the eastside lands would be within the no-harvest riparian buffers (Figure 4.2-2). These buffers would retain early to mid-seral forest characteristics~~ and, in~~; however, over time, they would develop ~~into~~ late-seral forest characteristics~~, compared to approximately 5 percent at present (Washington Forest Practices Board 2001a)~~. This would result in a large decrease in early- and mid-seral forest over that period. Another 50 percent are likely to be managed using a selection harvest prescription and may retain enough trees to develop some of the characteristics associated with mid- or late-seral forest.

While management under this alternative would result in much larger no-harvest RMZs compared to the No Action Alternative 1 scenarios, a reduction in landowner participation in non-regulatory programs would also likely result. Silvicultural investments by private forest landowners and the State (thinning and fertilization) are likely to be substantially reduced below current conditions and any of the other alternatives. Substantially more forestland would likely be converted to other uses, such as housing, because of the more restrictive regulations governing forest management compared to either scenario of No Action Alternative 1.

Alternative 4 would be expected to result in an increase in fires, especially in eastern Washington, as compared to the No Action Alternative 1 scenarios because of wider no-harvest RMZs that would contain more trees and snags than the other alternatives. Also, all existing down woody debris would be retained. The increased amount of standing and down wood and the "ladder effect" that would result from the mixture of understory trees and other plants, mid canopy trees, and upper canopy trees would result in an increase in fires. Any fires that do start would likely burn hotter and for a longer time under Alternative 4 than under either scenario of No Action Alternative 1. Therefore, the potential for intense, stand-replacement fires would be highest compared to other alternatives because of the lack of thinning or understory burning within the riparian zone.

4.6.3 Threatened and Endangered Plants

4.6.3.1 Overview of Effects

The species list on Table 3-16 shows that the federally listed and candidate species on covered lands have varying habitat needs, such as wetlands, stream edges, open meadows and forested areas. Several species (*Arenaria paludicola, Hackelia venusta, Castilleja leviseta, Lupinus sulphureus* spp. *Kindaidii*) prefer habitats such as open grassland, rock crevices, prairies, or bogs that are unlikely to be directly affected by tree harvest. However, they may occur adjacent to harvest areas and could be affected by related activities. Other species can occur in forest openings, edges, or along streams with relatively open canopies and could be affected by harvest or related activities. Direct effects to federally listed or candidate plants include physical damage or destruction of the plant due to harvest, including thinning, or related activities such as road construction or use of yarding corridors. Indirect effects include changes in the micro-environment, such as changes in canopy (i.e., available sunlight), changes in hydrology, and increases in competition from invasive weeds or other plants. The range of effects is varied because the species have different habitat requirements and life histories. Therefore, each species would potentially have a different sensitivity to particular disturbances.

The alternatives considered in this analysis do not propose to change any policies or procedures for managing threatened, endangered, and candidate plants. Under all alternatives, Washington DNR is required to consult with WDFW regarding State-designated threatened and endangered species and their habitats before approving forest practices applications. The difference in potential effects of the alternatives is a function of the type and amount of harvest in habitats that may contain federally listed or candidate plant species. Although the majority of species listed in Table 3-16 prefer open habitat, for purposes of this FEIS, it is assumed that more harvest and harvest related disturbance has a greater probability of physically disturbing existing plant populations or their habitat. For this analysis, it is assumed light management practices combined with large RMZs and significant wetland protection decreases the potential for adversely affecting currently existing federally listed and candidate plants.

4.6.3.2 Detailed Effects Analysis

<u>No Action Alternative 1-Scenario 2</u>

No Action Alternative 1-Scenario 2 has the greatest potential for effects on federally listed and candidate plants currently existing on the landscape because the amount of disturbed habitat would be highest under this alternative. Additionally, RMZs would be relatively narrow and allow broader management practices compared to the other alternatives, increasing the potential of additional direct and indirect affects from windthrow.

<u>No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3</u>

No Action Alternative 1-Scenario 1, and Alternatives 2 and 3 all would protect a similar amount of riparian and wetland area. However, Alternative 2 is likely to include greater amounts of thinning in the RMZ to speed the development of complex forest structure, depending on the results of research conducted under the Alternative 2 adaptive management program. This may result in greater direct and indirect effects on listed and candidate plants currently existing on the landscape than under No Action Alternative 1-Scenario 1 but less effect compared to No Action Alternative 1-Scenario 2.

Alternative 4

Alternative 4 would provide the most protection among all alternatives for listed and candidate plants currently existing on the landscape, because of the wide no-harvest buffers for RMZs (Figure 4.2-1), limited cutting of forested wetlands (70 percent canopy to remain), and buffers for all non-forested wetlands. However, there may be changes to available light, damage due to windthrow or fire, or increased competition due to noxious weed introduction. Protection of listed and candidate plants would be greater under this alternative than under No Action Alternative 1-Scenario 1 and much greater than under No Action Alternative 1-Scenario 2 because of the substantially more protective riparian buffers expected under this alternative.

4.6.4 Invasive Plants

4.6.4.1 Overview of Effects

Many invasive plants thrive in disturbed areas. Once they become established, they often out-compete native species because they often benefit from changes in microclimate, such as increased sunlight, changes in hydrology, and creation of bare mineral soil. It is assumed for this analysis that greater disturbance would result in increased opportunities for invasive plant species to become established.

State requirements under the Weed Law (RCW Chapter 17.10) would apply to all alternatives. Management programs to prevent new infestations and to contain existing ones would continue under all alternatives.

No Action Alternative 1-Scenario 2 is likely to provide the best conditions for invasive plants to colonize because there would be relatively little undisturbed habitat under this alternative.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would all protect a similar amount of riparian area, although much of the protected area would be available for partial harvest. In particular, Alternative 2 is likely to include greater amounts of thinning designed to speed the development of complex forest structure than No Action Alternative 1-Scenario 1. However, thinning and partial harvest may allow invasive plants to become established, increasing competition with desirable understory plant communities.

Alternative 4 would provide the largest amount of undisturbed area among all alternatives, especially when compared to No Action Alternative 1-Scenario 2 but also No Action Alternative 1-Scenario 1 because of the wide, no-harvest buffers (Figures 4.2-1 and 4.2-2); although there may be some disturbance from windthrow and fire. Alternative 4 may also result in less road construction because of the requirement of “no net increase” in roads within a watershed; this factor may also reduce the spread of invasive plants, allowing more desirable understory plant communities to have less competition from invasive species over large portions of the landscape. Approximately 41 percent of the westside covered lands and 25 percent of the eastside covered lands would be protected in no-harvest RMZs (Figures 4.2-1 and 4.2-2).

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4.7 RIPARIAN AND WETLAND PROCESSES

4.7.1 Riparian Processes

The establishment of RMZs is generally accepted as the most effective way of protecting aquatic and riparian habitats (Cummins et al. 1994 as quoted in Spence et al. 1996; Spence et al. 1996; FEMAT 1993). Evaluation of the anticipated effects of the proposed alternatives on riparian habitats is based primarily on the current or proposed widths and management prescriptions within RMZs and the associated acreages.

4.7.1.1 Evaluation Criteria for Riparian Processes

Criteria used to determine the effectiveness of the proposed RMZ management allowed under each alternative are based on the riparian functions that were described in subsection 3.7.1 (Riparian Functions). The effectiveness of each alternative can best be evaluated within the context of specific protection goals. Most functions are evaluated in terms of protection goals for fish and water quality. However, for microclimate, which is more likely to affect semi-aquatic species such as amphibians, a variety of components was considered including humidity, soil moisture and temperature, and air temperature. As a result, riparian functions are evaluated in terms of the estimated level of protection necessary to provide full protection (i.e., near 100 percent effectiveness), and is intended to serve only as a comparative method to evaluate each alternative.

The evaluation criteria are mostly defined in terms of curves, which represent the relationship between the cumulative effectiveness of the riparian function and the distance from the streambank. Therefore, these curves show the estimated degree of protection of riparian function provided by different RMZ widths. The curves are based on a wide variety of literature, and are generally conservative, (i.e., they reflect the widest RMZs needed to provide complete protection, as identified in the literature), although the discussions also consider lesser widths and other circumstances as appropriate. The relationships between distance from stream and the percent of function maintained are not all linear, and some are more theoretical than empirical. In all cases, the area closest to the stream is more important for providing function than the areas further away (FEMAT 1993).

Depending on the function, RMZ requirements may be defined as fixed RMZ widths or based on site potential tree height. A site potential tree height is sometimes defined as the average maximum height of the tallest dominant trees that can grow on a certain site (FEMAT 1993). However, to maintain consistency with Washington Forest Practices Rules, site potential tree height in this FEIS is defined as the average height of a stand at a given age (more commonly referred to as site index). Site potential tree height in Washington varies with site-class, species, and region (Table 4.7-1). Less productive forestlands (Site Classes IV and V) will have a shorter site potential tree height, and more productive forestlands (Site Classes I and II) will have a taller site potential tree height. Additionally, westside trees tend to grow taller than eastside trees for the same site class, due to climatic conditions and other factors on the westside (USDA Forest Service 1984).

Table 4.7-1. Site Potential Tree Height (SPTH) for Douglas-fir at 100 years and 250 years for Western and Eastern Washington.

Site Class	$SPTH_{100}$ (feet)		$SPTH_{250}$ (feet)	
	Westside	Eastside	Westside	Eastside
I	200	130	247	195
II	170	110	210	170
III	140	90	174	135
IV	110	70	136	105
V	90	60	100	85

Sources: McArdle 1949, USDA Forest Service 1984.

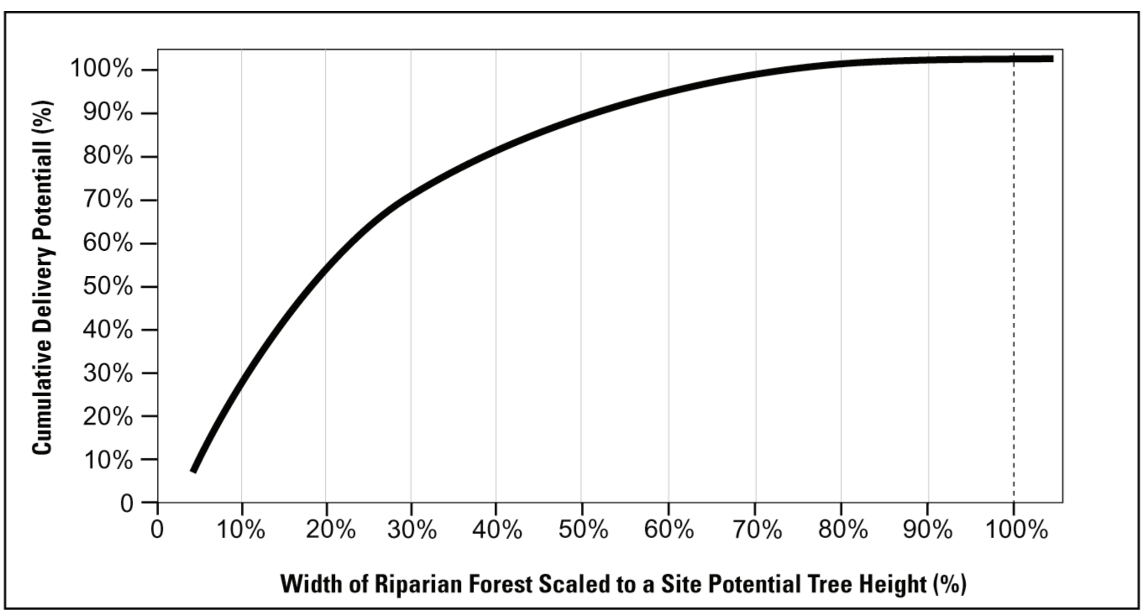
Two stand ages, 100 years and 250 years, were used to evaluate the level of protection for riparian functions. Forests and Fish Agreement stakeholders agreed to a site potential tree height projected at a stand age of 100 years to represent the site potential tree height for a mature riparian stand. However, old-growth stand characteristics may be a more appropriate baseline from which to define adequate riparian effectiveness. Consequently, riparian function effectiveness was analyzed for both 100-year and 250-year stands. The choice of a 250-year stand was based upon the age at which stands begin to display old-growth characteristics (Franklin and Spies 1991) and the return intervals for fire and blowdown for westside forests (Agee 1993). Site potential tree heights were based upon an average of Site Class II and III areas; these site classes represent the most frequent site classes on covered lands managed for timber production. The site potential tree height for Douglas-fir stands was chosen for both the westside (McArdle 1949) and eastside (extrapolated from Table I-12 in USDA Forest Service 1984). Notably, the site potential tree height for ponderosa pine (Meyer 1961) at 250 years is approximately the same as for Douglas-fir on the eastside. Neither of these stand-age criteria has been experimentally tested for providing an adequate level of riparian function that is sufficient for maintaining robust populations of salmonids.

It is assumed that RMZ widths based on 100- and 250-year site potential tree heights represent the range of site potential tree heights over which most riparian functions are likely to be fully expressed. For example, for an eastside Site Class II riparian area, adequate protection would be provided with a RMZ somewhere between 110 and 170 feet. This range represents the uncertainty surrounding the tree height that provides complete protection. If a 250-year site potential tree height is chosen as the standard against which to compare RMZ widths, but complete protection is actually provided by a 100-year site potential tree height, then 60 feet of the 170-foot RMZ width would represent over-protection. Conversely, if a 100-year site potential tree height is chosen for measuring RMZ widths, but a 250-year site potential tree height is the true site potential tree height that provides full protection, then the 110-foot RMZ would represent under-protection by 60 feet. It is possible that an intermediate site potential tree height is more appropriate or that streams with different morphological and riparian characteristics have different site potential tree height levels that provide full protection for that stream type.

LWD Recruitment

This evaluation is based on the level of protection provided for LWD recruitment potential from the riparian area using the RMZ width and silvicultural prescription. Based on a review of the literature (e.g., McDade et al. 1990; FEMAT 1993; Spence et al. 1996), it was concluded that an RMZ width of about one site potential tree height is needed to provide full protection of LWD recruitment by toppling, windthrow, or stream undercutting. An exception to this may occur in second-growth stands where hardwoods have excluded regeneration of conifers or overstocking of stands has lead to the depletion of large size classes of recruitable LWD (Spence et al. 1996). As a result, consideration was also given to stand manipulation to increase tree size over time. Therefore, growth rate modeling of tree diameter and age to reach functional and key piece recruitment size, based on different silvicultural prescriptions and different stream sizes, was also used when evaluating alternatives. The relationship between the estimated level of LWD recruitment potential and RMZ width used in the alternative evaluation is shown in Figure 4.7-1. The modeling assumes the effects of LWD recruitment when trees reach the designated age (i.e., 100 or 250 years). Actual recruitment of LWD, to the modeled level in most areas, will take decades or longer as most riparian areas have been harvested in the past and likely are only 50 years or less in age. To quantify this relationship over all streams under different alternatives, an equivalent buffer area index was calculated for each alternative using both 100-year and 250-year site potential tree height as baselines for full protection of LWD recruitment potential (DEIS Appendix B). The equivalent buffer area index provides a weighted measure of the degree of protection

Figure 4.7-1. Relationship between the Estimated Level of LWD Recruitment Potential and RMZ Width Used in the Alternative Evaluation.



Sources: McDade et al. 1990; FEMAT 1993.

provided by all streams giving consideration to stream size, RMZ widths, RMZ prescriptions, source distance, and the relative length of each stream type over the landscape.

The actual LWD model assumes that all major wood sources arrive at the stream primarily in a chronic manner through mortality of trees adjacent to the stream and does not attempt to determine wood from other sources (McDade et al. 1990). However, the actual sources of wood can vary quite widely in streams depending on natural tree mortality rate, topography, climate, substrate, natural disasters (fires, wind storms, large floods) (Benda et al 2003; Martin and Benda 2001; Reeves et al. 2003). Drainages with high mass wasting potential could have a substantial portion of the LWD originate outside of the riparian area (Reeves et al. 2003; Benda et al. 2003). The opposite is true for streams with eroding banks where active channel movement undercut trees along the stream edge. In the first case (i.e., mass wasting-dominated recruitment) the model would overestimate the contribution of wood from the protected RMZ in which case the model would overestimate the protection provided by an RMZ. While in the second case (bank erosion-dominated recruitment) the model would underestimate the contribution from the RMZ nearest the stream, and the model would underestimate the LWD contribution from the RMZ. It is likely that some of both situations will occur in different regions of the analysis area, so that the model both over and under estimates the RMZ protection provided. But the McDade et al. 1990 information is considered a useful tool for evaluating the effect of buffer width on LWD recruitment (Spence et al. 1996) and has been used by others (Welty et al. 2002) as a good representation of LWD sources for Pacific Northwest streams.

While McDade et al. (1990) served as the quantitative basis for establishing the equivalent buffer area index for LWD recruitment originating from RMZs, the analysis also considered supplemental LWD recruitment that would occur as a result of unstable slope protection under each alternative. Many unstable slopes and landforms (e.g., channel heads, bedrock hollows, inner gorges) are located in close proximity to stream channels and as such, serve as potential source areas for wood recruitment. Protection of these areas through tree retention increases potential LWD recruitment where unstable slopes and landforms extend beyond required RMZs. While not quantified in this analysis, unstable slopes protection under each alternative was considered when evaluating the effects on LWD recruitment.

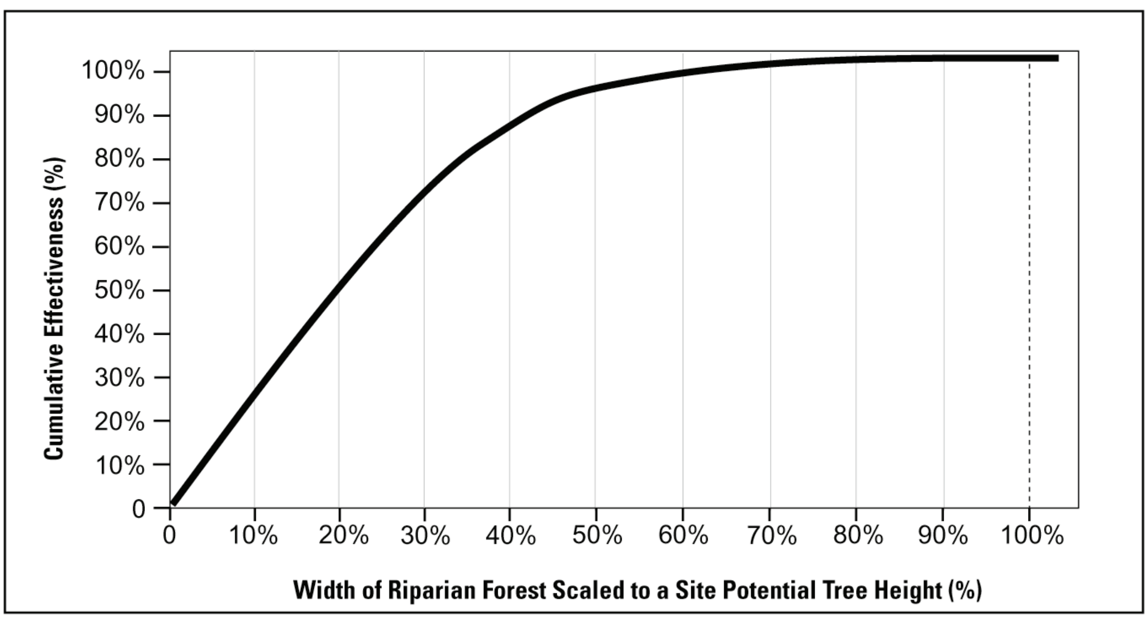
Leaf and Needle Litter Production

This evaluation is based on width of the respective RMZs and activities allowed within the RMZ that may affect leaf and needle litter inputs (i.e., "detrital input"). Leaves and needles, as well as other biological inputs (e.g., terrestrial insects), enter the stream from riparian vegetation and supply nutrients and food to stream systems. Due to historical harvest practices, leaf and needle litter supply has been substantially reduced. Leaf and needle inputs can be a major contributor to fish food production in streams (Wipfli 1997; Piccolo and Wipfli 2002; Bilby and Bisson 1992; Bisson and Bilby 1998). Little direct information is available that describes leaf and litter source distances from streams.

Spence et al. (1996) stated buffers designed to supply LWD recruitment would provide 100 percent of allochthonous detritus (See Glossary) (i.e., FEMAT (1993)) hypothesized that a distance of approximately 0.5 site potential tree height would provide most leaf and litter inputs. The estimated relationship used in this analysis is shown in Figure 4.7-2. FEMAT (1993) based this hypothesis on a study (Erman et al. 1977) of benthic invertebrate diversity in buffered and unbuffered streams in northern California. Others have found litter input to streams decreases exponentially with distance (Conners and Naiman 1984) so the curve (Figure 4.7-2) may be conservative relative to contribution by distance.

The amount of detrital input may remain high, and benthic invertebrate production diverse even in recently harvested riparian areas depending on the type of vegetation that regrows in the short term. But as the riparian area ages, following riparian zone tree harvest, it passes through stages where terrestrial input (e.g., leaf litter, needles) decreases substantially from old growth levels (Piccolo and Wipfli 2002). Although uncertainty exists about the validity of the leaf and litter distance hypothesis developed by FEMAT (1993) for use in the Pacific Northwest, it was used in this analysis because no other criteria are available.

Figure 4.7-2. Relationship between the Estimated Level of Leaf and Needle Litter Recruitment and RMZ Width Used in the Alternative Evaluation.



Source: FEMAT 1993.

Stream Shade

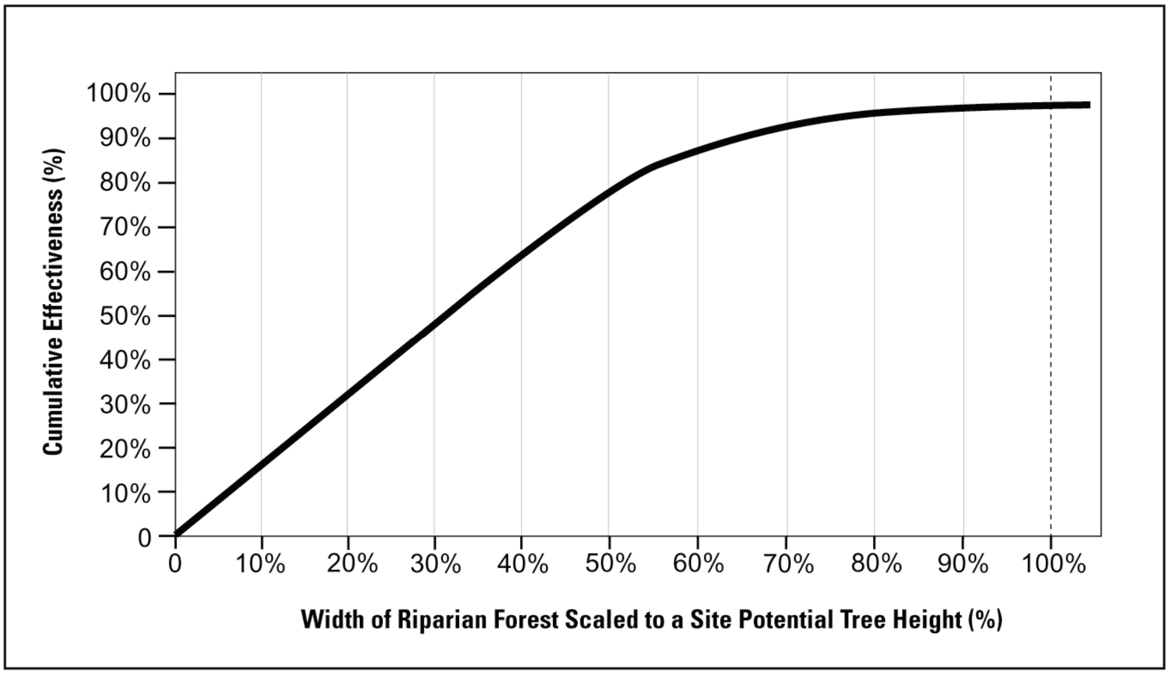
Given that there is site-specific variation that determines shade, it was concluded that RMZ widths of approximately 0.75 site potential tree height for both east and westsides are needed to provide full protection of stream shading capacity along most perennial streams. The criterion used here is not intended to correspond specifically to State water quality temperature standards, which do not necessarily require full shade retention, but instead, the criterion is used as a method of comparing the degree to which each alternative meets full shading capacity. The criterion is based upon the shade curve in FEMAT (1993). The estimated relationship used in our analysis for most perennial streams is shown in Figure 4.7-3. However, for small streams (less than 5 feet wide) that are often completely shaded by understory vegetation and therefore lack riparian canopy openings in their undisturbed state, an RMZ width of less than 0.75 site potential tree height was determined sufficient to provide enough shade to maintain stream temperatures. Broderson (1973) reported that for small streams (less than 5 cubic feet/second mean flow) a 50-foot buffer supplied 85 percent of maximum shade. As a result, a 50-foot buffer was used as the evaluation criterion for shade along small perennial streams. For seasonal streams that do not flow during the summer, stream shade should have minimal to no effect on temperature and therefore, were not considered when evaluating shade requirements.

According to this FEIS analysis, the protection of unstable slopes under each alternative supplements shade provided by RMZs. This is particularly true where unstable slopes and landforms such as channel heads, bedrock hollows, and inner gorges are located immediately adjacent to stream channels. While not quantified, the degree to which each alternative supplements shade levels via unstable slopes protection was also considered in the effects analysis.

Microclimate

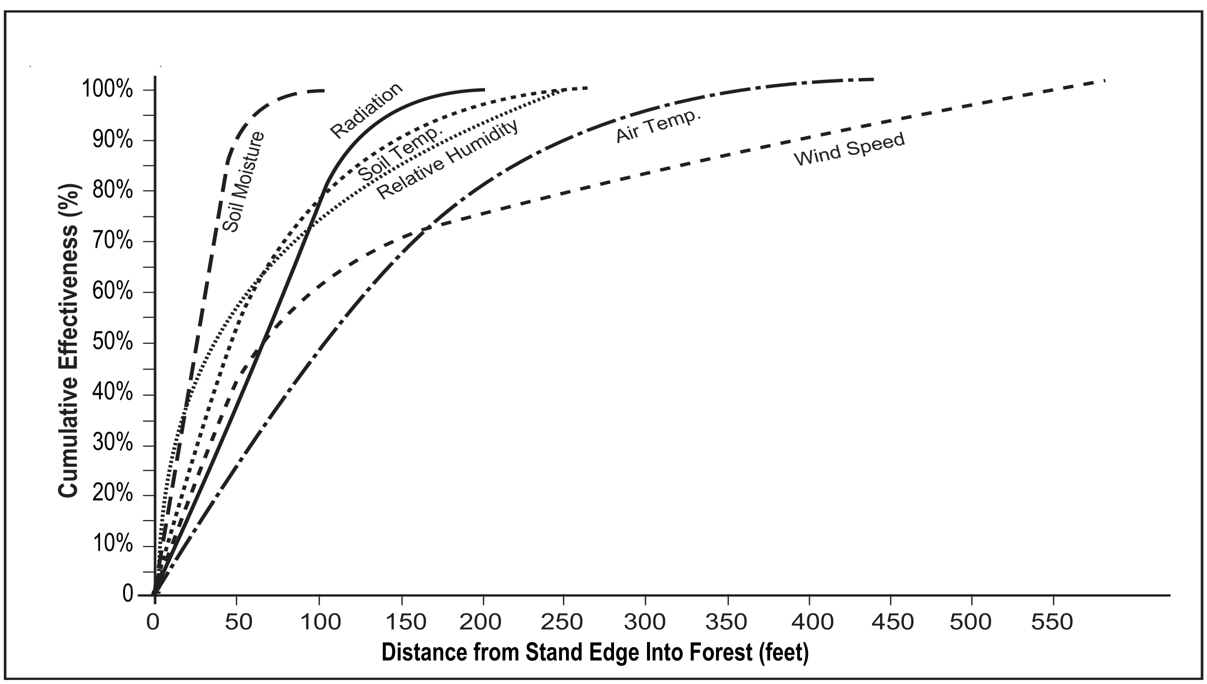
While there are differing recommendations on RMZ widths for maintaining microclimate gradients, the results of Brosofske et al. (1997); Dong et al. (1998); and FEMAT (1993) provide basic guidelines to evaluate the alternatives. Brosofske et al. (1997) noted that a buffer of at least 147 feet was needed to maintain natural microclimate conditions along small forest streams that they studied, but for some microclimate variables, buffer widths may need to be much greater. Because the conclusions of these studies were generally site specific, their applicability as evaluation criteria is uncertain. Dong et al. (1998) found that buffer widths ranging from 52 to 236 feet had similar effects on air temperature near the stream, with little correlation of temperature to buffer width. But this study also found that air temperature near all streams increased following harvest to the buffer edge, including those with buffers greater than 235 feet. While the results of these and other studies used by FEMAT (1993) do not show a clear correlation between buffer width and microclimate, they are useful in helping to narrow the range of possible buffer effects. Based on curves shown in Figure 4.7-4 and information provided in the above studies, a minimum of 147 feet is considered necessary to maintain most microclimatic gradients while for air temperature, buffer widths greater than 230 feet are thought to be required.

Figure 4.7-3. Relationship between the Estimated Level of Shade Protection and RMZ Width Used in the Alternative Evaluation.



Sources: FEMAT 1993; Pollock and Kennard 1999.

Figure 4.7-4. Relationship between the Estimated Level of Protection for Microclimate and RMZ Width Used in the Alternative Evaluation.



Source: FEMAT 1993.

Bank Stability

Bank stability is of direct and indirect importance to aquatic resources because it affects such factors as sediment inputs to streams and streambank habitat. Based on information presented in Spence et al. (1996), a buffer width of 0.3 site potential tree height is adequate to maintain bank stability of most streams (Figure 4.4-3). The details of the criteria used for assessing bank stability are discussed in detail in subsection 4.4.2.1 (Mass Wasting Evaluation Criteria).

4.7.1.1.1 Sediment Filtration

The amount of sediment reaching streams from timber harvest activity, independent of that entering directly from tributary streams but related to timber harvest activities, is dependent on many factors. These factors are often influenced by buffer width and type of ground disturbing activities. The details of the criteria used to evaluate the level of sediment filtration, or capacity for buffers to intercept sediment, are presented in subsection 4.4.1.1 (Surface Erosion Evaluation Criteria). The evaluation is based on the development of a simple sediment equivalent buffer area index that relates the relative filtration capacity to the buffer width and type of ground disturbance occurring. This equivalent buffer area index is explained in DEIS Appendix B.

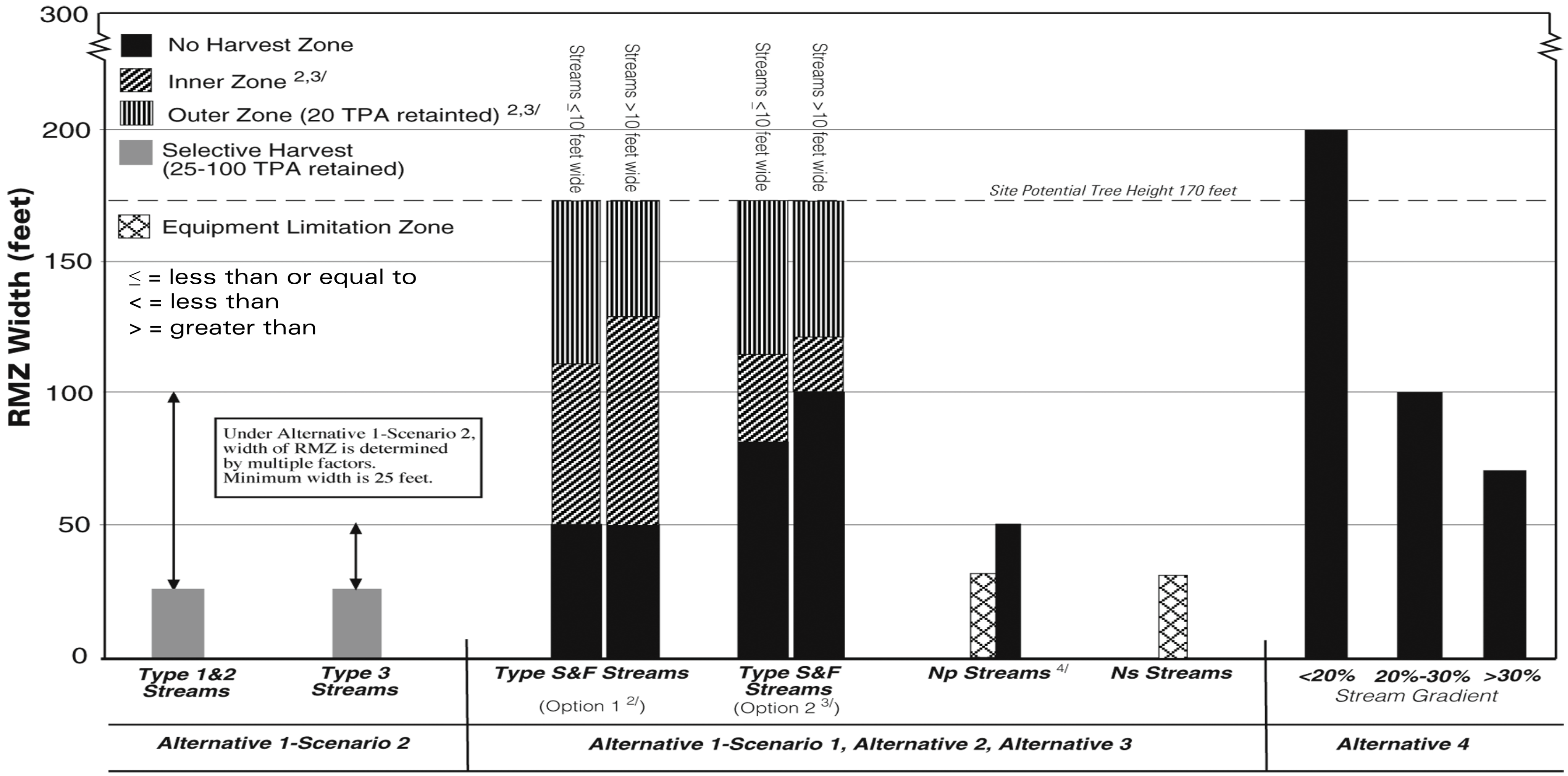
The analysis also considers floodplain and riparian roughness in the form of trees, understory vegetation and downed wood, which helps to dissipate energy and capture sediment delivered to the riparian area during overbank flows (Fetherson et al. 1995). The sediment equivalent buffer area index is used to evaluate this function as well, although its primary purpose is to measure sediment filtration function.

4.7.1.2 Evaluation of Effects of Alternatives on Riparian Processes

As noted in subsection 4.1.2 (Review of the Alternatives), because of the similarities of expected actions among some alternatives, especially relative to riparian RMZs, the effects discussion for the alternatives is primarily divided into three groups: 1) No Action Alternative 1-Senario 2; 2) No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3; and 3) Alternative 4.

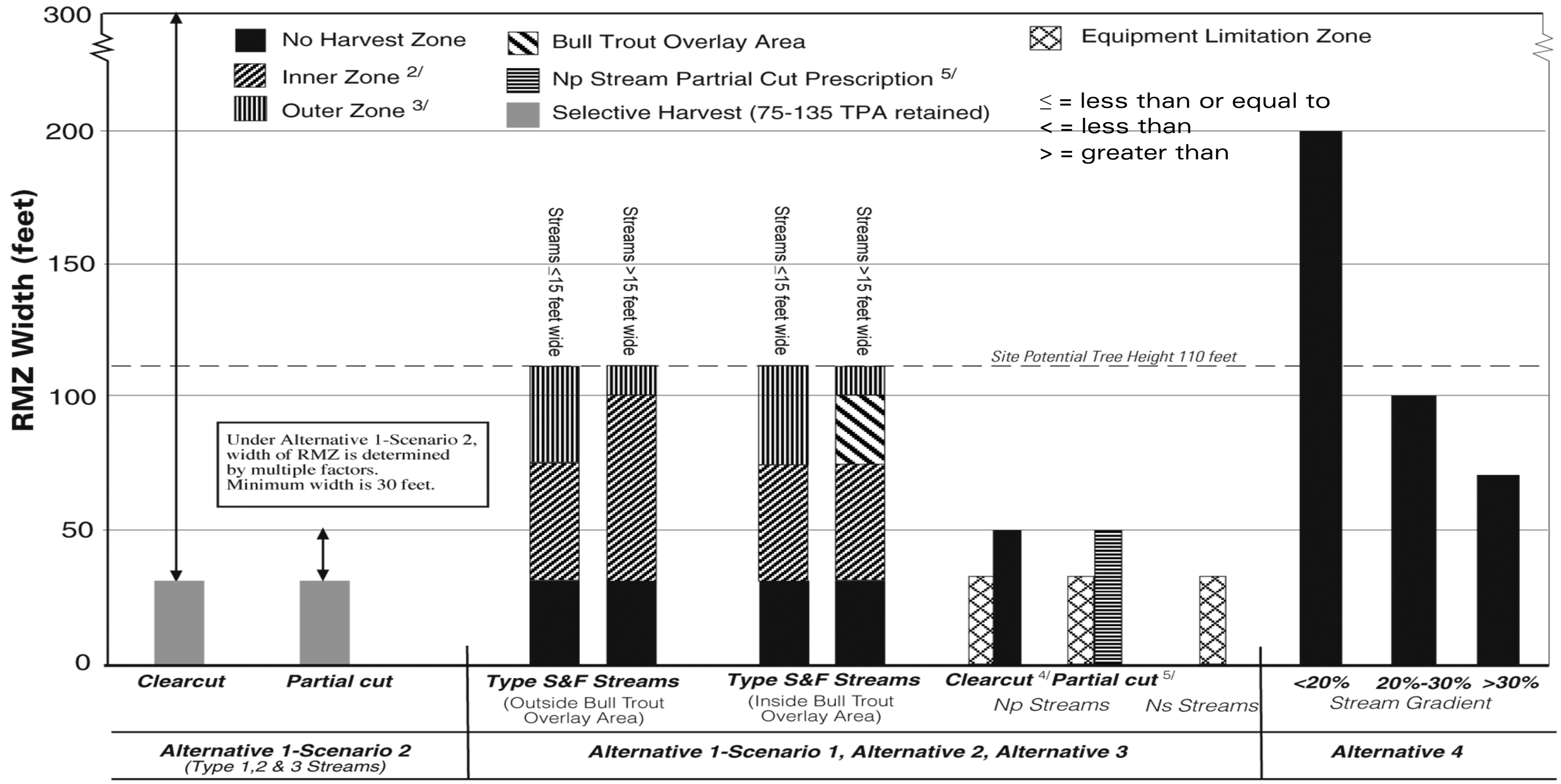
Because each alternative has a different stream classification scheme and different buffer requirements, it is difficult to quantitatively compare the effectiveness of the different alternatives in protecting riparian functions. Nevertheless, a quantitative sense of the level of protection afforded to specific processes can be gained by considering riparian RMZ width together with allowable level of activity within that RMZ. Therefore, for each function analyzed, an evaluation is made of both the RMZ widths and the allowable prescriptions that occur within the RMZ. Figure 4.7-5 compares the RMZ widths and the allowable prescriptions for each stream type under each alternative in western Washington, and Figure 4.7-6 provides the same comparison for the eastside.

Figure 4.7-5. Western Washington RMZ Characteristics by Alternative (using Site Class II, Site Potential Tree Height = 170 feet, as an example[1/]) (Note: Does not include Channel Migration Zone or Beaver Habitat Zone).



1/ Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, total width of the RMZ varies by site class, ranging from 90 feet (Site Class V) to 200 feet (Site Class I).
2/ For Type S and F streams, Option 1 calls for thinning from below in the inner zone, and 20 riparian leave trees per acre in the outer zone.
3/ For Type S and F streams, Options 2 calls for leaving enough riparian leave trees in the inner zone to meet the stand requirements (a basal area of 275 ft^2/acre at stand age 140 years, in this example of a Site Class II stand), plus an additional 20 riparian leave trees per acre in the outer zone. If no-harvest restrictions in the core zone result in conditions that will exceed the stand requirements, fewer trees may be left in the outer zone.
4/ For most Type Np streams, a no-harvest buffer is established along the first 300 to 500 feet upstream of the confluence of an Np stream with a Type S or F stream and adjacent to specified areas so that no less than 50 percent of the length of the stream is buffered.

Figure 4.7-6. Eastern Washington RMZ Characteristics by Alternative (using Site Class II, Site Potential Tree Height = 110 feet, as an example[1/]) (Note: Does not include Channel Mitigation Zone or Beaver Habitat Zone).



1/ Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, total width of the RMZ varies by site class, ranging from 75 feet (Site Class V) to 130 feet (Site Class I). Note that the minimum RMZ width for streams greater than 15 feet wide is 100 feet.

2/ For Type S and F streams, the inner zone prescription requires leaving at least 50 trees per acre after harvest, of which 21 are the largest trees and 29 are at least 10 inches diameter breast height (dbh). If the resulting basal area is less than 90 $feet^2$/acre, then enough additional 10-inch-or-greater trees must be left to meet this target.

3/ For Type S and F streams, the outer zone prescription requires leaving 50 trees per acres, of which 15 are at least 20 inches dbh.

4/ Clearcut strategy may be implemented in no more than 30 percent of the stream reach in a harvest unit, and only if an equal area is designated as a no-harvest zone.

5/ For most Type Np streams in partial cut areas, the 10 largest trees per acre, plus as many additional trees greater than 6 inches dbh as will result in a basal area of at least 90 ft^2/acre, must be left.

Another important aspect considered when evaluating the alternatives was susceptibility to windthrow or blowdown. If an RMZ experiences substantial windthrow, it may not be capable of maintaining desired functions. However, windthrow does improve LWD recruitment during the short-term, and many channels (especially on the westside) are currently in need of wood as a result of past riparian harvest and wood removal. The RMZs under all alternatives are likely to experience some degree of windthrow in localized areas. Windthrow is a normal occurrence in forests, but is known to increase along harvest unit edges after timber harvest opens formerly interior forest trees to more direct wind effects (Harris 1989).

RMZs along streams are subject to similar increases in windthrow. Several studies have attempted to define the relationship between riparian windthrow and various physical and biological features such as topography, valley morphology, aspect, slope, soil wetness, and tree type (~~Steinblums 1978;~~ Steinblums et al. 1984; Harris 1989). Though these site-specific factors may increase the vulnerability of an RMZ to wind events, no single factor has emerged as being of particular importance on a landscape scale. However, since blowdown is generally greater at the windward edge of a buffer, alternatives with wider RMZs would provide more protection for riparian function.

Pollock and Kennard (1998) reanalyzed several windthrow data sets looking at the relationship between buffer width and the likelihood of windthrow. They reached the conclusion that buffers of less than 75 feet have a higher probability of suffering appreciable mortality from windthrow than forests with wider buffers.

Data for blowdown within buffers from seven studies reported in Grizzel and Wolff (1998) had a mean windthrow level of about 15 percent for 344 sites in western Washington and Oregon with maximum windthrow levels ranging from 17 to 100 percent. Median windthrow levels were usually somewhat lower than the mean because the data are not normally distributed with relatively few sites having extensive blowdown. For example, the mean windthrow level for sites reported by Andrus and Froelich (1986) was 21.5 percent while the median value was 15.5 percent (i.e., half of the sites had less than 15.5 percent windthrow). Windthrow levels in Southeast Alaska were found to average about 9 percent in 66-foot no-harvest RMZs over a 4 to 6 year period following harvest, and most windthrow levels were less than 15 percent (Martin et al. 1998). Martin et al. (1998) also suggested that increased windthrow from buffers adjacent to geomorphic stream types with limited natural recruitment (via bank erosion) could be beneficial for fish habitat. Susceptibility to blowdown is addressed as appropriate in the effects analysis using a 75-feet buffer width as a general guideline.

Evaluation of the effects of the proposed alternatives on riparian habitats is also based on a comparison of the estimated changes in total riparian area protected in some way. The estimated amount of RMZ area, presented in terms of the total acreage protected in different protection levels, is compared by alternative in Figure 4.2-1 for both western and eastern Washington (See DEIS Appendix B for a description of the methods and assumptions used to derive these estimates). This analysis differs by making more simplified assumptions about tree density and removal quantity from that presented in

Appendix D of the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a), but draws similar conclusions about levels of protection.

Changes in riparian management and its effects on riparian habitat are addressed for the short term (10 years) and long term (50+ years). For each riparian function, the timeframe to transition from a non-functional riparian system to one that could provide most riparian functions is considered (Table 4.7-2). As discussed in subsection 3.7.1, (Riparian Processes), most of the riparian landscape occurring in forested areas appears to not be currently fully functioning.

Where some level of disturbance has occurred in riparian areas, an extended period would be needed to attain DFCs that approach full function (Table 4.7-2). Although a large proportion of State and private lands subject to Washington Forest Practices Rules is currently in early-seral stages, riparian habitat should improve over time (10 to 100+ years) to increase the amount of healthy riparian areas (Table 4.7-2).

LWD Recruitment

The effects of the alternatives on LWD recruitment are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regularoty Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1 [No

Table 4.7-2. Percentage of Total Stream Miles Found in the Sample Sections[1/] by Seral Stage, and Estimated Time Scales for Recovery[2/] of Each Riparian Parameter.[3/]

Seral Stage[4/]	Percent Seral Stage on the Westside	Percent Seral Stage on the Eastside	Recovery Periods (in years): Shade	LWD Recruitment	Leaf and Needle Lifter	Microclimate
Early-seral	78	61	5 to 40+ Years	100+ Years	30 to 80 Years	10 to 40+ Years
Mid-seral	21	34	20 to Full Functioning[5/]	50 to 100+ Years	30 to 60 Years	20 to Full Functioning[7/]
Late-seral	1	5	Full Functioning	Full Functioning to 100+ Years[6/]	30 to Full Functioning	Full Functioning

1/ Subsection 3.7.1.7, Current Condition of Riparian Areas, for a description of study.
2/ Estimated time scales for recovery are based largely on Gregory and Bisson in Stouder et al. 1997.
3/ Hardwoods were excluded because it is unknown if they would convert to coniferous forest in the future. Site-specific investigation would be required to determine whether this is a natural condition.
4/ Subsection 3.7.1.7, Current Condition of Riparian Areas, for definitions of seral stage.
5/ The upper end of the seral stage size range is fully functioning. The lower end of the seral stage size range requires more recovery time prior to being fully functioning.
6/ Full functioning LWD recruitment also depends on stream size for determining recovery. Larger streams require a larger proportion of big trees and, therefore, need a longer period to recover.
7/ Estimated to be the same timeframe as shade.

Action]) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on LWD recruitment are likely to fall between these two scenarios.

Overview of Effects

An overview of the effects of the alternatives on LWD supply to streams is presented in this subsection. For perspective, LWD in streams has been greatly reduced in nearly all streams within the State due to historic logging practices, but also other land uses (e.g., agriculture, urbanization) (subsection 3.7.1.6, Historic Protection of Riparian Areas, and subsection 3.7.1.7, Current Condition of Riparian Areas). However, the current Washington Forest Practices Rules, as well as the January 1, 1999 Washington Forest Practices Rules, would provide for substantially higher levels of LWD over the long term than was provided under historic harvest practices, especially along fish-bearing streams. The amount of LWD produced within riparian zones on covered forestlands is increasing due to tree growth and because the rules under any of the alternatives would result in the retention of a substantial portion of trees in the RMZ along fish-bearing streams, especially relative to historic practices. However, LWD in streams will continue to decrease in the near term, especially in larger streams (larger streams require larger LWD to be functional), as LWD supplied by previously logged old growth is naturally being removed due to decay and fluvial transport. In the long term, LWD in streams would remain close to baseline conditions or increase depending on the alternative. Since some LWD in fish-bearing streams is supplied from non-fish-bearing streams, those alternatives with no RMZs on non-fish-bearing streams would limit the increase in LWD supply to fish-bearing streams over the long term. Increases in LWD due to tree growth take a long time and represent long-term improvements. The following paragraphs describe the relative LWD recruitment levels of the alternatives and summarize the degree to which each alternative meets the evaluation criteria for LWD recruitment.

The LWD equivalent buffer area index was calculated to facilitate comparison of the LWD recruitment function among the alternatives. It is displayed graphically in Figures 4.7-7 to 4.7-10. The LWD equivalent buffer area index analysis is applied in this subsection as a relative measure of the protection of streams from loss of LWD recruitment potential. The equivalent buffer area index is only an approximate measure of full recruitment potential because it does not account for all factors that either contribute to recruitment or reduce the amount of recruitment of LWD. For example, the equivalent buffer area index does not account for redistribution of LWD within streams, reductions that could occur from yarding corridors or roads, LWD enhancement, or additions from mass wasting or channel migration.

No Action Alternative 1-Scenario 2 would provide the lowest level of LWD recruitment to both fish-bearing (Type 1, 2, and 3), and non-fish-bearing (Type 4 and 5) streams. Low recruitment levels are attributable to narrow RMZ widths on fish-bearing streams and the lack of RMZs along non-fish-bearing streams. No Action Alternative 1-Scenario 2 would provide an estimated 60 to 67 percent of full LWD recruitment potential along fish-bearing streams based on the 100-year site potential tree height criterion and an estimated 37 to 53 percent based on the 250-year site potential tree height criterion (Figures 4.7-7 to 4.7-10). For Type N_p streams, this alternative would provide between 0 and 18 percent of full LWD recruitment potential based on either the 100-year or 250-year site potential tree height criterion. Shoreline Management Act requirements would increase LWD recruitment to many Type 1 streams due to increased buffer widths.

No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would provide higher levels of LWD recruitment for fish-bearing streams (Types S and F), and substantially higher levels for non-fish-bearing streams (Type N) than No Action Alternative 1-Scenario 2. No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would provide greater than 90 percent of full LWD recruitment to fish-bearing streams based on the 100-year site potential tree height criterion and greater than 80 percent based on the 250-year site potential tree height criterion. For Type N_p streams, these three alternatives would provide 43 to 51 percent of full LWD recruitment based on the 100-year site potential tree height criterion and between 38 and 44 percent of full LWD recruitment based on the 250-year site potential tree height criterion. In reality, recruitment to Type N_p streams is likely to exceed these estimates due to protection of unstable slopes and landforms that are located in close proximity to non-fish-bearing streams. Supplemental LWD recruitment from unstable slopes protection was not quantified in this analysis due to the difficulty in precisely and accurately identifying unstable slopes and landforms using remote (i.e., map and/or aerial photo) means as would be necessary to estimate statewide coverage.

Alternative 4 would provide higher levels of LWD recruitment to fish-bearing streams and substantially higher levels to non-fish-bearing streams than No Action Alternative 1-Scenario 2. Relative to No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), Alternative 4 would provide slightly higher levels of LWD recruitment to fish-bearing streams and moderately higher levels to non-fish-bearing streams. This alternative would provide full (i.e., 100 percent) LWD recruitment for fish-bearing streams based on both the 100-year and 250-year site potential tree height criteria and would provide over 95 percent of full recruitment for Type N_p streams based on both evaluation criteria. It is likely that supplemental protection of unstable slopes would further increase LWD recruitment to Type N_p streams, providing full LWD recruitment in some areas.

Figure 4.7-7. Equivalent Buffer Area Index (EBAI) for LWD Summed for All Fish-Bearing, Non-Fish Perennial, and Non-Fish Seasonal Streams on the Westside, by Alternative, Assuming a 100-year Site Potential Tree Height.

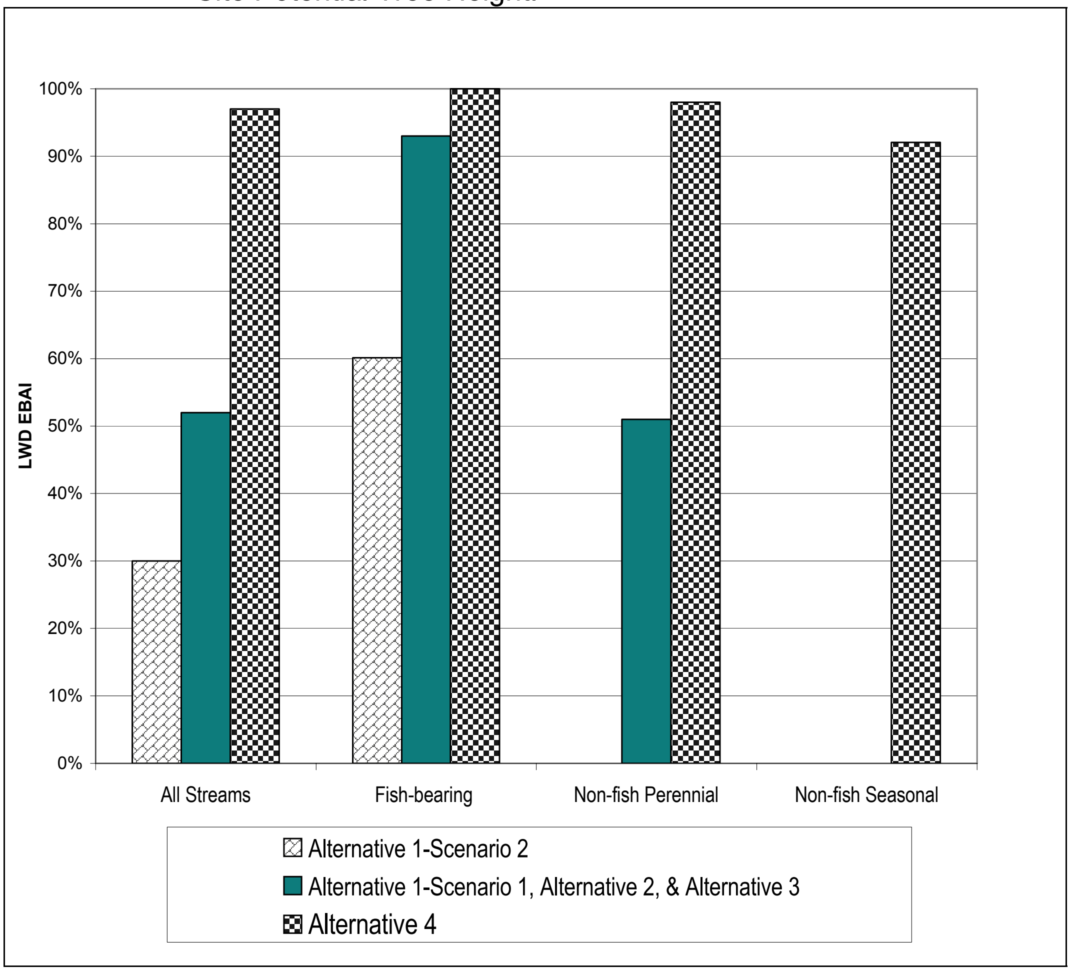


Figure 4.7-8. Equivalent Buffer Area Index (EBAI) for LWD for All Fish-Bearing, Non-Fish Perennial, and Non-Fish Seasonal Streams on the Eastside, by Alternative, Assuming a 100-year Site Potential Tree Height.

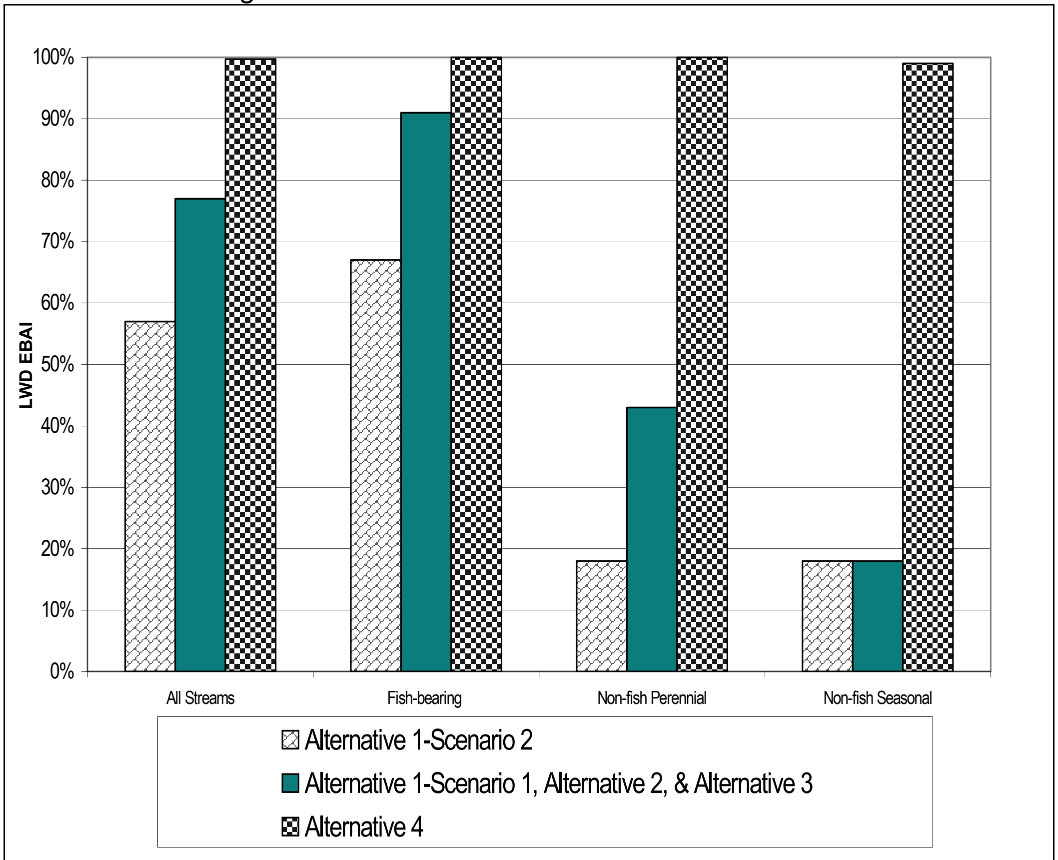


Figure 4.7-9. Equivalent Buffer Area Index (EBAI) for LWD Summed for All Fish-Bearing, Non-Fish Perennial, and Non-Fish Seasonal Streams on the Westside, by Alternative, Assuming a 250-year Site Potential Tree Height.

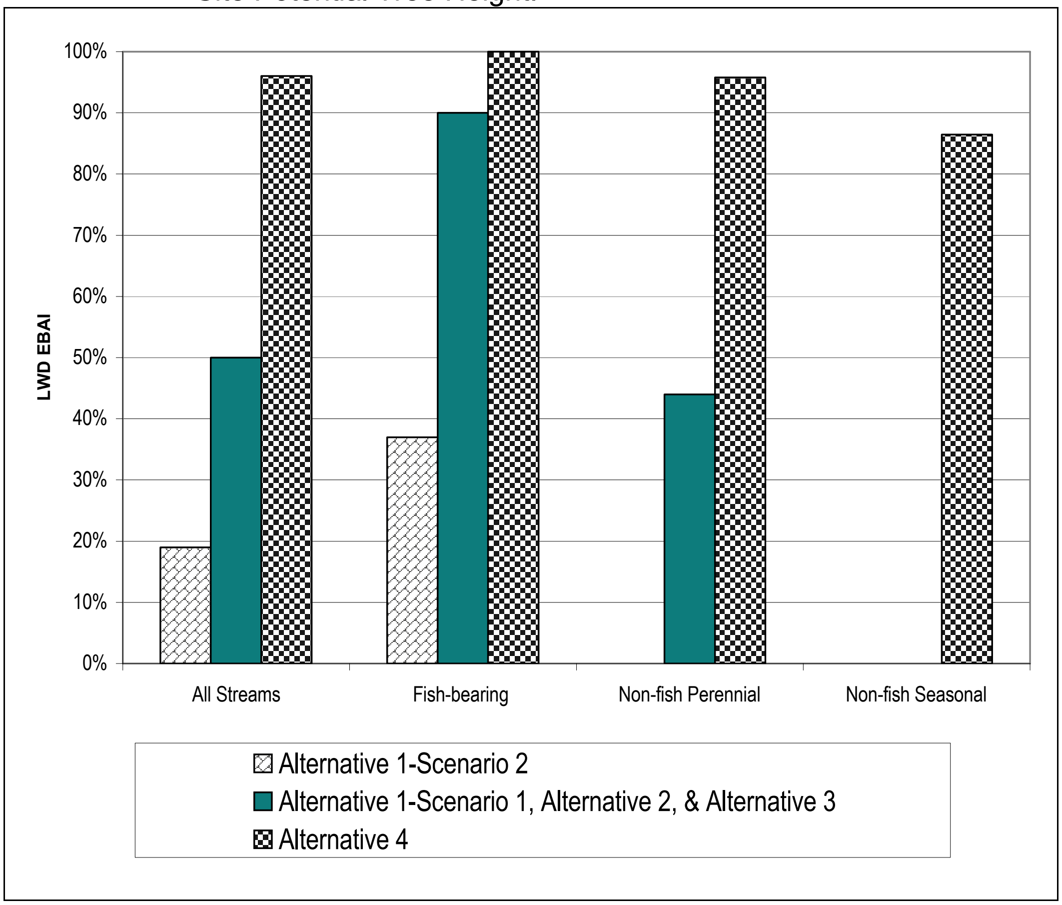
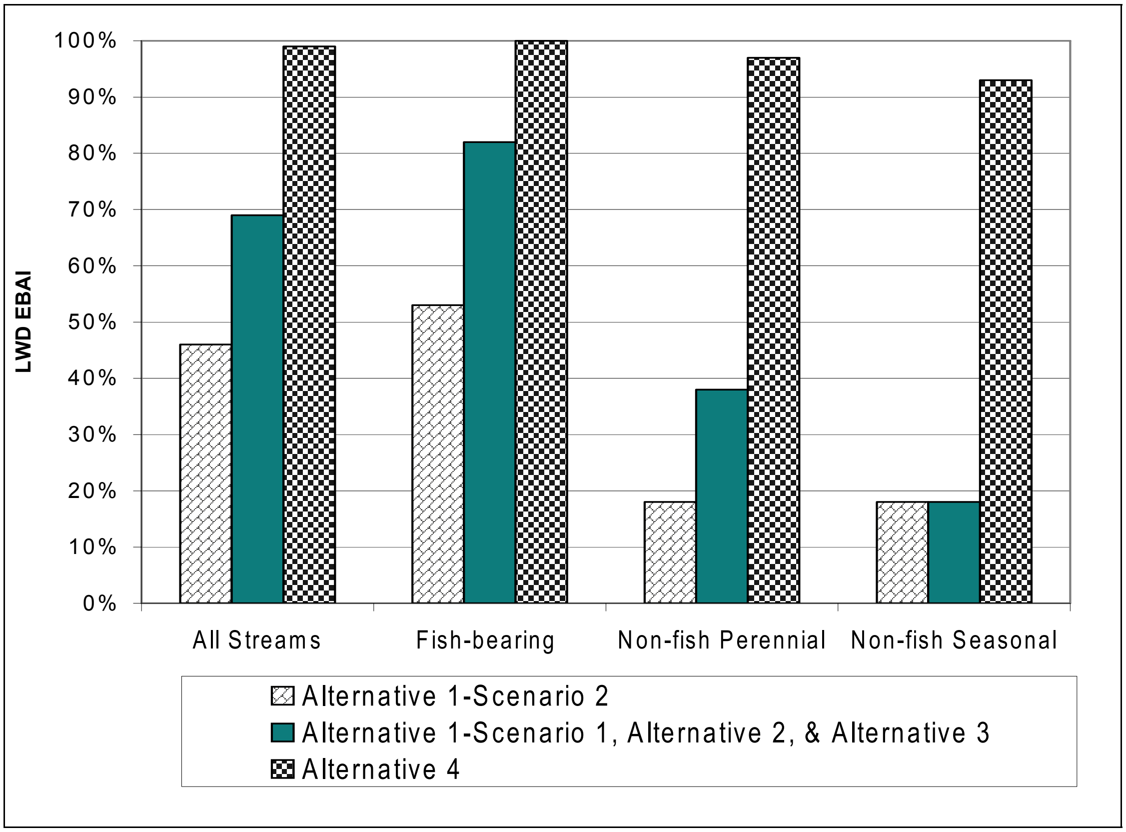


Figure 4.7-10. Equivalent Buffer Area Index (EBAI) for LWD for All Fish-Bearing, Non-Fish Perennial, and Non-Fish Seasonal Streams on the Eastside, by Alternative, Assuming a 250-year Site Potential Tree Height.



Redistribution of LWD is difficult to quantitatively model because additions to one stream section can represent a loss in another. However, provided wood is available for transport, headwater streams can be considered net sources of LWD because streamflows and mass wasting facilitate downstream transport. Consequently, reductions in LWD recruitment in low order, high-gradient streams may also indicate some level of reduction of LWD recruitment to higher order streams. In coastal Oregon, preliminary results suggested LWD recruitment from upstream sources ranged between 11 and 59 percent (Gresswell and May 2000). This may be an appropriate range for basins in Washington with a similar geomorphology (i.e., steep to moderate gradient second and third order streams with relatively narrow valleys) and precipitation, but may be an over-estimate for other areas, particularly eastside watersheds with substantially lower precipitation and likelihood of debris flows.

All alternatives would allow yarding corridors to be established through RMZs and over streams. Under No Action Alternative 1-Scenario 2, there would be no requirements for leaving trees harvested for yarding corridors (generally they are removed). Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, trees harvested in the core zone would have to be left, and only the volume of trees in excess of the stand requirement could be removed from the inner or outer zone.

Under Alternative 4, all trees harvested for yarding corridors would remain in the RMZ. Under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4, any harvested trees retained in the RMZ could provide potential habitat for wildlife species that utilize down wood. However, yarding across (over) fish-bearing streams requires a Hydraulic Project Approval from the WDFW that includes mitigation for trees harvested and/or removed from yarding corridors, requires removal of debris, and provides an opportunity for LWD placement.

Existing roads were not considered in the equivalent buffer area index because they are present under all of the alternatives, and their location is site-specific and difficult to incorporate in a representative fashion within the equivalent buffer area index model. Incorporating existing roads would, therefore, introduce additional complexity to the analysis while providing only limited insight into the differences among the alternatives in terms of LWD recruitment potential. However, the presence of roads would reduce the area available for LWD recruitment in an RMZ by approximately 5 percent or less depending upon the alternative and region of the State (based on Geographic Information System [GIS] analyses). No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 include requirements that would partially mitigate the presence of roads in RMZs. This mitigation will be discussed below under the No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 information.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Westside - Type 1, 2, and 3 Waters. On the westside, the January 1, 1999 Washington Forest Practices Rules would provide a minimum RMZ width of 25 feet on Type 1-3 waters. The maximum width would depend on stream type and size, the extent of wetland vegetation, or the width needed for implementation of the shade rule (WAC 222-30-040), which would range from 25 to 100 feet. Full LWD recruitment potential to the stream channel for most site classes would not be maintained. The RMZs would all be less than one site potential tree height (both 100- and 250-year) with the exception of those on Site Class V lands. As indicated earlier, 100-year and 250-year site potential tree height assumptions were used to express the range over which full LWD recruitment is likely to be met. The 100-year site potential tree height assumption is derived from the FRR and is the basis for RMZ widths under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, while the 250-year site potential tree height assumption is the age of stands beginning to display old-growth characteristics (Franklin and Spies 1991). Based on the more prevalent Site Classes (Classes II and III) found on State and private lands, the 100-year site potential tree height would equal 140 and 170 feet, respectively, and the 250-year site potential tree height would equal 174 and 210 feet, respectively. In addition, there would be a potential for increased blowdown along all streams that would have an RMZ under No Action Alternative 1-Scenario 2, since the average widths implemented would be relatively narrow (less than 75 feet) and therefore, would be more susceptible to blowdown. In addition, Channel Migration Zones would not be protected under this alternative.

Under No Action Alternative 1-Scenario 2, selective harvest could occur throughout the RMZ (Figure 4.7-5). Based on modeling (DEIS Appendix B), the post-harvest proportion of LWD recruitment potential remaining in the riparian zone would range from 37 to 60 percent based on the 250- and 100-year site potential tree height assumptions, respectively. Yarding corridors and roads would decrease these values. Under No Action Alternative 1-Scenario 2, no additional measures would be provided to address the reduction of LWD recruitment due to current or future roads. In addition, there would be no incentives for landowners to undertake LWD enhancement projects, so these would seldom be implemented.

Under No Action Alternative 1-Scenario 2, there would be few restrictions on the harvest of large trees. Therefore, a substantial reduction in trees of functional size would occur in the RMZ. Though only a percentage of functionally sized LWD may actually create pools, the greater the amount recruited, the greater the potential for pool formation. For larger streams, the size of LWD would need to be substantially larger than for small streams. For example, for a stream averaging 45 feet wide, the mean diameter of functional LWD is 22 inches compared to 8 inches in a 5-foot-wide stream (Bilby and Ward 1989) (subsection 3.7, Riparian and Wetland Processes). When considering key piece size (pieces with the capability of trapping other smaller pieces of LWD and forming log jams; subsection 3.7.1.2, LWD Recruitment) a much smaller proportion of trees would be left in the RMZ that would be considered large enough to be functional. The LWD equivalent buffer area index takes into consideration both RMZ width and the management activities that occur within the RMZ. The equivalent buffer area index demonstrates that No Action Alternative 1-Scenario 2 would provide the lowest level of protection for future recruitment of LWD (Figures 4.7-7 and 4.7-9).

Shorelines of Statewide Significance (which include a portion of Type 1 waters) are managed under the dual jurisdiction of the Forest Practices Act and the Shoreline Management Act. During implementation of forest practices, the more restrictive of the two acts is applied along Type 1 waters. Restrictions of the Shoreline Management Act along Shorelines of Statewide Significance include a 200-foot Shoreline Management Zone above the ordinary high water mark that is implemented and enforced at the county level. Within the Shoreline Management Zone, a landowner may remove no more than 30 percent of the available merchantable trees within a 10-year period. As a result, a 200-foot zone would complement the 25- to 100-foot RMZ applied under this alternative along Shorelines of Statewide Significance. Therefore, the area outside the RMZ, but within the Shoreline Management Zone, would receive the protection required under the Shoreline Management Act.

Under No Action Alternative 1-Scenario 2, the Shoreline Management Zone would provide for substantially higher protection for some Type 1 streams in the short-term than the standard Washington Forest Practices Rules. However, additional entries in Shoreline Management Zones could be conducted at 10-year intervals to remove 30 percent of the standing stock of trees. Although this would tend to reduce the level of protection over time, the Shoreline Management Zone would continue to maintain a higher level of protection than the standard rules under No Action Alternative 1-Scenario 2.

On the westside, most harvests occur on relatively young stands (e.g., 50 years old). Thus, the quality of LWD input would be substantially less than optimum until these stands grow to a point where trees of a sufficient size are prevalent. In addition, the January 1, 1999 Washington Forest Practices Rules would not encourage landowners to improve riparian stands for long-term gains in LWD recruitment. Under this alternative, young conifer stands and hardwood-dominated stands could require many years to grow to (and may never reach) the size where they can supply functional LWD. Compared to larger streams, riparian zones along smaller Type 2 and 3 streams would have a greater proportion of the available tree function with younger stand age because small tree sizes more often meet the criteria for functional wood in small streams than in large streams (Bisson et al. 1987). Key piece size would be more difficult to attain than if harvest rotation were longer.

RMZs are not static since trees left in an RMZ continue to grow, and regeneration occurs in harvested areas. Based on growth modeling that was conducted for the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a), it is apparent that there is an increase in tree growth rate in RMZs when thinning occurs. Under No Action Alternative 1-Scenario 2, thinning would increase the size of trees over the mid- and long-term (50 to 100 years). However, under No Action Alternative 1-Scenario 2 there would be no limitation on timber harvest re-entry within the RMZ. For the westside, it was assumed that the harvest rotation averages 50 years. Therefore, long-term growth projections are unrealistic, and riparian stands would not likely have enough large trees to provide for stable LWD in medium and large streams. In very large streams, (using a 120-foot wide stream as an example), trees as great as 40 inches in diameter (at a minimum) are needed as key pieces for long-term contributions to aquatic habitat (Abbe and Montgomery 1996). Otherwise the trees may be mobilized and transported downstream in large flood events. In addition, under No Action Alternative 1-Scenario 2 selective harvest would not encourage riparian stand improvements within the RMZ for long-term gains, but would instead encourage the maintenance of the status quo (i.e., maintaining the same ratio of conifers to hardwoods).

Westside - Type 4 and 5 Waters. For Type 4 and 5 waters under No Action Alternative 1-Scenario 2, RMZs would not be required except for site-specific conditions, and would not exceed 25 feet. For Type 4 and 5 streams under most scenarios, harvest would be allowed to the streambank. Consequently, there would be very limited LWD recruitment potential for these small streams. This is shown in the equivalent buffer area index for non-fish-bearing streams (Figures 4.7-7 and 4.7-9). However, there would be some potential for non-merchantable trees to provide some function if left in the short-term, because of the smaller LWD needed in small streams. Some supplemental LWD recruitment from the protection of unstable slopes may occur in certain areas.

Along Type 4 and 5 streams that are clearcut to the bankfull width, long-term modeling indicated that wood of functional and key piece sizes begins to be delivered to the channel in approximately 45 to 50 years (Bilby and Ward 1989; Bilby and Wasserman 1989; Washington Forest Practices Board 2001a, Appendix D). This was assuming an average channel width of 2 to 5 feet. If the harvest rotation rate is 50 years, minimal to no recruitment to the stream would occur over the near and long-term along Type 4 and 5 waters, except in areas where unstable slopes are protected.

Eastside - Type 1, 2, and 3 Waters. Under No Action Alternative 1- Scenario 2, the rules for eastern Washington would be generally similar to those for the westside. The RMZ width for Type 1, 2, and 3 waters would range between 30 and 50 feet on each side of the stream for areas under the partial cut strategy, and averages about 50 feet under the clearcut strategy, but could extend up to 300 feet if there is a channel-associated wetland. As for most RMZ prescriptions on the westside, the range of eastside RMZ widths under the January 1, 1999 Washington Forest Practices Rules would not maintain full LWD recruitment potential because the buffers would be less than one site potential tree height (which ranges from 60 to 130 feet depending on the site class for a 100-year old stand and 85 to 195 feet for a 250-year old stand).

However, an exception would occur when riparian vegetation is not adequate to provide required shading of the stream. In these cases the RMZ could be expanded far beyond the average 50 feet and could meet or exceed one site potential tree height. However, most timber harvest on the eastside is selective harvest and, therefore, would not require the more expansive RMZ widths (DEIS Appendix B). However, where the shade rule would be implemented, additional trees may be left in the RMZ. As a result, there would likely be an increase in the proportion of recruitable trees available in the RMZ under some conditions. In addition, under No Action Alternative 1-Scenario 2, there may be a potential of increased blowdown since the average RMZ widths (30 to 50 feet on the eastside) are relatively narrow (less than 75 feet) and therefore more susceptible to wind damage. Along streams that are prone to channel migration, no additional protection of potential recruitment is provided if the channel shifts to a previously harvested area. The maximum RMZ width of 300 feet for protection of channel-associated wetlands would be the only potential protection for migrating channels.

Similar to the westside, selective harvest in eastern Washington could occur throughout the RMZ under No Action Alternative 1-Scenario 2 (Figure 4.7-6). This would lead to soils and microclimate that are less favorable for tree growth bringing the average rotation length to an average age of 80 to 100 years for stands at timber harvest (Bolsinger et al. 1997). Therefore, 80 to 100-year-old stands were assumed for evaluating immediate post-harvest stand conditions.

The equivalent buffer area index for LWD under the 100-year site potential tree height and 250-year site potential tree height assumptions shows that this alternative provides the lowest level of protection for future recruitment of LWD when compared to other alternatives on the eastside (Figures 4.7-8 and 4.7-10). LWD recruitment potential along fish-bearing streams would range from 53 to 67 percent of the levels needed for adequate protection based on the 100-year site potential tree height and 250-year site potential tree height criteria, respectively.

On the eastside, the mean diameter required for LWD to be considered functional for a stream averaging 45 feet in width would be 12 inches, and for a stream averaging 5 feet in width it would be 8 inches (Bilby and Wasserman 1989). Key piece size has not yet been defined for the eastside, although pieces larger than what is considered functional would likely be required to provide the long-term stability that defines key piece size. Similar to functional LWD, key piece size would vary depending on channel size.

For some Type 1 streams, additional leave trees would likely be provided to larger streams due to their designation of Shorelines of Statewide Significance. The Shoreline Management Act defines a 200-foot Shoreline Management Zone for streams with flow greater than 1,000 cubic feet/second measured from the stream's ordinary high water mark. The Shoreline Management Act requires that no more than 30 percent of the merchantable trees within this zone be removed every 10 years using a selective harvest strategy. However, because the selective harvest strategy occurs more often than the even-aged strategy on the eastside (See Glossary), additional trees outside of the RMZ, but inside the one site potential tree height width, would frequently be available for recruitment.

In addition, no additional measures would be provided under No Action Alternative 1-Scenario 2 to address the reduction of LWD recruitment due to current or future roads.

On the eastside, younger seral stages currently dominate most riparian areas. Similar to the westside, the quality of LWD recruitment potential on the eastside would be less than optimal. Also, similar to the westside, there would be no limitation of timber harvest entries within the RMZ on the eastside. For the eastside it was assumed that harvest would occur on approximately an 80-year rotation, and the largest trees could be removed within the RMZ so long as leave tree requirements were met. The selective harvest requirements within the RMZ under No Action Alternative 1-Scenario 2 would not encourage improvement of the stand for LWD recruitment, but instead would require a minimum number of trees of a specific size and type along all Type 1 to 3 streams, without differentiating between stream size and riparian stand quality. Therefore, it is unlikely that a sufficient number of larger trees in riparian stands would be maintained.

Eastside - Type 4 and 5 Waters. Under No Action Alternative 1-Scenario 2, for Type 4 and 5 streams in most conditions, harvest would be allowed to the streambank. However, the trend on the eastside is that a relatively large proportion (approximately 60 percent) of forestland has been harvested under a selective harvest strategy that leaves some riparian trees. Along streams with a clearcut harvest strategy, there would be no protection of LWD sources and, therefore, no short-term and minimal long-term recruitment potential; an exception is where trees are retained on stream-adjacent unstable slopes to prevent harvest-related mass wasting. Together, the equivalent buffer area index suggests these harvest strategies would result in recruitment potential along non-fish-bearing streams of approximately 18 percent of adequate protection levels under both site potential tree height assumptions.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

General. The silvicultural prescriptions for RMZs under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would be implemented within three zones: the core zone is nearest to the water, the inner zone is the middle zone, and the outer zone is furthest from the water. In addition to the RMZ and silvicultural prescription discussions below, it is important to note that additional measures would be implemented to replace lost LWD recruitment due to the presence of roads under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. These mitigation measures include one of the following two measures:

- Stand requirements must be met regardless of the presence of stream crossings and stream adjacent roads; basal area shortfalls are made up in the inner and outer zones, if possible, or in nearby RMZs of the same harvest unit.
- An optional LWD placement plan (WDFW approval required) would be implemented.

The additional measures would provide greater LWD recruitment potential compared to No Action Alternative 1-Scenario 2. The first mitigation measure would mitigate the basal area of trees lost due to the road, but would not mitigate the same level of riparian recruitment potential because the location of mitigation leave trees would be further from the stream, and the mitigation leave trees have no size distribution requirements (i.e., the mitigation basal area could be reached entirely with small trees).

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are the only alternatives that provide incentives for an LWD placement plan by reducing leave-tree requirements in the outer zone. An LWD placement plan would increase instream LWD in the short-term in exchange for trees in the portion of the RMZ that has the lowest probability of providing LWD in the future. The number of trees that a landowner may remove in the outer zone would depend on the plan approved by the WDFW, but leave-tree requirements could not be reduced below 10 trees per acre under an LWD placement plan.

Similar to some Type 1 streams under No Action Alternative 1-Scenario 2, some Type S streams may provide additional leave trees under all harvest strategy options because of the Shoreline Management Act. As indicated earlier, the more restrictive rules would be implemented for any given situation where both the Shoreline Management Act and the Forest Practices Act are applied. In general, a Shoreline Management Zone would likely provide more leave trees in the short-term than an RMZ, particularly for Type S streams that do not have a Channel Migration Zone. A Shoreline Management Zone is measured from the ordinary high water mark regardless of whether a Channel Migration Zone is present. Consequently, the added level of protection from a Shoreline Management Zone would be reduced depending upon the width of the Channel Migration Zone. Similar to No Action Alternative 1-Scenario 2, the areas outside the RMZ, but inside the Shoreline Management Zone, would have a higher level of short-term protection due to the harvest restrictions required by the Shoreline Management Act. However, the level of added protection in the Shoreline Management Zone could decline over time because of additional harvest entries that would allow removal of up to 30 percent of the trees during each decade. Nevertheless, the overall level of protection to selected Type S waters would be equivalent to, or higher than, the standard rules.

Hardwood Conversion. Landowners would have the option of conducting hardwood conversion in the inner zone of the RMZ on the westside only. The riparian areas would have to be hardwood-dominated stands with evidence that conifers were present in the area in the past. The objective of the hardwood conversion rule would be to improve long-term riparian function by allowing landowners to remove hardwoods in the conversion area and to restock the area with conifers. There would be numerous requirements for implementing the hardwood conversion rules. These would include, but would not be limited to, the following:

- The combined core and inner zone do not meet stand requirements.
- There are fewer than 57 conifer trees per acre 8 inches or larger diameter at breast height (dbh).
- There are fewer than 100 conifer trees per acre 4 inches or larger dbh.
- Conversion areas are limited to 500 feet in length.
- Landowners must own the land 500 feet above and 500 feet below the conversion area.
- No stream-adjacent parallel roads are present in the core or inner zone.
- Several shade restrictions apply (WAC 222-30-021(1)(b)(i)).

When the hardwood conversion takes place, the harvest would be required to adhere to the following:

- Conifer trees greater than 20 inches dbh shall not be harvested in the conversion area.

- No more than 10 percent of the conifer trees greater than 8 inches dbh may be harvested.
- The conversion area must be restocked with conifers and provided with post-harvest treatment.

The hardwood conversion rule may slightly reduce short-term LWD recruitment from hardwood trees. The loss of LWD recruitment potential from harvested conifers would be insignificant because most of the larger trees are protected. The conversion areas would create a small to moderate reduction in shade in the immediate area, but the potential adverse effects on a larger scale may be reduced by the additional shade restrictions required for hardwood conversion to take place. Conversely, the potential long-term benefit from restoring the riparian stands to conifer would likely outweigh the short-term losses. As indicated earlier, conifers have the potential to provide larger and longer lasting LWD than hardwood trees (Harmon et al. 1986). Nevertheless, the Washington DNR recognizes there is some uncertainty about the adverse effects of the hardwood conversion rule, and thus would be required to track conversion rates on a watershed basis.

20-Acre Exemption Rule. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, small landowners (20-acre exempt parcels) would be permitted to implement less protective RMZs on non-contiguous parcels less than 20 acres in size (subsection 2.3, Alternatives Analyzed in Detail). Although these parcels represent a small fraction of the forestlands subject to Washington Forest Practices Rules (about 0.5 to 5 percent of all private forestlands, depending on the region, Rogers 2003), and the rate of forest practices to be implemented on these lands is unknown, this reduced protection increases the level of concern. In watersheds with a high proportion of small landowners, especially where a high level of past harvest has occurred, this rule would increase the likelihood that LWD recruitment would be inadequate to maintain a properly functioning system.

However, some factors suggest that while protections would be less, overall effects to riparian function (e.g., LWD, shade retention) would not be reduced substantially. ~~While the rules would allow for selective harvest within the RMZ, in practice it is likely this would rarely occur. In a recent evaluation of 20-acre exempt parcels, 86 percent of 37 parcels examined had no RMZ harvest, and all but 1 parcel had greater than 85 percent retention (Personal Communication, Jeff Grizzel, Washington DNR, May 10, 2004).~~ While harvesting to the established minimum is allowed under the 20-acre exemption rule if shade requirements can be met, data from the DNR Forest Practices Division indicate that harvest within the RMZ is uncommon. In a statewide sample of 37 RMZs established on exempt 20-acre parcels during 2002 and 2003, 32 (86 percent) were treated as no-harvest areas, and only two had 15 percent or more of the trees removed from the RMZ (FPHCP, Appendix J). Further sampling of an additional 39 RMZs established on exempt 20-acre parcels during 2004 and 2005 indicated a similar trend. That is, little if any harvest had occurred within RMZs. The 2004 and 2005 data showed that RMZs were treated as no-harvest areas in 90 percent of the harvested parcels reviewed. Only one had more than 15 percent of the trees removed from the RMZ (FPHCP, Appendix J). Although these data represent only a sample of the 20-acre exempt Forest Practices Applications, anecdotal information supplied by the DNR suggests they are typical of RMZ harvest practices since adoption of the Emergency Salmonid Rules in 1998 (Personal Communication, Sue Casey and Bob Anderson, Washington DNR, July 2005).

This low rate of harvest in our RMZs may be partly because of the shade rule, which would require retention of trees in the RMZ to meet the shade requirements. Since many of these parcels are at relatively low elevations, the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1and Alternatives 2 and 3 would require a high degree of shade. This requirement would also benefit LWD supply since a greater proportion of trees would be retained near the shoreline where a higher probability of LWD exists (McDade et al. 1990). Based on the estimated portion of LWD contributed by distance for mature conifer trees (from McDade et al. 1990) and the estimated range of RMZ requirements for fish-bearing streams, exempt parcels would supply 45 to 95 percent of total LWD, depending on RMZ width. This would be on average slightly lower than for other streams under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, as indicated by the LWD equivalent buffer area index for fish-bearing streams; the estimated LWD equivalent buffer area index for both westside and eastside fish-bearing streams ranges from 82 to 90 percent for the 250-year site potential tree height assumption and from 91 to 93 percent for the 100-year assumption (Figures 4.7-7 to 4.7-10). No RMZ would be required on non-fish-bearing streams, which would reduce LWD supply to these segments directly and would likely be less than other non-fish-bearing streams under these alternatives.

Shade provided by 20-acre exempt parcels varies with RMZ width and the species, age, and density of riparian vegetation. Retention of RMZs on fish-bearing streams that are 29 to 115 feet (9 to 35 meters) wide would likely provide between 25 and 85 percent shade or canopy cover (measured as angular canopy density). This conclusion is based on data from Brazier and Brown (1973) and Steinblums et al. (1984) (See Beschta et al. 1987). The smaller streams would typically have the lower estimated shade, but smaller stream channels can have shade requirement more easily met with smaller buffers than large streams (Broderson 1973). While the amount of shade in 20-acre exempt parcels may be slightly lower than that supplied by No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, moderate to high levels of protection in most fish-bearing streams would be maintained. As noted above, the limited amount of forest area affected by this exemption would limit the overall effects to stream systems in most areas.

Westside: Inner Zone Options. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide two options for harvesting within the inner zone on the westside, providing that the riparian stand exceeds the requirements for meeting the DFC. The Option 1 approach is designed for riparian stands that have a skewed distribution with more numerous, but relatively small trees. In contrast, the Option 2 approach is designed for stands that have a more normal distribution of tree sizes. Option 1 would allow harvest by thinning from below. That is, surplus basal area could be harvested, but is limited to smaller diameter trees. Option 1 was developed with the objective of shortening the time required to meet LWD and water quality needs. Option 2 would allow harvest of surplus basal area by prioritizing harvest of inner zone trees furthest from the stream and leaving inner zone trees closest to the stream. The objective of Option 2 would be to retain those trees closest to the stream that provide proportionally more functional benefit than trees farther from the stream. As described in Chapter 2 (Alternatives), both options would have specific leave-tree requirements.

Westside: Type S and F Waters – Option 1 (Thinning From Below). On the westside, Type S and F RMZ widths under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would be based on the average height of a 100-year-old stand. These RMZs would be measured from the edge of the Channel Migration Zone, where present, or from the edge of the bankfull channel. Where Channel Migration Zones are present, additional protection would be provided if a change in channel location occurs. Protection of the Channel Migration Zone would ensure that an established stand of trees would be available for recruitment in a relocated stream channel.

Some harvest could occur in some portions of the RMZ. For Type S and F streams under Option 1, no harvest would occur in the core zone, which would be 50 feet from the outer edge of either the bankfull width or Channel Migration Zone (whichever is greater). Approximately 48 to 92 percent of LWD recruitment potential comes from the core zone of the RMZ, based on McDade et al. (1990), site class, and the two site potential tree height assumptions for stand age (e.g., 100 and 250 years) (Table 4.7-1). For Site Class II, the core zone accounts for 56 percent (site potential tree height 210 feet) to 70 percent (site potential tree height 170 feet) of total recruitment.

Selective harvest (thinning from below) would be allowed in the inner zone, or the middle zone, of the RMZ. Specific stand requirements would exist, and thinning would be based on an assessment of specific site characteristics including site class, species, trees-per-acre, ratio of hardwoods to conifers, average stand age, and basal area. The objective of this strategy would be to shorten the time required for trees in the inner zone to reach a size adequate to provide functional LWD. This strategy would allow for the removal of a portion of the smaller trees present in the inner zone while leaving the largest trees. The width of the inner zone under Option 1 would vary depending on site class and stream size. Using a Site Class II modeled stand, approximately 24 percent of LWD recruitment potential comes from the 50- to 100-foot portion of the RMZ if all trees are left uncut (Figure 4.7-1, which is a normalized representation of LWD supply for any site potential tree height).

The inner zone selective harvest prescription would initially reduce the LWD recruitment potential in the RMZ inner zone by approximately 5 percent along small streams (less than or equal to 10 feet wide) with no reduction in recruitable size trees along the larger streams. However, because stand requirements are intended to mimic mature forest stand characteristics, full recruitment from the inner zone should be maintained over the long term. Stream size affects both functional LWD size and the width of the inner zone. In general, a wider range of tree sizes along smaller streams would function if recruited (i.e., smaller LWD would also be functional); therefore, a larger percentage of source trees would be lost if harvested compared to a larger river that requires larger trees to function.

The outer zone under Option 1 would provide for commercial harvest with requirements for a specific number and size of leave trees. Similar to the inner zone, the outer zone width would also vary depending on site class and stream width and would range from 22 to 67 feet. However, based on the stand modeling developed in the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a), functional LWD recruitment would be unlikely to occur from the outer zone for over 200 years after harvest for most fish-bearing streams assuming an age 50 stand at the time of harvest. Approximately 6 to 14 percent of the LWD recruitment potential would come from the outer zone of a Site Class II stand under no-harvest conditions depending upon the site potential tree height assumptions. Under the 250-year site potential tree height assumption, about 6 percent of the recruitment potential would be derive from outside the outer zone (i.e., 170 to 210 feet) and would receive no RMZ protection. Based on the modeled harvest, the outer zone would contribute approximately 2 to 5 percent of the recruitment potential (Washington Forest Practices Board 2001a, Appendix D).

The total post-harvest proportion of recruitable trees remaining in the three zones of the RMZ would range between 91 percent (for smaller streams less than 10 feet wide) and 96 percent (for larger streams greater than 10 feet wide) based on the 100-year site potential tree height assumption and between 80 and 85 percent based on the 250-year site potential tree height assumption (Washington Forest Practices Board 2001a, Appendix D).

A sensitivity analysis was conducted using the 100-year site potential tree height assumption to see if recruitment potential would vary substantially between stands of different site classes. Four channel widths (5 to 44 feet) representative of each stream type were compared by site classes to estimate the proportion of trees (those that would contribute to LWD without harvest) that would be present after harvest. The variation in recruitment potential based on the stands modeled (which included a low, medium and high Site Classes II and III) was relatively small, ranging between 87 and 93 percent for smaller streams and between 93 and 96 percent for larger streams (Washington Forest Practices Board 2001a, Appendix D).

Based on the modeled harvest, the same proportion of trees sufficiently large to be considered key pieces would be present in the RMZ both pre- and post-harvest. This would occur because the inner zone would be thinned from below, leaving the largest trees in the inner zone available for potential recruitment. Therefore, depending on stream size, trees of key piece size could be maintained under this option if they already exist in the stand. However, as stream size increases, the proportion of trees of key piece size decreases because minimum key piece size increases with stream size. This was highlighted in the sensitivity analysis where no trees of functional size (or larger key pieces) were available for recruitment along modeled Site Class III stands. Growth modeling using the Riparian Aquatic Interaction Simulator model suggests that stands would need to be at least 160 years old to obtain key pieces for streams 44 feet wide

(Washington Forest Practices Board 2001a, Appendix D). Therefore, the concern is over the long-term (well beyond the expected life span of No Action Alternative 1-Scenario 1 and Alternatives 2 and 3) because many stands would not have sufficient trees of key piece size immediately after harvest.

The equivalent buffer area index for LWD on the westside shows that under both the 100-year site potential tree height and 250-year site potential tree height assumptions these alternatives would produce substantially greater recruitment to Type S and F streams when compared to No Action Alternative 1-Scenario 2, (but lower recruitment when compared to Alternative 4) (Figures 4.7-7 and 4.7-9). In addition, it is clear that fish-bearing streams receive more protection than non-fish-bearing streams under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. However, the equivalent buffer area index does not reflect the long-term benefits associated with thinning, which boosts the growth rates of source trees remaining in the RMZ.

The current quality of LWD input potential along most westside streams is well below the optimum, and will remain that way until riparian areas grow to a point when trees are of sufficient size to provide functional LWD. The 50-year old stand modeled for long-term recruitment using the Riparian Aquatic Interaction Simulator demonstrates there would be an increase in tree growth rate under Option 1 (Washington Forest Practices Board 2001a). However, the modeling suggested that thinning adjacent to small streams (less than 10 feet) would not result in a decrease in the time required for trees to reach a functional size (about an 80-year old stand, regardless of thinning). In addition, a wider range of tree sizes along small streams would provide functional LWD if recruited; therefore, a larger percentage of potential source trees would be lost if harvested.

However, the benefit of thinning appears to be substantial when considering large streams and key piece size, especially in highly productive stands (100-year site index of 128 or greater). For streams 44 feet wide, the modeling suggested that compared to no harvest, thinning resulted in a shorter time period for trees to reach key piece size (160-year stand if thinned and 290-year stand with no harvest). In addition, the modeling suggested there could be an increase in the amount of LWD. The Riparian Aquatic Interaction Simulator model indicated that a 300-year old, Site Class II stand would have about 14 percent (nearly 2 pieces per 1,000 feet) more functional LWD following thinning under Option 1 compared to Option 2 or Alternative 4. The modeling suggests that for lower productivity riparian stands or streams less than 30 feet wide, thinning does not provide a substantial benefit for producing functional and key piece side LWD more rapidly than no-harvest (Washington Forest Practices Board 2001a, Appendix D).

<u>Westside: Type S and F Waters – Option 2 (Leaving Trees Closest to the Water)</u>. Under Option 2 of No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, no-harvest RMZs would be 80 feet wide on streams less than 10 feet wide and 100 feet wide on streams greater than 10 feet wide. Similar to Option 1, no harvest would occur under Option 2 in the 50-foot-wide core zone measured from the bankfull width or Channel Migration Zone (if present). Consequently, the core zone would provide the same level of protection under Option 2 as it would under Option 1. In addition to the core zone, the next 30 feet of the inner zone on streams less than 10 feet wide and the next 50 feet on streams greater than 10 feet wide would also be no-harvest zones. Option 2 could only be applied to Site Class I, II, and III sites on streams less than or equal to 10 feet wide and Site Class I and II sites on streams greater than 10 feet wide. Depending upon the site potential tree height assumption (for Site Class II), the combined no-harvest RMZs from the core zone and inner zone would provide from 73 to 86.5 percent of full LWD recruitment potential for smaller streams (less than 10 feet) and 80 to 95 percent of full potential for larger streams.

Selective harvest would be allowed in the remaining portion of the inner zone, which varies in width, depending on site class and stream size. Based on modeling in the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a), the total inner zone LWD recruitment potential for streams greater than 10 feet wide would be maintained. For streams less than or equal to 10 feet in width, a reduction of approximately 3 percent of potentially recruitable trees would occur over the short term.

Under Option 2, if prescriptions in the core and inner zone result in a basal area that exceeds the basal area target, a greater reduction of trees would be allowed in the outer zone. In the modeled example, there was no excess (i.e., all 20 trees per acre were retained in the outer zone) resulting in a range of 0 to 2 percent of the recruitable trees remaining, depending on stream size. The leave tree requirement for the outer zone could also be reduced if conifers are retained in the Channel Migration Zone.

The post-harvest proportion of potentially recruitable trees remaining in the combined three zones of the RMZ would range from 94 to 95 percent of the pre-harvest condition (Washington Forest Practices Board 2001a, Appendix D). The overall recruitment potential of smaller streams (less than 10 feet) under Option 2 would be higher than the recruitment potential under Option 1. In contrast, Option 1 would produce greater recruitment potential for larger streams (greater than 10 feet). However, the differences between the two options would not be large; less than 3 percent of the pre-harvest potential. Consequently, the different strategies would not substantially change the number of recruitable trees. A sensitivity analysis using the 100-year site potential tree height assumption and Site Class III (low) to Site Class II (high) showed similar patterns. The differences between options were 5 percent or less, and both options retained 87 percent or more of the potentially recruitable trees.

Under Option 2, the equivalent buffer area index ranged from 90 to 93 percent for fish-bearing (Type S and F) streams under the 250-year site potential tree height and 100-year site potential tree height assumptions, respectively. The equivalent buffer area index under both site potential tree height assumptions, suggests that Option 2 of No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would produce a substantially greater recruitment potential along Type S and F streams compared to No Action Alternative 1-Scenario 2, a similar recruitment potential compared to Option 1, but a lower recruitment potential compared to Alternative 4.

One limitation of the equivalent buffer area index is that it fails to take into consideration the growth rate of trees remaining in the RMZ following harvest. Stand growth modeling suggests the rate of growth would be slower with the wider no-harvest area of Option 2 compared to Option 1. Consequently, under this option, wider streams would require a longer period of time to produce the larger trees needed to provide functional LWD. However, for smaller streams where smaller size LWD will function, a greater number of source trees would be retained in the RMZ.

Westside: Non-fish Waters. On portions of Type N_p streams, RMZ widths would be 50 feet, which is less than the one site potential tree height (both 100-year site potential tree height and 250-year site potential tree height) evaluation criteria recommended in most literature to provide an adequate level of LWD recruitment. The 50-foot buffer would provide approximately 48 to 92 percent of the LWD recruitment potential of a mature stand where the buffer would be implemented, depending upon site class (McDade et al. 1990). At least 50 percent of the length of N_p streams, which would include all sensitive sites within the harvest unit, would be required to have the 50-foot no-harvest RMZ. Depending on the number of sensitive sites, more than 50 percent of the N_p stream length could be protected with an RMZ. In practice, substantially more than 50 percent of N_p stream lengths would have RMZs under the current rules and this would likely continue in the future under these alternatives (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004). This is primarily because additional protection would be provided in the form of unstable slopes buffers, which would often be retained as no-harvest areas in close proximity to small, headwater streams (i.e., Type N_p and N_s streams).

Because of the relatively narrow RMZs, there would be a greater potential that blowdown would occur. As mentioned previously, observed blowdown levels average about 15 percent, but vary widely depending upon site characteristics and could approach 100 percent in rare circumstances (~~Steinblums 1978;~~ Steinblums et al. 1984; Harris 1989; Grizzel and Wolf 1998). On Type N_s and all other Type N_p streams, harvest would be allowed to the streambank. Therefore, there would be no direct protection of LWD recruitment potential. However, as mentioned above, because many unstable landforms (e.g., inner gorges, bedrock hollows, channel heads) are located along Type N_p and N_s streams, LWD recruitment would be provided for some streams even though RMZs would not be required (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004).

While processes for LWD inputs from Type N_p and N_s streams to Type S and F (fish-bearing) streams are reasonably well understood, rates of LWD input are not well documented (Benda et al. 2003; Reeves et al. 2003; Potts and Anderson 1990). In narrow coastal streams in Oregon, movement of LWD in second- and third-order streams has been observed between 11 and 49 percent (Gresswell and May 2000). In some streams, the level of input can be very high as a result of debris torrents. In addition, trees that fall into streams are important for sediment retention (Keller and Swanson 1979; Sedell et al. 1988), gradient modification (Bilby 1979), and nutrient production (Cummins 1974) in Type N_p and N_s streams.

Eastside: Type S and F Waters. On the eastside, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would require an RMZ width of at least one 100-year site potential tree height along Type S and F streams. A few exceptions would exist, including streams less than 15 feet wide on Site Class V soils and streams greater than 15 feet wide on Site Class of III, IV, or V (which all exceed the 100-year site potential tree height). Therefore, Type S and F RMZs would meet the width recommended in the literature for maintaining full LWD recruitment. In addition, because these RMZs are measured from the Channel Migration Zone or the bankfull width, additional protection would be provided in cases where the stream channel shifts or migrates. This would ensure that an established stand of trees would be available for recruitment in the relocated stream channel.

For Type S and F streams, no harvest would occur in the core zone, which would be 30 feet from the Channel Migration Zone or bankfull width. Approximately 65 percent of LWD recruitment potential comes from the core zone, based on McDade et al. (1990) using a 100-year site potential tree height of 110 feet and 44 percent of the recruitment potential using a 250-year site potential tree height of 170 feet.

Selective harvest would be allowed in the inner zone, which would vary in width depending on stream width. For streams less than 15 feet wide, the inner zone would be 45 feet wide, and for streams greater than 15 feet wide the inner zone would equal 70 feet. Using a Site Class II modeled stand for comparative purposes, approximately 31 (100-year site potential tree height) to 33 (250-year site potential tree height) percent of LWD recruitment potential would come from the 30 to 75-foot zone of the RMZ if all source trees are left uncut along a stream less than 15 feet wide. For streams wider than 15 feet, 33.5 (100-year site potential tree height) to 42 (250-year site potential tree height) percent of recruitment potential would originate from between 30 and 100 feet (i.e., the inner zone) of the RMZ. The inner zone selective harvest prescription (using the modeled stand) would maintain 8 (100-year site potential tree height) to 9 (250-year site potential tree height) percent of the no-harvest LWD recruitment potential along streams less than 15 feet wide. For streams greater than 15 feet wide, the inner zone selective harvest prescription would maintain between 6 (100-year site potential tree height) and 14 (250-year site potential tree height) percent of the LWD recruitment potential.

More restrictive prescriptions would be implemented within the bull trout overlay. The bull trout overlay would include those portions of eastern Washington streams containing bull trout habitat as identified on the WDFW's bull trout overlay map (Washington Forest Practices Board 2002). The more restrictive prescriptions would be designed for a higher level of protection for trees that contribute towards "all available" shade, which could also provide increased protection for trees that could become LWD. For purposes of this FEIS, the inner zone was modeled as no-harvest between 30 and 75 feet for all streams within the bull trout overlay to represent the maximum likely shade-retention strategy. For streams greater than 15 feet wide, the area 75 to 100 feet from the stream or Channel Migration Zone edge was modeled as a partial harvest leaving at least 50 trees per acre including the 21 largest trees, at least 29 trees greater than 10 inches dbh, and basal area of at least 90 feet^2 per acre. Under this scenario, 31 (100-year site potential tree height) to 36 (250-year site potential tree height) percent of the no-harvest LWD recruitment potential would come from the inner zone (Washington Forest Practices Board 2001a, Appendix D, Tables 31a and 31b).

The outer zone would have prescriptions that allow for a more intensive selective harvest. Similar to the inner zone, the outer zone width would also vary, depending on site class and stream width, and range between 0 and 55 feet. The outer zone would provide approximately 1.5 (100-year site potential tree height) to 2.5 (250-year site potential tree height) percent of the LWD recruitment potential if all trees are left unharvested. Under the 250-year site potential tree height assumption for Site Class II soils, about 11.5 percent of the recruitment potential would originate from outside the outer zone (i.e., 110 to 170 feet) and would receive no RMZ protection. The outer zone would maintain less than 1 percent of the recruitment potential under the 100-year site potential tree height assumption, but would provide about 2 percent of the potential under the 250-year site potential tree height assumption. This would result from the different cumulative recruitment potential curves used under the two assumptions. The 100-year site potential tree height assumption was based upon the mature stand curve, and the 250-year site potential tree height assumption was based upon the old-growth curve from McDade et al. (1990). Compared to the mature curve, the old-growth curve has a higher percentage of the total recruitment derived farther from the stream.

With all zones combined, in areas outside the bull trout overlay, the post-harvest recruitment potential in the three zones of the RMZ would range from 55 (250-year site potential tree height) to 74 (100-year site potential tree height) percent of the no-harvest potential for smaller streams less than 15 feet. The range for larger streams greater than 15 feet would range from 52 (250-year site potential tree height) to 76 (100-year site potential tree height) percent (Washington Forest Practices Board 2001a, Appendix D). Within the bull trout overlay, the post-harvest recruitment potential would range from 80 (250-year site potential tree height) to 96 (100-year site potential tree height) percent for streams less than 15 feet and 79 (250-year site potential tree height) to 97 (100-year site potential tree height) percent for streams greater than 15 feet. However, these estimates are likely conservative, because the “all available shade” rule within the bull trout overlay does not necessarily equate to “no-harvest” within the inner zone.

A sensitivity analysis was prepared using the 100-year site potential tree height assumption to determine the variation in post-harvest recruitment potential between vegetative habitat types (mixed conifer versus ponderosa pine), areas within or outside the bull trout habitat overlay, site classes, and stream size. The results suggested there were moderate differences between vegetative habitat types (8 percent or less), large differences (10 to 28 percent) between areas in or out of the bull trout overlay, large differences (up to 19 percent) between site classes, and small differences (less than 5 percent) between stream sizes (Washington Forest Practices Board 2001a, Appendix D). For both the mixed conifer and ponderosa pine habitat types the post-harvest LWD recruitment potential was consistently higher on sites with lower productivity (Washington Forest Practices Board 2001a, Appendix D). This is because sites with lower productivity (e.g., Site Class IV and V) have a lower site potential tree height than those with higher productivity. Therefore, the 30-foot core zone represents a greater percentage of the total site potential tree height and recruitment potential on lower site classes.

Also, for most of the stands modeled in the sensitivity analysis, it was apparent that larger streams that require large wood (greater than 10 inch dbh) to function may not benefit from the 29 smaller trees retained in addition to the 21 largest trees (to make up the minimum of 50 trees per acre) retained in the inner zone over the short term. Recruitment potential for these larger streams would likely only come from the 21 largest trees per acre left in the RMZ until the rest of the trees grew to a size that would be functional when recruited. This disparity would likely be even larger for the recruitment of key piece LWD. For these large streams, depending on the size class distribution in the stand, there is a greater likelihood that trees that could provide functional LWD would be harvested (i.e., trees that fall between the minimum size trees that are retained [10 inch dbh] and the largest trees in the stand that are required to be retained). Mid-size streams, with a wider inner zone compared to streams less than 15 feet wide, would have the lowest likelihood of LWD recruitment reduction due to harvest, though some reduction would occur.

The equivalent buffer area index for LWD weights the recruitment potential for each stream type and size by the length of the stream in those categories and provides an overall measure of recruitment potential by alternative. The equivalent buffer area index for LWD on the eastside ranges from 82 (250-year site potential tree height) to 93 percent (100-year site potential tree height) of the no-harvest potential along Type S and F streams. The equivalent buffer area index suggests that there is substantially greater recruitment for Type S and F streams under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 compared to No Action Alternative 1-Scenario 2, but less when compared to Alternative 4 under both site potential tree height assumptions (Figures 4.7-8 and 4.7-10).

Within the bull trout overlay, which covers most of the eastside forested areas, if all trees within 75 feet of the stream must be retained because they provide shade (See the Stream Shade discussion, below), then the level of protection would increase substantially over the standard shade rule (applied outside the bull trout overlay). Notably, shade-producing trees in the inner zone are those most likely to be the larger trees that would provide LWD if they reach the stream. In practice, it is expected that most landowners would harvest some trees (not identified as shade trees) between the outer edge of the core zone (i.e., 30 feet) and 75 feet.

The equivalent buffer area index under the 250-year site potential tree height assumption is lower than the 100-year site potential tree height assumption. Consequently, less protection would be provided under the 250-year site potential tree height than under the 100-year assumption. Overall, it is likely that LWD recruitment to Type F and S streams would be at levels adequate to sustain robust salmonid populations, given the implementation of the shade rule, which would effectively reduce harvest opportunities within the bull trout overlay.

On the eastside under current conditions, most riparian areas are dominated by forests in early-seral stages. Thus, the quality of LWD input potential is currently less than optimal to provide LWD recruitment. Using the Riparian Aquatic Interaction Simulator growth model to predict tree growth rate, it is apparent that thinning results in increasing tree diameter at a faster rate. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, thinning the inner zone would increase the size of trees over the mid- and long-term, and would produce larger trees sooner (See discussion under Westside, above). However, because the growth rate is slower on much of the eastside, the time frame would likely be extended. Though key piece sizes have not been calculated for the eastside specifically, the time to reach key piece size would likely be reduced to some extent, similar to the westside. However, the actual timeframe required to reach key piece size would likely be longer than for the westside. For large streams there may be a greater lag time before a larger proportion of trees would be of recruitable size, since some of the medium/large size trees would have the most potential of being harvested in the short-term.

Eastside: Non-fish Waters. On Type N_p streams, the RMZ width would be 50 feet. Harvest within Type N_p RMZs could follow a partial cut, clearcut, or no-harvest strategy and would be identified by the landowner as part of a forest practices application. The RMZ would be less than the one site potential tree width recommended in most literature to encompass the entire LWD recruitment source area. The 50-foot buffer would provide approximately 48 to 92 percent of full LWD recruitment potential, depending upon site class and site potential tree height assumption (McDade et al. 1990). On some N_p and all N_s stream reaches, harvest would be allowed to the streambank. Consequently, there would be no direct requirement for protection of LWD recruitment potential along these stream reaches. However substantial buffering would occur in some areas as a result of unstable slope protections, which would often restrict harvest along many N_p and N_p stream channels (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004). Trees along Type N_p and N_s streams (like Type S and F streams) that reach the channel are important for sediment retention (Keller and Swanson 1979; Sedell et al. 1988), gradient modification (Bilby 1979), and nutrient production (Cummins 1974).

Harvest opportunities within RMZs along Type N_p streams would include a partial cut and a clearcut option. The partial cut option would have a selective harvest prescription that would be the same as the inner zone along Type S and F streams. The clearcut option could be implemented along no more than 30 percent of the stream length within the harvest unit, could not be more than 300 feet in length, and would be at least 500 feet upstream from the confluence with a Type S or F stream. A no-harvest prescription would be implemented on both sides of the stream over a length similar to that implemented for the clearcut prescription. Under the partial cut option, 24 to 36 percent of the potentially recruitable trees would be left in the RMZ depending on site-class and vegetation zone (i.e., timber habitat type) under the 100-year site potential tree height assumption. Once a partial cut or clearcut strategy is selected, there would be no opportunity to change it during the term of the ITP under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Under the modeled clearcut option, 55 to 59 percent of the potentially recruitable trees were retained in the RMZ (Washington Forest Practices Board 2001a). For all Type N_s streams, no RMZs would be maintained, and, therefore, no protection of LWD recruitment potential would occur except in cases where unstable slopes buffers were retained to prevent management-related mass wasting.

Alternative 4

General. Unlike No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3), the 20-acre exemption for small landowners would not apply to the riparian rules under Alternative 4; there would also be no such exemption under No Action Alternative 1-Scenario 2. Small landowners (owning less than 80 acres of forestland) would not be permitted to implement less protective RMZs on non-contiguous parcels less than 20 acres in size (subsection 2.3, Alternatives Analyzed in Detail). Therefore, there would be no increased likelihood of inadequate LWD recruitment in watersheds with a high proportion of small landowners.

Under Alternative 4, the Shoreline Management Act would not result in additional retention of riparian trees along Shorelines of Statewide Significance as under the other alternatives. This is because Alternative 4 would provide a greater level of protection than the Shoreline Management Act because the 200-foot RMZs would be no-harvest areas, measured from the outer edge of the Channel Migration Zone.

Westside. On the westside, Alternative 4 would implement 200-foot, no-harvest RMZs along streams with less than 20 percent gradient; 100-foot, no-harvest RMZs along streams with 20 to 30 percent gradient; and 70-foot, no-harvest RMZs along streams with greater than 30 percent gradient. These RMZs would provide 94 to 100 percent, 75 to 100 percent, and 62 to 98 percent of full LWD recruitment potential for a Site Class II stand, respectively, depending upon the site potential tree height assumption (i.e., 100-year or 250-year).

Similar to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, additional protection of LWD recruitment potential would be provided by beginning the RMZ at the outer edge of the Channel Migration Zone. Other zones that would provide additional protection for LWD recruitment potential include measuring the RMZ from the edge of Beaver Habitat Zones and Channel Disturbance Zones. These no-harvest zones would provide additional LWD recruitment in areas that are unprotected under either scenario of No Action Alternative 1. Also, because of the relatively wide RMZs under Alternative 4, the likelihood for blowdown within RMZs would be slightly lower compared to No Action Alternative 1-Scenario 1, and much lower than No Action Alternative 1-Scenario 2 (Pollock and Kennard 1998).

For all three stream types, no harvest would be allowed within the RMZ except for specific cases, which include: 1) converting a hardwood-dominated stand to one that is conifer-dominated, or 2) facilitating the development of 200 year-old stand conditions. As a result, most if not all of the LWD recruitment potential (described above) would be maintained unless stand manipulation was deemed necessary to improve riparian condition and function.

Under both the 100-year and 250-year site potential tree height assumptions, the equivalent buffer area index analysis suggests that Alternative 4 would provide 100 percent of the LWD recruitment potential to fish-bearing streams (i.e., those less than 20 percent gradient) (Figures 4.7-7 and 4.7-9). Although the higher gradient streams would not fully meet the one site potential tree height width to provide complete recruitment potential, virtually all high gradient streams (i.e., those greater than 20 percent gradient) are non-fish-bearing streams.

Using growth modeling, tree diameters clearly increase at a faster rate when thinning is implemented. Therefore, within riparian stands adjacent to larger streams, thinning as provided by Option 1 of No Action Alternative 1-Scenario 1 may be important to increase tree growth rate depending on the channel condition. However, along smaller fish-bearing and non-fish-bearing streams that do not necessarily benefit from thinning, Alternative 4 would provide the highest LWD recruitment potential of all the alternatives.

Eastside. Silvicultural prescriptions in RMZs are the same on the eastside as on the westside, although site potential tree height would be less than on the westside. Therefore, there would be some differences in the level of protection for LWD recruitment potential. On the eastside, Alternative 4 would provide full LWD recruitment potential for streams less than 20 percent gradient on all site classes through the designation of a 200-foot RMZ. This would apply to both the 100-year and 250-year site potential tree height assumptions.

For non-fish-bearing streams on Site Class II and III lands, LWD recruitment potential would range from 97 to 100 percent of full potential on perennial streams and between 93 and 99 percent for seasonal streams, depending on the site potential tree height assumption. Similar to No Action Alternative 1-Scenario 1, additional protection of LWD recruitment potential would be provided by beginning the RMZ at the outer edge of the Channel Migration Zone and by requiring no-harvest within the Channel Migration Zone. Other zones that would provide additional protection of recruitment potential include measuring the RMZ from the edge of Beaver Habitat Zones and Channel Disturbance Zones where they apply. Also, because of the relatively wide RMZs under Alternative 4, the likelihood of RMZ blowdown would be relatively low (Pollock and Kennard 1998).

For all three stream types, no harvest could occur within RMZs except for specific cases, which are described above under the Westside discussion. As a result, most if not all of the LWD recruitment potential (described above) would be maintained unless stand manipulation was deemed necessary to improve riparian condition and function.

Similar to the westside, under both the 100-year site potential tree height and 250-year site potential tree height assumptions, the equivalent buffer area index suggests Alternative 4 would provide the highest level of recruitment potential compared to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1, and Alternatives 2 and 3 (Figure 4.7-8 and 4.7-10).

The major differences in the two site potential tree height assumptions would occur along steeper (greater than 20 percent gradient) channels that are generally (but not always) non-fish-bearing streams. In particular, the equivalent buffer area index for all streams demonstrates almost complete protection under the 100-year site potential tree height assumption and almost complete protection for fish-bearing streams under the 250-year site potential tree height assumption as well. These results are primarily due to the fact that, although high gradient stream RMZ width would be less than one site potential tree height, most of the LWD recruitment potential would exist within 70 feet of the stream. In addition, a large proportion of seasonal streams (defined under No Action Alternative 1-Scenario 1), which make up a large proportion of stream miles across the landscape, would fall within the 0 to 20 percent gradient category and therefore, receive a 200-foot, no-harvest RMZ.

Stream Shade

The effects of the alternatives on stream shade are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on stream shade are likely to fall between these two scenarios.

Overview of Effects

An overview of the effects of the alternatives on stream shade is presented in this subsection. Stream shade has already been greatly reduced along many streams within the State due to historical logging practices, as well as other land uses (e.g., agriculture, urbanization) (subsection 3.7.1.6, Historic Protection of Riparian Areas, and subsection 3.7.1.7, Current Condition of Riparian Areas). However, the current Washington Forest Practices Rules, as well as the January 1, 1999 Washington Forest Practices Rules, provide for substantially more shade retention than was provided historically, especially along fish-bearing streams. Therefore, the amount of shade produced within riparian zones on covered forestlands is increasing due to tree growth and because the rules under any of the alternatives would result in the retention of most existing stream shade along fish-bearing streams during harvest operations. This means that shade along fish-bearing streams would be expected to increase under any of the alternatives, relative to baseline conditions. Along non-fish-bearing streams, the amount of shade would likely remain close to baseline conditions or increase depending on the alternative. Note that increases in shade due to tree growth would be very slow to occur and would represent long-term improvements. Changes in shade due to greater retention during harvest operations can have positive effects over the short-term as well as long-term. The following paragraph summarizes the degree to which each alternative is expected to affect shade levels.

Because of the shade rule, No Action Alternative 1-Scenario 2 would result in a moderate reduction in shade along fish-bearing streams relative to all other alternatives. The lack of a shade rule for non-fish-bearing streams would greatly reduce shade along these streams. Of all the alternatives, No Action Alternative 1-Scenario 2 would provide the lowest level of shade protection.

The amount of shade retention along fish-bearing streams would be slightly higher under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, relative to No Action Alternative 1-Scenario 2, as a result of wider RMZs and higher leave tree requirements. RMZs along N_p streams and the protection of unstable landforms and other sensitive sites would provide increased shade retention along non-fish-bearing streams relative to No Action Alternative 1-Scenario 2. Compared to Alternative 4, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 provide slightly less shade along fish-bearing streams and moderately less shade along non-fish-bearing streams.

Under Alternative 4, the amount of shade retention would be increased relative to No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, but would be only slightly increased along fish-bearing streams (since most shade would already be protected under these alternatives). Shade levels along non-fish-bearing streams would be moderately higher under Alternative 4 relative to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. The amount of shade retention provided by Alternative 4 would be substantially higher for all streams compared to No Action Alternative 1-Scenario 2.

The comparisons among the alternatives described in the preceding paragraphs would hold true for both western and eastern Washington. A detailed analysis of the alternatives is presented in the following subsections.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Westside: Type 1, 2, and 3 Waters. The evaluation criterion for stream shade is 0.75 site potential tree height, which represents full protection (Figure 4.7-3). Generally, trees closer to the stream would be more likely to provide shade than those farther away (Figure 4.7-3). On the westside, a 0.75 site potential tree height, which would range from 68 to 150 feet based on the 100-year site potential tree height and 75 to 185 feet based on the 250-year site potential tree height, would provide full protection for stream shade along Type 1-3 streams. Along most Type 1, 2, and 3 streams, the RMZ widths would not meet this requirement under No Action Alternative 1-Scenario 2. The few exceptions would be primarily where maximum RMZ widths are applied to low site classes.

The RMZs under this alternative would be, for the most part, less than the evaluation criterion used for stream shade (0.75 site potential tree height). Also, some tree removal could occur within the RMZ, which may reduce shade, although the shade rule would specify the conditions under which trees can be removed (WAC 222-30-040). However, these conditions suggest that full shade would not be provided in most cases. This has the potential to allow some increase in stream temperatures relative to fully shaded conditions.

Under No Action Alternative 1-Scenario 2, the Washington Forest Practices Rules would include the shade rule, which would be designed to retain shade so water temperatures will not exceed State water quality standards. As guidance for meeting the requirements of the shade rule, the Washington Forest Practices Board Manual would include a shade screening tool and, if necessary, water temperature modeling to determine the likely effect of reducing shade levels. The shade rule would require maintenance of specific shade levels depending upon the waterbody class (Class A or AA, designated by Ecology) and elevation. The screening tool would use overhead canopy closure (measured mid-stream using a spherical densiometer) as an index for shade. Depending on elevation (particularly lower elevations) there would be increased shade requirements along Type 1-3 streams due to the implementation of the shade rule. As a result, the width of the RMZ and leave tree requirements within the RMZ may increase to the maximum and shade levels are likely to increase. The shade rule would apply to trees within the RMZ, which would range in width from 25 to 100 feet for Type 1-3 waters.

In tests of the shade screening tool, Rashin and Graber (1992) found that the screening tool was effective at seven of the nine sites examined (excluding those with flow loss within the reach). These results suggest that some streams may not be fully protected from increases in temperature even with implementation of the shade rule guidelines. The results from Rashin and Graber (1992) also suggested that prior to implementation of the shade rule, low elevation streams less than 1,640 feet were at higher risk of exceeding water quality standards than higher elevation streams. It is not known to what degree the shade rule has been effective at protecting these low elevation streams.

Currently, the majority of trees in riparian zones are in early-seral stages (Table 3-18 and 3-19). Therefore, many riparian areas may not provide effective shade under existing conditions, and it may take many years before riparian stands will be capable of providing adequate shade. However, because there is no limitation on entry into RMZs under No Action Alternative 1-Scenario 2, it is likely that many stands would be harvested again during the next rotation, prior to or near the time that riparian stands approach full shade function.

Westside: Type 4 and 5 Waters. Under No Action Alternative 1-Scenario 2, RMZs would not be required for Type 4 waters except under limited site-specific conditions or where stream-adjacent unstable slopes are protected through tree retention. Therefore, in most cases, RMZs for Type 4 streams would not meet the minimum widths required to maintain adequate shade.

Type 4 streams are most susceptible to alteration in shade since there are no RMZ or leave tree requirements. Temperature effects in some Type 4 streams are likely to be partially mitigated due to the fact that smaller streams can be partially or fully shaded with overhanging shrubs, young trees, and slash (timber harvest debris), which are not large enough to shade larger streams.

Eastside: Type 1, 2, and 3 Waters. A 0.75 site potential tree height, which ranges from 45 to 98 feet based on the 100-year site potential tree height and from 64 to 147 feet based on the 250-year site potential tree height, is assumed to provide full shade retention on the eastside (Spence et al. 1996; FEMAT 1993). Most RMZ widths for Type 1, 2, and 3 streams would not meet this requirement since the minimum RMZ width is 30 feet, which is less than 0.75 site potential tree height for all site classes. The few exceptions where the 0.75 site potential tree height would be met would be primarily where maximum RMZs are applied to low site classes.

Similar to the westside, the potential for harvest within the RMZ under No Action Alternative 1-Scenario 2, for all stream types would increase the likelihood that shade will be further reduced. However, the shade rule would also be implemented on the eastside, and RMZ width (30 to 300 feet) and leave tree requirements could be increased to the maximum in order to meet required shade levels. The magnitude of temperature increases resulting from canopy removal on the eastside might be expected to be slightly less than for the westside because more open forest types (e.g., ponderosa pine) provide less shading than coastal and western Cascade forests. However, many streams east of the Cascades approach the maximum thermal tolerance level for salmonids during the summer, and these smaller increases in temperature might be equally or more detrimental to salmonids.

Similar to the westside, a majority of riparian stands are currently in early-seral stages, and most of the remaining stands are in a mid-seral stage condition (Table 3-19). The younger stands are not expected to provide shade that provides adequate function in the short-term. Similar to the westside, the riparian stands would likely be harvested again before reaching adequate shade along all streams. However, because the rotation is longer in eastern Washington than on the westside, a greater proportion of the landscape would likely be functioning prior to the subsequent rotation.

Eastside: Type 4 and 5 Waters. Under No Action Alternative 1-Scenario 2, RMZs would not be required for Type 4 and 5 streams, except for limited site-specific conditions and in cases where unstable slopes protection results in tree retention along non-fish-bearing streams. Therefore, in most cases, RMZs for Type 4 and 5 streams would be less than the minimum buffer width required for adequate retention of shade.

The greatest potential for adverse effects is for Type 4 and 5 streams with no leave tree requirement and consequently no provisions for retention of shade. However, for many Type 4 and 5 streams, the loss of shade would be somewhat mitigated because overhanging shrubs, young trees, and slash are thought to provide effective shade. In addition, selective harvest is the main silvicultural strategy (approximately 60 percent of the landbase) applied to the eastside (Personal Communication, Charlene Rodgers, Washington DNR, April 6, 2004). Therefore, some protection may be provided even if no RMZ is established. Overall, however, the lack of RMZs on Type 4 streams would not meet the level recommended for minimum protection, at least in the short- and mid-term.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Westside: Type S and F Streams. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the Type S and F RMZ widths under the 100-year site potential tree height and 250-year assumptions would nominally exceed the width recommended in the literature to provide complete shade if considering only the RMZ width and not the RMZ prescriptions. However, a substantial portion of inner and outer zone trees could be harvested. Consequently some level of shade reduction would be expected under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Nevertheless, the cumulative percent curve for shade (Figure 4.7-3) shows that the relationship between buffer width and potential shade is non-linear, with more shade provided from trees closer to the stream. For example, approximately 75 percent of shade effectiveness is within 0.5 site potential tree height. In addition, RMZ widths begin at the edge of the Channel Migration Zone where they are present, which provides additional protection to vegetation in close proximity to the stream. Also, the shade rule would require that minimum shade levels be maintained to meet State water temperature standards. Additionally, it would be required that all trees within 75 feet of the stream (or Channel Migration Zone) that contribute to minimum shade levels be retained.

While exempt 20-acre parcels would have less protective RMZ requirements, they would be required to follow the shade rule. Therefore, RMZs on exempt parcels would be required to include enough trees to meet the minimum shade requirements for achieving State water temperature standards. However, exempt parcel RMZs would still not meet the 0.75 site potential tree height evaluation criteria for full shade protection.

The no-harvest zones adjacent to the stream or Channel Migration Zone would range from 50 feet under Option 1 (thinning from below) to 80 to 100 feet under Option 2 (leaving trees closest to the water). A 50-foot no-harvest RMZ would be expected to provide 53 to 91 percent of full shade based on the 100-year site potential tree height and from 44 to 86 percent of full shade based on the 250-year site potential tree height, depending upon site class. Under Option 2, an 80-foot no-harvest zone would provide between 75 and 100 percent of full shade based on the 100-year site potential tree height and from 64 to 100 percent based on the 250-year site potential tree height. A 100-foot no-harvest zone would provide between 86 and 100 percent (100-year site potential tree height) or 76 and 100 percent (250-year site potential tree height) of full shade. Because no harvest would be allowed in the core zone, all available shade within 50 feet of the stream (or Channel Migration Zone) would be retained along Type S and F waters.

Under Option 1, besides the core zone adjacent to the stream or Channel Migration Zone, the inner zone would extend out to 0.66 of the 100-year site potential tree height for streams less than or equal to 10 feet wide and to 0.75 of the 100-year site potential tree height for streams greater than 10 feet wide. These widths would equate to 0.54 and 0.61

site potential tree height for small and large streams, respectively, based on the 250-year site potential tree height for Site Classes I-IV. The combined core and inner zone width would exceed 100 feet for Site Class I and II soils and Site Class III soils for streams greater than 10 feet wide. However, no data exists in the literature that demonstrates the level of shade retention that is available from the combination of a no-harvest zone (i.e., core) and a selective harvest zone (i.e., inner). The selective harvest that would occur within the inner zone of Option 1 would leave the largest, and therefore the tallest, trees which have the highest likelihood to provide shade. It is possible that under some circumstances leave trees in the outer zone would also provide shade, but this would likely be minimal or none in most cases.

Similar to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would include the shade rule. The rule would require that minimum shade levels be met within the RMZ to meet State water temperature standards. However, the shade rule would be implemented slightly differently under these alternatives compared to No Action Alternative 1-Scenario 2.

Under No Action Alternative 1-Scenario 2 the shade rule would apply to trees up to the maximum RMZ width for that stream type and width. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the shade rule would apply to the area within 75 feet of the stream or Channel Migration Zone. In addition, canopy closure measurements would be made at the edge of the Channel Migration Zone when it is present or, otherwise, measurements would be made mid-stream. Nevertheless, it is unclear to what extent the shade rule would actually contribute additional shade retention when implemented because most shade producing trees that would be retained by the shade rule would already be protected by the no-harvest core zone, the "thin from below" requirements under Option 1, and the no-harvest portions of the inner zone under Option 2. Similar to all other alternatives, reductions in shade would occur from yarding corridors and roads located in or across the RMZ.

All factors considered, the overall RMZ effectiveness for providing shade protection to Type S and F streams under these alternatives is moderate to high based upon the FEMAT (1993) shade curve, but high under most situations. Consequently, the likelihood of negative temperature effects is considered low to moderate. No-harvest buffers 100 feet wide have been suggested to have similar levels of shade retention as old-growth forests in western Oregon and Washington (Murphy 1995; Johnson and Ryba 1992), and this width would be met under many Option 2 situations. In addition, if the channel shifts within the Channel Migration Zone, the stream would still be provided shade.

The large proportion of RMZs that are in early-seral stages are not expected to reach full shade capacity within the short-term (Tables 3-18 and 3-19), and some of these stands are under-stocked by conifers and dominated by hardwoods. Many mid-seral stands would develop to a point where canopy closure would be sufficient to produce shade comparable to a late-seral stand in 20 or so years (Table 4.7-2); however, core zones that are developing as under-stocked, hardwood-dominated stands may not attain shade levels typical of an old-growth conifer forest (Washington Forest Practices Board 2001a). Consequently, even no-harvest zones may not meet long-term shade needs.

<u>Westside: Type N Streams</u>. At least 50 percent of the Type N_p stream length would be protected with a 50-foot RMZ under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, which would meet the small stream width criterion. Sensitive sites (which include seeps, springs, perennial initiation points, and others) would also receive protection from 50-foot RMZs. In addition, a 50-foot RMZ would be required for the first 500 feet upstream of the confluence with a Type F or S stream. These 50-foot RMZs would provide 53 to 91 percent of full shade protection based on the 100-year site potential tree height and from 44 to 86 percent of full shade based on the 250-year site potential tree height, depending upon site class. Higher levels of shade may be retained along Type N_p stream reaches where the protection of stream-adjacent unstable slopes results in the retention of no- or limited-harvest buffers. Because many unstable landforms (e.g., inner gorges, channel heads, bedrock hollows) are often located in close proximity to non-fish-bearing waters, there is a high likelihood (particularly in western Washington) that additional shade would be retained along Type N_p streams as a result of unstable slopes protection. For all other Type N streams, no RMZ would be provided and, therefore, no shade protection is guaranteed, although some shade would be maintained from understory vegetation.

The greatest potential for shade reduction would be along the portion of N_p streams that have no leave tree requirement, resulting in even-aged timber harvest adjacent to the stream and no shade protection. Similar to Type 4 waters under No Action Alternative 1-Scenario 2, these streams would not receive adequate shade protection, at least in the short term, which could result in water temperature increases.

However, the potential for increased temperatures would be partially mitigated by overhanging shrubs and young trees, which provide effective shade for Type N_p waters in many cases. As discussed above, at least 50 percent of these streams would be provided 50-foot no-harvest RMZs. The intent of the 50-foot no-harvest RMZs along the lower 500 feet of Type N_p streams would be to allow water temperatures to equilibrate to shaded conditions prior to mixing with, or becoming, a Type F or S stream. Also, as observed from current harvest practices, many additional N_p and N_s streams would receive additional protection due to restrictions on forest practices activities on unstable slopes, where many of these streams are located (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004). There is a moderate level of uncertainty that the cumulative protection for Type N_p waters would be effective at providing adequate shade for these small streams. Consequently, this is a priority research topic under the adaptive management program under the current Washington Forest Practices Rules.

In watersheds with high proportions of exempt 20-acre parcels, the lack of RMZs on all Type 4 and 5 streams required under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, would increase the likelihood of adverse temperature effects. These effects on Type N streams could also be transferred to downstream fish-bearing streams until stream temperatures equilibrated with local environmental conditions.

Eastside: Type S and F Streams. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the total RMZ widths would nominally exceed the evaluation criteria for widths recommended in the literature for shade along Type S and F streams, but would include both no-harvest and partial cut silvicultural prescriptions. The 30-foot no-harvest core zone adjacent to the stream or Channel Migration Zone would provide between 49 and 86 percent of full shade based on the 100-year site potential tree height and between 35 and 69 percent of full shade based on the 250-year site potential tree height. Inner zone widths would be 45 feet for streams less than or equal to 15 feet wide and 70 feet for streams greater than 15 feet wide. In cases where the inner zone is treated as no-harvest, 75 feet would provide between 93 and 100 percent of full shade based on the 100-year site potential tree height, and between 73 and 100 percent based on the 250-year site potential tree height. A 100-foot buffer would provide 100 percent of full shade based on the 100-year site potential tree height and between 87 and 100 percent of full shade based on the 250-year site potential tree height. However, some reduction in shade would occur in many cases because some harvest would be allowed within the inner zone. Leave tree requirements for inner zones would be dependent upon habitat type (ponderosa pine, mixed conifer, or high elevation) and site class. Leave trees would include 21 to 50 of the largest, and consequently tallest, trees per acre in the ponderosa pine and mixed conifer habitat types. The high elevation timber habitat type would follow the “thin from below” prescriptions used in western Washington.

There is a moderate level of uncertainty that leave tree requirements in the inner zone would provide adequate shade protection, particularly if the core zone is not fully stocked. In regions with higher ambient air temperature, any shade reduction could increase the likelihood of adverse temperature effects (subsection 4.4.2.2, Evaluation of Alternatives). However, other prescriptions may reduce this uncertainty, including implementation of the “all available shade” rule within the bull trout overlay. This rule would require that all available shade within 75 feet of the stream edge or Channel Migration Zone be retained on Type S and F streams located within the bull trout overlay. All available shade would be equivalent to the existing pre-harvest canopy closure, which is measured with a densiometer (See above).

Under the shade rule, areas within the bull trout overlay, an additional 45 feet outside the core zone (75 feet total) would be prescribed to maintain all available shade. This does not necessarily imply no-harvest since the level of additional protection would be highly site specific. As discussed previously for the westside, the shade rule would be based upon canopy closure and shade protection under the bull trout overlay would be implemented similarly. The shade rule would protect existing shade rather than potential future shade. Consequently, some inner zone trees (or trees within 75 feet of the stream within the bull trout overlay) could be harvested because they do not currently provide shade, but could if they were taller. This limitation of the rule would be more important on the eastside than the westside because stands tend to be more open on the eastside.

In a fully stocked stand, the trees closest to the stream would provide the bulk of the shade protection with trees farther out providing relatively little additional shade. In contrast, trees further from the stream have a higher potential to provide shade in a more open stand. Compared to the westside, there would be a greater likelihood that the shade rule would protect additional shade producing trees on the eastside, particularly within the bull trout overlay, because the core zone would be narrower, and the shade rule would consequently be applied to a larger area.

Also, while the 20-acre exemption lands would have narrower RMZ requirements, they would still be required to follow the shade rule. Therefore, stream temperature could be adversely affected. But the shade rule should moderate potential adverse effects in these sites.

Similar to the westside, any yarding corridors and roads located within the RMZ would reduce shade. All factors considered, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would have a low to moderate likelihood of negative temperature effects along Type S and F streams. This assessment is based on the fact that some shading would be diminished because the shade rule would only require that trees be left within 75 feet of the stream, which would be less than what is considered full shade protection based on the 0.75 site potential tree height criterion (FEMAT 1993). It would also be based on the fact that some non-fish-bearing perennial streams would have no or limited shade protection from RMZs. However, the basis of the shade rule would consider the likely adverse effects from increased temperature and should help mitigate negative effects. There is a moderate level of uncertainty in the effects assessment for shade under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 because of the lack of specific information on the assessment method (actual site-specific tree height may vary among harvest sites, independent of stream temperature) and the overall effectiveness of the shade rule at regulating stream temperature.

A large proportion of riparian stands are in the early-seral stages of development, so the resulting levels of shade are lower than full potential. Most of the early-seral stages are maturing and, in the absence of harvest, increased canopy cover development over the mid-term would provide increased stream shade over most streams.

Eastside: Type N Streams. Type N_p streams with 50-foot RMZs would meet the shade criterion for smaller streams (less than 5 feet). For some other Type N_p streams, no RMZ would be provided and, therefore, no overstory shade protection would be provided either.

The 50-foot no-harvest RMZ along some Type N_p streams would provide complete shade protection. Type N_p streams with 50-foot selective harvest RMZs would be less likely to provide complete shade protection. However, for small Type N_p streams, the likelihood for negative temperature effects would be reduced because overhanging shrubs and young trees are thought to effectively shade these streams. Also, protection of stream-adjacent unstable slopes would result in the retention of additional shade along Type N_p streams in some cases. The highest likelihood for negative temperature effects would be along N_p streams that lack RMZs, similar to the westside because these streams are most susceptible to shade loss over the short and long term until new trees grow large enough.

As is the case for the westside, under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, watersheds on the eastside with high proportions of exempt 20-acre parcels would have a higher likelihood of adverse temperature effects because no RMZs would be required for Type N_p streams, and leave tree requirements would be reduced relative to the standard rules. Water temperature increases could affect downstream fish-bearing streams until temperatures reach equilibrium with local environmental conditions.

Alternative 4

Under Alternative 4, the 200-foot RMZs for streams with gradients of 0 to 20 percent would meet or exceed the width recommended in the literature for full protection of shade based on both the 100-year and 250-year site potential tree height. Streams with 20 to 30 percent gradient would receive a 100-foot no-harvest RMZ that would provide full shade protection based on the 100-year site potential tree height and between 87 and 100 percent of full protection based on the 250-year site potential tree height. Assuming that nearly all channels greater than 30 percent slope would be very small (less than 5 feet wide), it would be expected that nearly 100 percent would meet the 50-foot buffer criterion for small streams on both the west and eastsides with the 70-foot no-harvest RMZ. Overall, the RMZ width provided should be sufficient to maintain most if not all sources of shade on these streams. The recovery period for shade along early- and mid-seral stage riparian stands would be similar to No Action Alternative 1-Scenario 1.

Overall, most if not all shade would be protected under Alternative 4 for all streams on both the east and westsides. In general, the no-harvest RMZs would provide a high level of protection, and would pose a low likelihood of negative temperature effects. In addition, all RMZ widths would be less likely to be susceptible to appreciable mortality from windthrow. Alternative 4 would provide a higher to much higher level of shade protection compared to either scenario of No Action Alternative 1 for all streams.

<u>Leaf and Needle Litter Production</u>

Overview of Effects

The effects of the alternatives on leaf and needle litter delivery (i.e., "detritus;" See Glossary) are analyzed in this subsection. Leaves and needles, as well as other biological inputs (e.g., terrestrial insects), enter the stream from riparian vegetation and supply nutrients and food to stream systems. Due to historical harvest practices, leaf and needle litter supply has been substantially reduced. Therefore, compared to baseline conditions, the amount of leaf and needle litter delivery and the resulting effects on riparian processes are expected to increase under any of the alternatives. The following paragraphs address leaf and needle supply and associated effects under each alternative.

No Action Alternative 1-Scenario 2 would result in moderate (Type 1, 2, and 3 waters) to very high (for Type 4 and 5 waters) reductions in leaf and needle litter recruitment potential relative to all other alternatives. However, negative effects on aquatic food and nutrient supply would be less likely, as some early-successional trees, shrubs, and herbaceous plants supply leaf and needle litter and other detritus that may be of high quality as food and nutrient sources. The amount and quality depends on the type of regrowth (e.g., alder leaves appear to be high quality) that occurs. Also, increased short-term autochthonous production (See Glossary) following harvesting would be expected to supplement allocthonous food sources (See Glossary) such as leaf and needle fall.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide high (for Type S and F waters) to moderate (for Type N waters) levels of leaf and needle litter recruitment potential compared to No Action Alternative 1-Scenario 2. The supply of leaf and needle litter would be expected to be the same among No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 since the rules among the alternatives are the same. Like No Action Alternative 1-Scenario 2, these alternatives would compensate for reduced coniferous leaf and needle litter through non-coniferous riparian vegetation along streams, reducing the likelihood for negative effects.

Alternative 4 would provide the highest level of leaf and needle litter recruitment potential of all the alternatives. Alternative 4 would provide much greater leaf and needle recruitment than No Action Alternative 1-Scenario 2 and slightly greater recruitment than No Action Alternative 1-Scenario 1. The likelihood for negative effects associated with reductions or changes in leaf and needle supply would be very low under Alternative 4.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Westside. A 0.5 site potential tree height, which ranges from 45 to 100 feet depending on site class based on the 100-year site potential tree height and from 50 to 124 feet based on the 250-year site potential tree height, is considered to provide full protection for leaf and needle litter inputs based on FEMAT (1993). For January 1, 1999 Washington Forest Practices Rules, depending on site class, full protection would be provided based on maximum RMZ widths for Type 1, 2, and 3 streams. However, the minimum RMZ width of 25 feet would not meet the 0.5 site potential tree height required for complete protection of leaf and needle litter (Figure 4.7-2).

For each stream type, RMZ width could vary between the minimum and maximum values, depending on the extent of wetland vegetation or the width needed to meet shade requirements. For Type 4 and 5 waters, RMZs would not be required except for site-specific conditions and, in all cases, would not exceed 25 feet. Therefore, RMZs for Type 4 and 5 streams would not meet the 0.5 site potential tree height required for complete protection.

Under No Action Alternative 1-Scenario 2, leaf and needle litter recruitment would be compromised along Type 1 through 3 streams because the January 1, 1999 Washington Forest Practices Rules allow substantial reduction in overstory conifers and hardwood removal through selective harvest within the RMZ, thus reducing the biomass that would likely be recruited. For streams with RMZs that do not meet the 0.5 site potential tree height criterion combined with the selective harvest prescriptions, the likelihood for reduced leaf and needle litter recruitment would increase. The likelihood would be further increased when both the required RMZ width is not met and selective harvest is allowed within the RMZ.

Further reductions in leaf and needle recruitment would be associated with Type 4 and 5 streams that lack an RMZ or leave-tree requirement. The size and morphology of small low-order streams greatly influences the deposition and processing of organic materials. Litter is primarily deposited in small steep-gradient streams in forested areas high in a watershed. Small (low-order) streams are important to the productivity of larger (high-order) stream in lower reaches of the watershed because they are a major source of organic material (IMST 1999). The exact proportion of detrital production that comes from Type 4 and 5 streams is poorly documented in the literature; however, it may be important to overall productivity. The lack of RMZs on Type 4 and 5 streams would not meet the protection recommended for detrital input needs, at least in the short term, and probably only in localized areas while vegetation grows back.

There would likely be an interruption of detrital inputs (i.e., fine organic matter; often leaves, needles, and small sticks) and terrestrial insects to Type 4 and 5 streams until the riparian forest becomes reestablished after harvest. Riparian stands would then produce some leaf and needle litter, although production might not reach full potential in the short or long term. In addition, the type of the litter may be different than that provided by pre-harvest stands because of shifts in the ratio of coniferous versus deciduous vegetation. The type of detrital input can affect not only its nutritional value, but also the amount of time needed for decomposition (Gregory et al. 1987).

In some cases detrital input has been found to be quite high shortly after clearcutting (within 5 years) depending on the type of riparian vegetation that develops (such as red alder) although still lower than old-growth input (Piccolo and Wipfli 2002~~1~~; Bilby and Bisson 1992). Also, as the forest develops, possibly progressing through a deciduous forest stage to a young coniferous forest and finally to mature and old-growth forest, the type and amount of detrital input changes both in type and amount, often with a decrease in supply during the young conifer stage (Piccolo and Wipfli 2002). The degree to which leaf and needle litter composition is altered is difficult to determine because: 1) timber harvest occurs in localized areas at varying times within a watershed, and 2) all seral stages provide some level of leaf and needle input, although in varying quantities.

Currently, most riparian vegetation is in early to mid-seral stages (Tables 3-18 and 3-19). Stand age significantly influences detrital input to a stream system. Therefore, these stands will not produce leaf and needle litter in quantities that approach natural background levels in the short term (Table 4.7-2). Mid-seral stands would develop to the point that canopy structure would be sufficient to produce leaf and needle litter comparable to a late-seral stand near the end of a 50-year period (Table 4.7-2). As a result, just as the stand is meeting detrital input production levels, the stand would likely be harvested again for the next rotation, never allowing complete return to pre-harvest production levels.

Eastside. A 0.5 site potential tree height, which ranges from 30 to 65 feet, depending on site class based on the 100-year site potential tree height and from 43 to 98 feet based on the 250-year site potential tree height, would be considered to provide full protection of leaf and litter inputs on the eastside. Under January 1, 1999 Washington Forest Practices Rules in eastern Washington, full protection would be provided based on the maximum and average RMZ widths for Type 1, 2, and 3 streams. The only exception is for Site Class I, which would require a wider RMZ to meet the 0.5 site potential tree height necessary for complete protection. The minimum RMZ width of 30 feet only meets the 0.5 site potential tree height criterion for Site Class V sites based on the 100-year site potential tree height (Figure 4.7-2). RMZs are not required for Type 4 and 5 waters and, therefore, these streams do not meet the 0.5 site potential tree height required for complete protection.

As for the westside, the possibility of harvest activity within the RMZ under No Action Alternative 1-Scenario 2 for all stream types leaves the possibility that leaf and needle litter production would be compromised. The greatest reductions would be associated with Type 4 and 5 streams that lack a leave tree requirement and where timber harvest could occur adjacent to the stream. The lack of an RMZ on these smaller streams would indicate that Type 4 and 5 waters receive no protection of leaf and needle litter recruitment. However, uneven-aged (partial cut) timber harvest strategies are the most common harvest method used on the eastside (about 60 percent of eastside forestland) (Personal Communication, Charlene Rodgers, Washington DNR, April 6, 2004). Therefore, some incidental protection would exist even if no RMZ is applied. Overall, the lack of RMZs on Type 4 and 5 streams would not meet the level required for full protection of leaf and needle litter input, at least in the short term, and probably in most areas for the mid- and long-term.

Currently, most riparian vegetation is in early-seral and mid-seral stages (Tables 3-18 and 3-19). These young stands would not be producing leaf and needle litter that approach pre-harvest levels in the short term (Table 4.7-2). Similar to the westside, most stands would likely be entered again prior to the complete return of detrital production.

No Action Alternative 1-Scenario 1, Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Westside. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 the overall RMZ widths would exceed the evaluation criteria for widths recommended in the literature for leaf and needle litter production for Type S and F streams. Type N_p streams with a 50-foot RMZ would receive most of the protection required to maintain leaf and needle litter input, but not at the level recommended by the literature for full protection. For some portions of Type N_p and N_s streams, no RMZ would be provided and, therefore, no protection of leaf and needle litter would be provided.

The no-harvest zone would range from 50 feet under Option 1 to between 80 and 100 feet under Option 2 and would maintain most leaf and needle litter input along Type S and F streams. In addition, harvesting within the inner zone would not be expected to appreciably reduce the capacity of the RMZ to contribute leaf and needle litter, especially when combined with the core zone no-harvest area. These RMZs would provide continuous inputs for leaf and needle litter to streams and would allow the maintenance of stream productivity in the short and long term depending on the stand age and structure.

The greatest reductions in leaf and needle input would be along Type N_p and N_s streams that have no leave tree requirement along some of their lengths due to even-aged timber harvest adjacent to the stream. However, implementation of the rules under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 related to operations on unstable slopes would result in the protection of many streams located in close proximity to unstable areas (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004). While the lack of an RMZ requirement on most of these smaller streams would indicate that these waters receive little protection of leaf and needle litter recruitment, the application of the unstable slopes rules and the RMZ requirement on portions of N_p streams would maintain the sources of much natural detrital input. While some protection would occur, these streams would not meet the requirements for adequate protection of detrital input, at least in the short term, and probably only in localized areas while vegetation grows back. Similar to No Action Alternative 1-Scenario 2, a shift in the initial type of detrital input would be expected from coniferous needles to deciduous vegetation in many areas.

Because of the large proportion of RMZs that are in early- and mid-seral stages, they would not be expected to produce leaf and needle litter that approaches pre-harvest levels in the short term (Tables 3-18 and 3-19). Mid-seral stands would develop to the point that canopy closure would be sufficient to produce leaf and needle litter comparable to late-seral stands near the end of a 50-year period (Table 4.7-2). Because RMZs would not be re-entered until the DFC was met, most stands would have the opportunity to return to natural production levels over the long-term.

Eastside. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, all RMZ widths for Type S and F streams would exceed the 0.5 site potential tree height recommended in the literature for leaf and needle litter production. For Type N_p streams that receive a 50-foot RMZ, the 0.5 site potential tree height would be met for Site Classes II through V and would protect most of the Site Class I riparian areas. Under the partial cut strategy, all N_p streams would be provided with an RMZ, and under the clearcut strategy, at least 70 percent of the N_p streams would be provided with an RMZ. For all other Type N_p and N_s streams, no RMZ would be provided, and, therefore, no protection of leaf and needle litter would be directly provided. However, as noted for westside streams above, unstable slope protection would provide additional protection for these streams where unstable slopes and landforms are located in streamside areas.

Along Type S and F streams, the 30-foot core zone combined with the selective harvest inner zone should maintain most leaf and needle litter input. Type S and F RMZs would provide continuous inputs of leaf and needle litter to streams and would allow the maintenance of stream productivity in the short- and long-term depending on the stand age and structure.

As described earlier, landowners must identify either a partial cut and/or clearcut strategy within the 50-foot RMZ along Type N_p waters when they submit a forest practices application to Washington DNR. When the clearcut strategy is identified along no more than 30 percent of the stream in the harvest unit, no-harvest RMZs of equal length on both sides of the stream must also be identified. The 50-foot no-harvest RMZ along some Type N_p streams and the 50-foot selective harvest RMZ along others would maintain some if not all of the leaf and needle recruitment capacity. However, some reduction in leaf and needle recruitment would occur along Type N_p streams designated for the clearcut strategy and Type N_s stream reaches without any leave tree requirements. Therefore, these streams would be most susceptible to reduced detrital inputs over the short- and long-term until new trees grow back in localized areas. For a large proportion of the RMZs in early-seral stage, production of leaf and needle litter is currently compromised. As a result, only over time will the increased tree biomass occur to allow for increased litter recruitment to streams.

Alternative 4

Statewide. Under Alternative 4, the RMZ width for most streams (0 to 30 percent gradient) would meet or exceed the evaluation criteria for widths recommended in the literature for maintaining full leaf and needle litter recruitment potential. In addition, there would be no harvest in the RMZs, which would provide complete protection of leaf and needle litter production. The only exceptions would be along streams with a gradient greater than 30 percent. These high gradient streams would meet the 0.5 site potential tree height for westside Site Classes III through V and all site classes on the eastside. These streams would be protected with no-harvest RMZs 70 feet in width. Although the exact proportion of detrital production that comes from these streams is poorly documented in the literature, it may be important to overall productivity. However, the RMZs provided should be sufficient to maintain most the detrital inputs to these streams at or near pre-harvest conditions. The timing for recovery of leaf and needle input along streams dominated by early and mid-seral stage riparian forests would be similar to No Action Alternative 1-Scenario 1.

Overall, most if not all leaf and needle litter input would be protected for all streams statewide under Alternative 4. Alternative 4 would provide more to substantially more protection of leaf and needle input when compared to either scenario of No Action Alternative 1 for all streams.

Microclimate

Overview of Effects

An overview of the effects of the alternatives on microclimate is presented in this subsection. Microclimate can be greatly influenced by the size of the riparian buffer and also adjacent management practices. For perspective, it is important to note that microclimate has already been greatly diminished from removal of trees along many streams within the State due to historical logging practices, as well as other development impacts (e.g., agriculture, urbanization) (subsection 3.7.1.6, Historic Protection of Riparian Areas, and subsection 3.7.1.7, Current Condition of Riparian Areas). However, the current Washington Forest Practices Rules, as well as the January 1, 1999 Washington Forest Practices Rules, provide for substantially more riparian area protection than was provided historically, especially along fish-bearing streams. Therefore, the amount of forested riparian zones on covered forestlands, which benefit microclimate, is increasing due to tree growth. It is also increasing because the rules under any of the alternatives would result in the retention of more trees along fish-bearing streams during harvest operations, resulting in more desirable microclimate conditions relative to baseline conditions. Along non-fish-bearing streams, microclimate conditions would likely remain close to baseline. Changes in microclimate due to greater retention during harvest operations can have positive effects over the short-term as well as long-term. The following paragraphs summarize the extent to which each alternative is expected to affect microclimate function.

Relative to No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, the likelihood under No Action Alternative 1-Scenario 2 for reduced microclimate function would be moderate for fish-bearing streams and high for non-fish-bearing streams. This is because RMZs are relatively narrow and microclimate is markedly affected by both riparian retention and clearcutting or substantial removal of vegetation adjacent to the riparian area. The result from this alternative would be an increased likelihood for higher air temperatures and reduced humidity within RMZs along fish-bearing, and particularly non-fish-bearing, streams. The retention of buffers along more than half of the length of N_p channels due to RMZs and unstable slopes protection under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 explains the high likelihood of increased microclimate function compared to No Action Alternative 1-Scenario 2.

Microclimate function would not be expected to differ between No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 since the rules are the same for each alternative.

Relative to No Action Alternative 1-Scenario 2, Alternative 4 would have a low likelihood for reduced microclimate function along streams with less than 20 percent gradient (primarily inclusive of all fish-bearing streams) and a very low likelihood for all other streams. The likelihood for reduced microclimate function would be moderate relative to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Statewide. Under this alternative, microclimatic gradients, and particularly relative humidity and air temperature, would be negatively affected. Sullivan et al. (1990) studied the effects of current Washington Forest Practices Rules on water and air temperature in riparian areas and found significant increases in air temperature. A nearly one-to-one correlation was found between air temperature and percent shade.

Microclimatic conditions would be negatively affected, relative to pre-harvest conditions, on all stream types. This is anticipated because the RMZ widths would, at most, be only about two-thirds or less of the 147 feet minimum (maximum of 100 feet on Type 1 and 2 streams on the westside and generally 50 feet on the eastside). Microclimate conditions would also be negatively affected because harvest would be allowed within RMZs.

Under No Action Alternative 1-Scenario 2, air temperature and humidity would be adversely affected on both the west and eastsides. On the eastside, which has high average ambient air temperatures, the change in microclimate could further increase air temperature.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Statewide. Although there are some differences between the two westside harvest options under these alternatives that might affect air temperature and overall microclimatic gradients, there is enough existing knowledge of microclimatic gradients to distinguish between the effects of Options 1 and 2. Therefore, they are treated the same.

In contrast to No Action Alternative 1-Scenario 2, total RMZ widths for Site Classes I and II would approach or exceed the evaluation criteria for minimum buffer widths for overall microclimate gradient maintenance, at least on fish-bearing streams. However, because some level of harvest would be allowed within the RMZs, the natural gradients would not likely be maintained. Within the no-harvest zone of RMZs on fish-bearing streams, relative humidity, and other parameters would probably be somewhat lower than under natural conditions since decreased humidity in the adjacent selectively harvested inner and outer zones would affect the core zone to some extent.

The adverse effects to microclimate along non-fish-bearing streams would be greater than along fish-bearing streams. For Type N_p and N_s stream segments that would not have RMZs, no protection would be provided. On Type N_p stream segments that would receive some protection from no-harvest RMZs, the 50-foot width would be at most one-third of the minimum recommended buffer for the various microclimate variables. In cases where stream-adjacent unstable slopes would extend out to or beyond the minimum 147 feet needed to maintain microclimatic gradients, little or no adverse effect on microclimate function would be expected. However, the degree to which this would occur is solely a function of the distribution of unstable slopes and would most likely occur in western Washington where unstable slopes are more common.

Air temperature and humidity would be affected under this alternative because the buffer width for maintaining these gradients would be even greater than for other microclimatic gradients. Eastside air temperatures within RMZs would be likely to experience a greater change since ambient air temperatures tend to be higher on the eastside than on the westside.

Alternative 4

Statewide. Alternative 4 would provide the highest degree of protection of microclimatic gradients. Streams with channel gradients of less than 20 percent would receive 200-foot no-harvest RMZs. This would be sufficient to maintain microclimatic gradients for most variables. Air temperature, humidity, and wind speed would nonetheless be affected to some extent since they would require wider buffers (240 to 787 feet) to maintain pre-harvest gradients.

Streams with higher channel gradients would receive somewhat less protection. Streams with gradients between 20 and 30 percent would receive 100-foot, no-harvest RMZs, while streams with higher gradients would receive 70-foot, no-harvest RMZs, which would be unlikely to maintain most microclimate gradients. Under both situations, pre-harvest microclimate gradients would be modified, but the extent of modification would be lower than under either scenario of No Action Alternative 1. However, as with lower gradient streams, air temperature, humidity, and wind speed would be substantially affected across riparian areas.

Bank Stability

Overview of Effects

The effects of the alternatives on bank stability, which results in streambank erosion, are summarized in this subsection. From an historical perspective, bank stability was affected much more from past harvest practices than recent management actions (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). Therefore, compared to baseline conditions, bank stability and resulting effects on streambank erosion would be expected to improve under any of the alternatives. The following paragraphs address the effects of each alternative on bank erosion.

No Action Alternative 1-Scenario 2 would maintain bank stability for all fish-bearing streams (Type 1, 2, and 3) except those with minimum (25- to 30-foot) RMZs. Bank stability would not be maintained along non-fish-bearing streams (Type 4 and 5), which generally have no RMZ requirement. Bank stability in these smaller streams, however, would have less effect on fish-bearing streams than bank stability in fish-bearing streams because of their lower erosion potential. Relative to all other alternatives, No Action Alternative 1-Scenario 2 provides the lowest level of bank stability maintenance.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would fully maintain bank stability of fish-bearing streams due to RMZ widths. The 50-foot no-harvest RMZ would fully maintain bank stability along more than 50 percent of Type N_p channels (non-fish-bearing perennial streams), and partial cutting on the eastside should be nearly as effective. The unstable slope protection rules would supplement the protection provided by RMZs along a substantial proportion of N_p and N_s channels. These alternatives would provide higher levels of bank stability and maintenance on streams, especially non-fish-bearing streams, than No Action Alternative 1-Scenario 2.

Alternative 4 would fully maintain bank stability on all stream channels. It would maintain bank stability at slightly higher levels than No Action Alternative 1-Scenario 1 and at much higher levels than No Action Alternative 1-Scenario 2.

Detailed Effects Analysis

The analysis and details of the alternative assessments on bank stability are presented in subsection 4.4.2.2 (Evaluation of Alternatives) and are only summarized here because of the function that riparian zones serve in maintaining bank stability. Readers should refer to the noted subsection for further details.

No Action Alternative 1-Scenario 2

Statewide. Along westside fish-bearing streams (Type 1, 2, and 3), bank stability under No Action Alternative 1-Scenario 2 would be fully maintained if maximum RMZs are implemented. However, the 25-foot minimum RMZ would be less than needed to fully maintain bank stability on most fish-bearing streams. Therefore, in some situations, fish-bearing streams would be only partly protected on the westside.

Bank stability would be fully maintained with maximum and average RMZ widths for all fish-bearing streams on the eastside, except along some Site Class I streams, which would require greater width for full maintenance. Full maintenance for all other site classes would be provided with 30-foot RMZs on fish-bearing streams.

The general lack of any RMZs or leave tree requirements along all Type 4 and 5 streams would mean that bank stability would rarely be fully maintained. But because of their small size and low stream power, these streams would likely be less adversely affected relative to reduced bank stability than larger Type 1, 2, and 3 streams.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Statewide. In both western and eastern Washington, Type S and Type F bank stability would be fully maintained based on suggested minimum no-harvest RMZs for one-half crown diameter (0.3 site potential tree height) (FEMAT 1993). No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would supply much greater maintenance of bank stability than No Action Alternative 1-Scenario 2.

Most reaches on Type N_p streams would be fully maintained due to the combined protection afforded by 50-foot no-harvest RMZs on at least 50 percent of the stream length, along with the incidental protection realized by the presence and protection of unstable slopes and sensitive sites, and partial cuts occurring on some eastside streams. The lower power of the typically more confined stream channels would likely reduce the need for the widest buffers stated in the literature for full maintenance, so even in reaches without RMZs, adverse effects would likely be relatively low.

Other than a 30-foot Equipment Limitation Zone no direct protection would be provided for bank stability for small N_s channels. However, some protection would be provided from unstable slope buffering, which would often include these channels (Personal Communication, Jeff Grizzel, Washington DNR, April 6, 2004). As noted above, the small size of Type N_p streams would reduce the chance of adverse effects to these stream systems from bank instability. Maintenance levels for Type N streams, which correspond to Type 4 and 5 streams under No Action Alternative 1-Scenario 2, would generally be much greater than under No Action Alternative 1-Scenario 2.

Alternative 4

Statewide. Overall, bank stability would be fully maintained under Alternative 4 for all streams on both the east and westside, due to the width of RMZs. This alternative would provide much greater bank stability maintenance than No Action Alternative 1-Scenario 2. Alternative 4 would be only slightly better than No Action Alternative 1-Scenario 1 at maintaining bank stability because most fish-bearing streams would be protected under all alternatives. Also, a majority of the smaller streams that would have potential to contribute sediment through bank erosion would also be protected; although there still would be greater protection under Alternative 4 as all of these streams would be fully protected.

Sediment Filtration

Overview of Effects

The effects of the alternatives on sediment filtration are summarized in this subsection (See subsection 3.4.2.2, Forest Practices Effects on Erosion and Sedimentation). Historically, providing filtration of overland sediment movement to streams was not part of harvest prescriptions. But retention of RMZs has been increasing, improving sediment filtration. These practices represent a small portion of total past harvest. Filtration mechanisms likely have their greatest benefit over the short term (a few years). As vegetation reestablishes, the need for filtration decreases (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). Therefore, relative to baseline, any alternative that does not supply full filtration would reduce protections of overland sediment entering streams. So some alternatives would increase overland sediment delivery to streams relative to baseline. The following paragraphs address the effects of each alternative on sediment filtration.

No Action Alternative 1-Scenario 2 would maintain moderate to high levels of sediment filtration capacity for fish-bearing streams, depending on the assumptions used. If a 30-foot buffer were adequate to prevent most overland sediment from entering streams, maintenance would be high if the buffer was a no-harvest buffer. If 200-foot buffers were needed, the maintenance would be low. A 30-foot buffer may be adequate under some conditions, but information is not available for confirmation in all situations. Maintenance would be low for non-fish-bearing streams since no RMZs would be required. Overall, No Action Alternative 1-Scenario 2 would maintain the lowest level of sediment filtration capacity of all the alternatives.

Sediment filtration capacity would be expected to be the same for No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 because the rules governing hillslope erosion would be the same among these alternatives. No Action Alternative 1- Scenario 1 and Alternatives 2 and 3 would provide mostly high maintenance of sediment filtration for fish-bearing streams, although it could be lower depending on the assumptions used. Maintenance of filtration capacity on non-fish-bearing, perennial streams would be mostly moderate due to inclusion of RMZs over more than 50 percent of perennial channels. Overall, maintenance of sediment filtration capacity would be higher than under No Action Alternative 1-Scenario 2 but lower than that provided by Alternative 4.

Alternative 4 would maintain the highest level of sediment filtration capacity of all the alternatives. Maintenance would be substantially higher than under No Action Alternative 1- Scenario 2, but only slightly higher than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, assuming a 30-foot buffer is adequate to filter most sediment.

Detailed Effects Analysis

The current status and types of sediment filtration is presented under Harvest-Related Surface Erosion in subsection 3.4.2.2 (Forest Practices Effects on Erosion and Sedimentation). The analysis and details of the alternatives' assessment on the capacity of riparian zones to filter sediment are presented in subsection 4.4.1.2 (Evaluation of Alternatives) and are only summarized here. This analysis uses an equivalent buffer area index for sediment filtration. Readers should refer to the noted subsection and Appendix B, Riparian Modeling, for further details.

No Action Alternative 1-Scenario 2

Statewide. The sediment equivalent buffer area index analysis was similar for east and westside streams (Figures 4.4-1 and 4.4-2). Although there were slight differences for east and westside conditions, sediment equivalent buffer area index values for fish-bearing streams were estimated at over 92 percent and about 70 percent for 30- and 200-foot buffer assumptions, respectively. For comparison, a clearcut sediment equivalent buffer area index would be 60 percent, and a gravel or dirt road equivalent buffer area index would be 0 percent. While full protection of filtration is site-specific, as noted in subsection 4.4.1.2 (Evaluation of Alternatives), most erosion features that were identified as delivering sediment, occurred within 30 feet of the stream. This indicates that protection would only be modest if 200-foot buffers were needed to adequately filter sediment for fish-bearing streams. If a 30-foot buffer was adequate to prevent most overland flow of sediment, fish-bearing stream protection would be high. For non-fish-bearing streams (Type 4 and 5) potential filtration of overland sediment would be much less than for fish-bearing streams. Filtration for either the 30- or 200-foot equivalent buffer area index is nearly at the same level as that provided by clearcuts for non-fish-bearing, perennial or seasonal streams. This result would be expected due to a lack of RMZs on non-fish-bearing streams under No Action Alternative 1-Scenario 2. Sediment that enters non-fish-bearing streams would eventually enter fish-bearing streams, although the rate of delivery may vary with stream conditions. So, the likelihood of sediment not being filtered from non-fish-bearing streams is high for this alternative.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management programs among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Statewide. The no-harvest portion of RMZs of 50 feet (westside) or 30 feet (eastside) would result in full protection (equivalent buffer area indexes of 100 percent) of sediment filtration for fish-bearing streams on the west and eastsides. The addition of 50-foot RMZs on many perennial, non-fish-bearing streams on both the west and eastsides (over more than 50 percent of stream length) would maintain modest protections of 85 to 92 percent for the 30-foot equivalent buffer area index on the west and eastside, respectively. The 200-foot equivalent buffer area index is much lower at 67 and 70 percent, for the west and eastside, respectively. Because of unstable slope protections that include many N_p and N_s streams, overall sediment filtration protection would be higher than estimated by the equivalent buffer area indexes. The N_p streams, because of perennial flow, would be more likely to carry sediment downstream to fish-bearing streams than the smaller seasonal streams, so protection of these streams may benefit downstream fish-bearing streams. The seasonal N_s streams have equivalent buffer area indexes of 80 percent for 30-foot, and 62 to 68 percent for 200-foot equivalent buffer area index assessments. Considering that 30-foot buffers may be adequate to prevent most overland sediment transport, these alternatives would supply much greater sediment filtration protection than No Action Alternative 1-Scenario 2, although they would still be low for many seasonal N_s non-fish-bearing streams.

Alternative 4

Statewide. Because of the large RMZs on all streams, Alternative 4 had the highest estimated equivalent buffer area indexes. The sediment equivalent buffer area index for all fish-bearing streams (30- or 200-foot assumptions) was estimated at 100 percent, which was the same as No Action Alternative 1-Scenario 1 for the 30-foot buffer assessment. But the largest differences between this and other alternatives would be in non-fish-bearing streams, which had an equivalent buffer area index of 100 percent for 30-foot buffers in all areas; the range was about 91 percent for N_p streams and 79 percent of all N_s streams for 200-foot buffers. Considering that most overland sediment transport is likely protected with a 30-foot buffer, these non-fish-bearing streams would likely be fully protected under Alternative 4.

4.7.2 Wetlands

4.7.2.1 Wetlands Evaluation Criteria

The evaluation criteria for wetland resources includes an analysis of the degree of protection provided by the Washington Forest Practices Rules for wetlands and their associated functions (i.e., water quality, hydrology, and fish and wildlife habitat). Provisions under the alternatives that are evaluated against the evaluation criteria include timber harvest (application of protective buffers [Wetland Management Zones and RMZs] and the degree of harvest or disturbance allowed in forested wetlands), road management practices, and application of new wetland mapping and classification systems.

Timber Harvest

Forested Wetlands

Timber harvest and associated activities can affect wetland sites by changing species composition, reducing stand density and shading, changing fuel profiles, and altering disturbance regimes (Castelle et al. 1992; Harris and Marshall 1963; Darnell et al. 1976). Timber harvest may alter wetland hydrology and cause a rise in the water table elevation (Verry 1997). Changes in hydrologic patterns of wetland sites can directly influence plant species and growth within the wetland site resulting in an increase in undesirable plant species. Additionally, the altered water table and associated streamflow relationship could increase localized runoff and flooding (Grigal and Brooks 1997). Soil rutting and compaction from timber harvest activities can reduce infiltration, redirect flow, and alter pathways by which water moves through and from wetlands.

Water quality of wetland sites can be affected by harvest activities (Shepard 1994). Harvest and associated activities can deliver sediment to wetlands, diminish water quality, and lead to the filling of wetland sites. Nutrient pathways within wetlands can also be affected.

Alterations of forested wetland sites discussed above can impact microclimates within wetland sites and can affect habitats of associated fish and wildlife species. Changes to wetland hydrology may diminish suitable amphibian breeding, feeding, and rearing habitat (Hruby et al. 1998). Reduced cover and changes in plant species composition can influence invertebrate populations (Cyr and Downing 1988) and impact food sources, den/nest sites for aquatic mammals, birds, and amphibians (Hruby et al. 1998). Additionally, fish populations in waterways associated with harvested forested wetlands may be affected by increased sedimentation and hydrologic and temperature alterations.

A method of reducing impacts to forested wetland sites is to implement reduced harvest scenarios such as selective harvest, and to restrict equipment operation and yarding practices in these areas. Residual vegetation left behind after reduced harvest and associated activities would provide shading for wetland sites and act as a buffer to filter out sediments and pollutants (Broderson 1973; Corbett and Lynch 1985). Effects on wetland hydrology would be reduced in light harvest areas. As a result, impacts to fish and wildlife would be reduced.

Non-Forested Wetlands

Non-forested wetland habitats would not be harvested due to the lack of commercial timber within these areas. However, adjacent timber harvest may indirectly impact these sites through increased sedimentation from upslope timber harvest activities and potential reduction of shading from removal of adjacent trees. These disturbances could disrupt nutrient pathways, affect water temperatures, and affect hydrology within these non-forested wetlands, causing short-term indirect effects on water quality, vegetation composition, and microclimates.

A method of reducing impacts on wetlands from land management activities is to apply a protective buffer (i.e., Wetland Management Zone) around wetland sites. Characteristics of Wetland Management Zones, particularly slope and vegetative cover, directly influence zone effectiveness. The effectiveness of removing sediments, nutrients, bacteria, and other pollutants from surface water runoff increases with buffer width (FEMAT 1993). Although Wetland Management Zone protection distances from wetlands can vary markedly, depending upon site conditions, buffers of 100 feet or greater have been found to control coarse and fine sediments if channelization in the buffer zone does not occur (Broderson 1973; Corbett and Lynch 1985; Lynch et al. 1985). Additionally, buffers of at least 100 feet have been found to minimize water temperature fluctuations (Lynch et al. 1985). To protect wetland values for wetland-associated wildlife species, slightly larger buffers, ranging from 200-300 feet, may be needed (Washington Department of Wildlife 1992).

Wetland buffers (Wetland Management Zones) that are required under the alternatives are described in Table 4.7-3.

Table 4.7-3. Wetland Management Zone (WMZ) Characteristics By Alternative.

Wetland Type	Size of Non-forested Wetland (in acres)	No Action Alternative 1- Scenario 1 and Scenario 2, Alternative 2, and Alternative 3 Average WMZ Width (feet)	Alternative 4 Average WMZ Width (feet)
A (including bogs)	> 5	100	200
A (including bogs)	0.5 to 5	50	200
A (bogs only)	0.25 to 0.5	50	200
A (including bogs)	< 0.25	No WMZ required	No WMZ required
B	> 5	50	100
B	.5 to 5	25	100
B	0.25 to 0.5	No WMZ required	100
B	< 0.25	No WMZ required	No WMZ required
Forested		No WMZ required, some restrictions may apply	Leave 70 percent canopy closure, understory vegetation, snags, and non-merchantable trees.

Note: > means greater than; < means less than.
Source: Chapter 2, Subsection 2.3, Alternatives Analyzed in Detail.

Road and Landing Management

Road construction in wetland areas can directly impact wetland sites by permanently removing or eliminating the biological functions (i.e., water quality, hydrology, and fish and wildlife habitat) from the affected portion of the wetland (CH2MHill 2000). Additionally, crossing wetlands with roads, without adequate provision for cross-drainage, can lead to flooding on the upslope side and drainage changes on the downslope side of crossings (Stoeckeler 1967; Boelter and Close 1974). Road and landing construction and use can deliver sediment to wetlands, diminish water quality, and lead to the filling of wetland sites. Nutrient pathways within wetlands can also be affected (CH2MHill 2000).

Avoidance of wetlands during road and landing layout is a primary method for eliminating direct impacts to wetlands associated with road and landing establishment. Where wetlands cannot be avoided, a method of offsetting impacts from road construction includes the implementation of wetland replacement mitigation measures. Mitigation ratios may vary depending upon the type, size, and health of an affectedwetland site. Additionally, BMPs implemented during road and landing construction and use can minimize associated impacts to wetland sites. Road management options under the alternatives are outlined in Chapter 2 (Alternatives) (Washington Forest Practices Board 2001a, Appendix F).

Wetland Classification System

Wetland ecosystems in the United States occur under a wide range of climatic, geologic, geomorphic, and hydrologic conditions. This diversity of conditions makes the task of assessing wetland functions difficult because not all wetlands perform functions in the same manner, or to the same degree. Therefore, to simplify the assessment process, it is useful to classify wetlands into groups that function similarly. Classification narrows the focus of attention to: 1) the functions a particular type of wetland is most likely to perform, and 2) the characteristics of the ecosystem and landscape that control these functions. Classification provides a faster and more accurate assessment procedure, thereby providing land managers a better tool for identifying and protecting wetlands, or for mitigating for lost wetlands or wetland functions (water quality, hydrology, and fish and wildlife habitat).

Current Washington DNR wetland classification and mapping is based on the National Wetland Inventory (a.k.a. NWI) maps, which uses the Cowardin classification system (Cowardin et al. 1979). Wetlands are mapped and classified based on size, vegetative structure, and hydrology. A shortcoming of this classification system is that it does not identify functional values of wetland sites. In contrast, hydrogeomorphic classifications group wetlands on the basis of three fundamental characteristics: 1)geomorphic setting, 2) water source, and 3) hydrodynamics. At the highest level of the classification, wetlands fall into one of five basic hydrogeomorphic classes including: 1) depressional, 2) slope-flat, 3) riverine, 4) fringe, and 5) extensive peatland.

A hydrogeomorphic classification can be applied at a regional level to narrow the focus even further. The regions identified by Omernik (1987)~~, Bailey (1994),~~ or Bailey et al. (1994) are based on climatic, geologic, physiographic, and other criteria and provide a convenient starting point for applying the classification within a region. Any number of regional hydrogeomorphic wetland subclasses can be identified based on landscape scale factors such as geomorphic setting, water source, soil type, and vegetation. The number of regional subclasses identified depends on the diversity of conditions in a region and on assessment objectives.

A description of wetland mapping and classification provisions under the alternatives can be found in Chapter 2 (subsection 2.3, Alternatives Analyzed in Detail).

4.7.2.2 Evaluation of Effects of Alternatives on Wetland Processes

The effects of the alternatives on wetlands are analyzed in this subsection. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative no ITPs or ESA Section 4(d) take authorization would be issued. This lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1 [(No Action]) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on wetlands are likely to fall between these two scenarios.

<u>Timber Harvest</u>

Forested Wetlands

Under all the alternatives, forested wetlands may be harvested with some restrictions (Table 4.7-3). Harvest of forested areas on or adjacent to wetland sites would have the greatest short-term impacts on these resources by changing species composition, reducing stand density and shading, altering disturbance regimes, altering successional rates and pathways, altering hydrologic regimes, increasing undesirable vegetation, and altering nutrient/chemical cycles (Castelle et al. 1992; Harris and Marshall 1963; Darnell <u>et al.</u> 1976).

The greatest restrictions (protection) for forested wetlands would occur under Alternative 4 since a minimum of 70 percent canopy closure along with understory vegetation, snags, and non-merchantable timber would be retained. This harvest restriction associated with Alternative 4 would lessen impacts to wetlands, particularly hydrologic alterations and impacts on fish and wildlife habitat. Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, protection would be afforded to forested wetlands associated with non-forested wetlands sites. Harvest of forested wetlands that are surrounded by open water and emergent wetlands would require a plan approved in writing by Washington DNR. Additionally, under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, forested seeps and springs with an obvious connection to Type N perennial streams would be protected.

Wetland Management Zones and RMZs established under the alternatives would provide varying levels of incidental protection to forested wetlands sites. Many Wetland Management Zones and RMZs, which would be intended to protect non-forested wetlands or riparian zones, overlap with forested wetlands and, in this way, would provide incidental protection for forested wetlands as well. Reduced management could occur in these Wetland Management Zones and RMZs to varying degrees (subsection 2.3, Alternatives Analyzed in Detail); however, impacts to hydrologic, water quality, and fish and wildlife functions of incidentally protected wetlands would likely be reduced.

The greatest degree of incidental protection would occur under Alternative 4 where 52 percent of forested wetlands would be protected under established Wetland Management

Zones and RMZs followed by No Action Alternative 1-Scenario 1, Alternative 2 and Alternative 3 (27 percent), and No Action Alternative 1-Scenario 2 (20 percent) (Table 4.7-4). The high degree of incidental wetland protection provided under the alternatives would be mainly due to protection provided to riparian-associated wetlands through the establishment or RMZs. Incidental protection would also occur to non-forested wetland sites; however, because these sites are non-forested, no management activity in these areas is anticipated.

Table 4.7-4. Percent of Forested Wetlands in Sample Sections Incidentally Protected through Establishment of Wetland Management Zones and RMZs.

Alternative and Wetland Type	Percent of Wetlands Protected by WMZs Only			Percent of Wetlands Protected by RMZs Only			Percent of Wetlands Protected by Both WMZs and RMZs			Percent Total Incidental Protection
	East-side	West-side	State-wide	East-side	West-side	State-wide	East-side	West-side	State-wide	Statewide
No Action Alternative 1-Scenario 2	15	5	6	6	14	13	1	1	1	20
No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3	12	4	6	12	21	20	4	1	2	27
Alternative 4	13	9	10	27	35	34	20	7	8	52

Source: These estimates are based on an evaluation of wetlands and RMZs on sample sections conducted for the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a, Appendix G).

Non-forested Wetlands

Under all alternatives, non-forested wetlands would be provided varying levels of protection through the application of Wetland Management Zones. Wetland type and size determine the widths of Wetland Management Zones and their application (Table 4.7-3). The greatest level of protection to wetland sites would occur under Alternative 4 due to greater widths of established Wetland Management Zones, and application of a Wetland Management Zone for Type B wetlands between 0.25 and 0.5 acre (Table 4.7-3). Under this alternative, all Type A non-forested wetlands greater than 0.25 acre would receive a minimum average Wetland Management Zone of 200 feet, and all Type B wetlands greater than 0.25 acre would receive a minimum average Wetland Management Zone of 100 feet.

No Action Alternative 1-Scenario 1 and Scenario 2, Alternative 2, and Alternative 3 would provide similar levels of protection to non-forested wetland sites (Table 4.7-3).

As stated earlier, although site-specific characteristics of wetland sites dictate Wetland Management Zone requirements, in general, a protective Wetland Management Zone width of 100 feet or greater has been found to provide protection to wetland sites from hydrologic and water quality impacts including sedimentation and temperature alteration and water table fluctuations. Larger Wetland Management Zones may be required to provide protection to habitat for fish and wildlife species associated with wetland sites. Therefore, using this rationale, Alternative 4 would provide the greatest level of protection by providing Wetland Management Zones of 100 feet or greater to areas of Type A and B wetlands. Additionally, unlike Alternatives 1, 2, and 3, Alternative 4 would provide a Wetland Management Zone for Type B wetlands between 0.25 and 0.5 acre (Tables 4.7-3). No Action Alternative 1-Scenario 2 and Alternative 2 would provide less protection to non-forested wetland sites due to reduced Wetland Management Zone widths and Wetland Management Zone applications.

Management may also occur within established Wetland Management Zones under all the alternatives. Management activities within these Wetland Management Zones can reduce the functional value of the Wetland Management Zones. Additionally, timber harvest may indirectly impact wetlands through increased sedimentation from upslope timber harvest activities and potential reduction of shading from removal of adjacent trees. These disturbances can disrupt nutrient pathways within these wetland sites causing short-term indirect effects on water quality, vegetation composition, and fish and wildlife. Additionally, harvest of adjacent areas could initially increase water tables in harvested areas due to reduced transpiration from tree removal. However, if the Wetland Management Zone is revegetated quickly, impacts may be reduced. Consequently, long-term effects are expected to be minor. Additionally, some areas of the Wetland Management Zones are provided incidental protection by the establishment of RMZs. Prescriptions within RMZs are dependent upon water types and other site conditions.

Table 4.7-5 presents an estimate of the percent of Wetland Management Zones that overlap with RMZs, under each of the alternatives. Under Alternative 4 approximately 43 percent of Wetland Management Zones overlap established RMZs and, therefore, would be provided a high degree of incidental protection (Table 4.7-5). Under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3, approximately 27 percent would occur within RMZs. Under No Action Alternative 1-Scenario 2 approximately

Table 4.7-5. Percent of Wetland Management Zones in Sample Sections on Forestlands Incidentally Protected through the Establishment of RMZs Under the Alternatives.

Alternative	Percent of WMZ within RMZ (%)
No Action Alternative 1-Scenario 2	15
No Action Alternative 1-Scenario 1, Alternatives 2, and Alternative 3	27
Alternative 4	43

Source: These estimates are based on an evaluation of wetlands and RMZs on sample sections conducted for the Forest Practices Alternatives SEPA EIS (Washington Forest Practices Board 2001a, Appendix G).

15 percent would occur within RMZs. These Wetland Management Zones would be expected to receive fewer disturbances due to their inclusion in RMZs although the level of incidental protection in these areas would be dependent upon the specific prescriptions of the RMZs and location of the Wetland Management Zones in relation to the RMZs (i.e., core zone, inner zone, or outer zone of the RMZ).

Road Management

As stated earlier, road construction and use may have the greatest direct impact on wetland sites by permanently removing portions of the affected wetland from the landscape. Further, roads that cross wetlands without adequate provision for cross-drainage can lead to hydrologic changes (Stoeckeler 1967; Boelter and Close 1974). Additionally, sedimentation from road construction and use has been found to indirectly impact wetland ecosystems (Stoeckeler 1967; Boelter and Close 1974). To offset impacts to wetland sites from these actions, BMPs and wetland replacement mitigation is proposed under the alternatives.

Under No Action Alternative 1-Scenario 2 wetlands would be avoided during road and landing construction. If wetlands could not be avoided, impacts would be reduced by minimizing subgrade width and spoil areas. Applications that propose to fill or drain more than 0.5 acre of an individual wetland (Class IV-special) would require an accurate wetland delineation and replacement of the lost wetland functions. This would be accomplished by replacing the lost wetland functions by enhancement of existing wetlands or creation of new wetlands, generally on an acre-for-acre basis and of the same type and in the same general location.

No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would contain the most stringent protection/mitigation measures by implementing a policy of no net loss of wetland functions following road and landing construction. Under these alternatives, roads could not be constructed in bogs or fens or in wetlands if substantial loss or damage to wetland functions or acreage would occur. Additionally, accurate wetland delineations must be performed if road or landing construction would fill or drain more than one-tenth of an acre of wetland, which would better quantify wetland impacts than No Action Alternative 1-Scenario 2. Filling or draining more than 0.5 acre of a wetland would be classified as a Class IV-special action and would require replacement by substitution or enhancement of the lost wetland functions, generally on a two-for-one basis of the same type and in the same general location. Additionally, sediment deposition to wetland sites would likely be reduced (compared to No Action Alternative 1-Scenario 2) during road and landing construction and use due to the implementation of new BMPs (Washington Forest Practices Board 2001a, Appendix F).

Classification System and Wetland Mapping

As described earlier, the current wetland classification and mapping system (No Action Alternative 1-Scenario 2) used by Washington DNR is based on the National Wetland Inventory system. This wetland classification system does not identify functions of wetland types within the affected landscape, and therefore, is a less effective tool for evaluating wetland impacts or for developing protection or mitigation measures.

Under Alternative 4, a new wetland classification system, likely hydrogeomorphic, would be adopted. A hydrogeomorphic system could provide additional protection to wetland areas by identifying functions of wetland types within the landscape, thereby providing a mechanism for implementing appropriate protection measures. This system could provide a tool for comparing project alternatives and pre- and post-project conditions for determining impacts. Additionally, it could compare mitigation success to provide guidance for avoiding and minimizing project impacts and to determine mitigation requirements.

Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, landowners would be required to perform additional wetland mapping procedures (Chapter 2, Alternatives) (Washington Forest Practices Board 2001a, Appendix G). The Washington DNR would incorporate the mapped wetlands into a GIS layer. This increased mapping effort would enhance the ability to apply wetland protection measures outlined in the Washington Forest Practices Rules.

Summary of Alternatives

Overall, Alternative 4 would provide the highest level of protection for wetland resources due to Wetland Management Zone and RMZ widths and the level of forested wetland protection. For road and landing construction, No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would provide greater protection to wetlands than No Action Alternative 1-Scenario 2 by implementing a policy of no net loss of wetland functions, outlining higher replacement mitigation ratios for wetlands (of 0.5 acre in size) that are filled or drained, and avoiding roads and landings in bogs and fens. Additionally, No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would require accurate delineation of wetlands where impacts to wetlands would be 0.1 acre or more. These alternatives would also reduce potential sedimentation of wetland sites through the application of new BMPs.

Alternative 4 would mandate the adoption of a new classification system that would incorporate the evaluation of wetland functions, thus providing a better tool for evaluating wetland impacts and designing wetland protection and mitigation measures. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide more protection than No Action Alternative 1-Scenario 2 because these alternatives would mandate the mapping of select wetland types and would incorporate these into a Washington DNR GIS database that would provide data for wetland evaluation and protection measure development.

To some extent, wetland functions (i.e., hydrology, water quality, and fish and wildlife habitat) would be allowed to be reduced under all the alternatives since forested wetlands may be harvested; however, wetland impacts under Alternative 4 would be expected to be less due to the 70 percent canopy retention in forested wetlands. Non-forested wetlands receiving a Wetland Management Zone of less than 100 feet may be impacted by adjacent timber harvest. However, these functions would likely be reduced for the short-term if the wetland sites or Wetland Management Zones become revegetated. All of the alternatives would contain provisions for mitigating wetland loss due to road and landing construction. However, "no net loss" of wetlands or wetland functions due to road or landing construction would be anticipated only under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4.

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4.8 FISH AND FISH HABITAT

4.8.1 Introduction

The Washington Forest Practices Rules are designed to protect public resources while maintaining an economically viable commercial forest industry (Washington Forest Practices Board 2001c, 2002). Public resource protection includes maintaining aquatic habitat and fish populations at levels that comply with the ESA. Evaluation of the potential effects of the alternatives on fish and aquatic habitat was based on two factors:

- Management approaches under each alternative in riparian and upslope areas.
- Habitat needs and biological requirements of listed and covered fish species.

This analysis addresses the effects on all species (subsection 3.8, Fish and Fish Habitat). Salmonids are emphasized in the analysis because: 1) they include all species listed as federally threatened or endangered in the analysis area, 2) they are covered species in the FPHCP, 3) they are present within covered lands, and 4) they are typically most sensitive to forest practices impacts and, therefore, determination of the relative effects of alternatives on the habitats of these species should be a conservative indicator of effects on other covered species. Also, the evaluation criteria primarily relate to the maintenance or improvement of aquatic ecosystems, which is beneficial for all aquatic species. Deviations from this general approach are noted.

Aquatic habitat in the planning area is extensive and complex. Current freshwater habitat conditions in many areas do not meet requirements for covered fish species. For example, at certain times of the year (e.g., during late summer), water temperatures in some streams exceed levels suitable for salmonid species (MacDonald et al. 1991). This is often associated with lack of streamside vegetation to provide shading. Reduced shade can increase water temperature, but it can also be influenced by other factors such as weather conditions, air temperatures, elevation, water withdrawals, and groundwater inflow (Adams and Sullivan 1989; Beschta 1997a; Beschta et al. 1987).

The nearshore marine and estuary conditions in Washington State have been severely modified. Many freshwater fish species rear or pass through these areas during their life cycle (subsection 3.8, Fish and Fish Habitat). Approximately, 39 percent of coastal wetlands and 70 percent of Puget Sound emergent wetlands have been lost due to human development (Palmisano et al. 1993). All of the major estuaries in Puget Sound, except the Nisqually River, have undergone major modification including dredging, diking, and filling, which has reduced the quantity and quality of rearing habitat for many species including many salmonids (DEIS Appendix A). Other estuaries along the coast and Columbia River have also had substantial modifications.

In a broad sense, management approaches under each alternative are expected to affect aquatic habitat and nearshore marine conditions in similar ways. However, the magnitude of the effects may be different depending upon site-specific conditions. For example, conditions in some areas may be at or near levels that would support healthy populations of covered fish species, and a change in management approach might not appreciably change those conditions. This is particularly true for regions of the State that do not have much State or commercial forestlands or that lack covered species for reasons unrelated to forest practices. In contrast, conditions in water quality limited streams may be less capable of fully supporting populations of covered fish species, and management changes could substantially change those conditions.

Predicting aquatic habitat conditions under a specific alternative is difficult, particularly if predictions are long term and could include significant changes in the Washington Forest Practices Rules resulting from adaptive management. To varying degrees, adaptive management is incorporated under all alternatives (subsection 4.1.5, Adaptive Management). The reason for this difficulty is the complex and dynamic nature of the aquatic systems and their surrounding terrestrial environments.

Trends in aquatic habitat conditions also involve temporal considerations. For example, many covered fish species such as most salmon and trout, have a relatively short life cycle (usually less than 6 years). In areas where habitat is degraded, habitat restoration would only begin to take effect after a longer period (greater than 10 years). Therefore, specific populations of fish species may encounter less than desirable habitat conditions before any management measures become effective. However, an improvement in any factor that limits aquatic habitat during the short term (e.g., a reduction in stream temperatures) should establish a trend toward more favorable conditions for maintaining or recovering fish species.

When predictions cannot be precisely made, as is the situation when applying any of the alternatives to the planning area, monitoring is often required to determine if a trend toward favorable or target conditions is occurring and the strength of that trend. For example, monitoring of water temperature at various locations over a number of years would provide the information needed to determine if a trend toward lower summer temperatures is correlated with growth of streamside vegetation.

Evaluation of the environmental consequences for aquatic resources focused on the strength of the trends that management conditions would have in achieving target conditions under each alternative. A strong trend in changes leading to attainment of target conditions would indicate that maintaining or restoring fish populations is more probable than under weaker trends. Even with conditions meeting requirements for a properly functioning aquatic system, however, no certainty exists that current populations would be maintained or recover because of off-site factors (e.g., ocean conditions, harvest, and non-forestland use practices).

For any particular alternative, predicting population numbers for any salmon species is difficult. It is also difficult to predict the degree to which other factors (e.g., ocean conditions, predation, disease, harvest, or competition) affect populations. Therefore, the assessment of potential effects focuses on habitat requirements. If habitat is properly functioning, then other factors need to be assessed to determine why Pacific salmon and other salmonid species may either be depressed or at risk of extinction.

Full protection across a landscape may not be necessary to maintain a properly functioning aquatic system and to safeguard fish species or populations. A point exists beyond which, for example, the width of an RMZ would not provide additional benefit from an aquatic habitat standpoint. For instance, stream buffers greater than about 0.75 site potential tree height on most streams would not provide additional shade to maintain or recover stream temperatures (subsection 4.7.1, Riparian Processes). Less than full protection can achieve target conditions because it is the complete set of protection measures (both riparian and upland) that must be considered. In addition, forest practices often occur within a mosaic of other land uses that provide different levels of protection. For example, private or State timberlands can be adjacent to National Forest lands that are managed to meet different goals under the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994). Prescriptions that provide substantial LWD, detrital input, shade, coarse and fine sediment control, and streambank stability, for example, can set a trend toward achieving target conditions and a properly functioning aquatic system.

This subsection relies on the conclusions of several other subsections. This is because the threshold of significance for fish and aquatic habitat must consider the effects of an aggregate of management prescriptions under each alternative. For example, the amount of LWD that is recruited to a stream is determined by RMZ width and the number of trees retained within the zone (subsection 4.7.1, Riparian Processes). Similarly, changes in erosion and sediment from upslope areas or from roads also directly affect aquatic habitat conditions (subsection 4.4, Geology, Soils, and Erosional Processes, and subsection 4.7.1, Riparian Processes). Evaluation criteria for measuring effects from riparian and upslope management are identified below in subsection 4.8.2 (Evaluation Criteria).

The following subsection (subsection 4.8.2, Evaluation Criteria) evaluates these individual criteria and aggregates their overall effects on the aquatic system to determine if an individual alternative is likely to achieve target conditions (i.e., properly functioning aquatic system) and does not threaten individual fish species or fish populations. The concluding subsection (subsection 4.8.4, Synthesis by Region) places lands regulated under the Washington Forest Practices Rules in perspective with other practices that affect the viability of Pacific salmon, trout, and other fish species.

4.8.2 Evaluation Criteria

Issues relevant to fish resources were identified during the scoping process described in Chapter 1 (Purpose and Need). The issues were categorized according to the NMFS matrix of pathways and indicators of a properly functioning aquatic ecosystem (NMFS 1996a); the pathways and indicators are relevant to most anadromous and non-anadromous fish species. A few special habitats were added to this matrix, including lakes, reservoirs, and nearshore marine habitat. These areas provide important habitat for fish that were not directly assessed in the NMFS matrix (which was primarily directed at watershed activities away from marine or lake environments). The issue categories evaluated here includes the following:

- Coarse sediment
- Fine sediment
- Hydrology
- Large woody debris
- Leaf/needle litter recruitment
- Floodplains, off-channel areas, and the hyporheic zones
- Lakes, reservoirs, and nearshore marine areas
- Water temperature
- Dissolved oxygen
- Forest chemicals
- Fish passage

Evaluation criteria were identified for each of the issues and are used to compare and contrast the likely effects of implementing each of the alternatives. As described earlier, the measures used in this subsection are drawn primarily from analyses described in other subsections of this document and from DEIS Appendix A, Regional Summaries, which include details on current conditions by region. The goal of this chapter section is to synthesize and examine these measures and others as they relate to covered fish species and a properly functioning aquatic ecosystem. The following is a brief description of the issues and their measures and criteria. Most of the descriptions will refer the reader to previous subsections where more complete descriptions have been provided.

4.8.2.1 Coarse Sediment

Coarse sediment (particles typically larger than sand) affects the amount of spawning habitat, pool filling, bank stability, and stream hydrology (Spence et al. 1996) (subsection 3.8.3.1, Fine Sediment). The four alternatives address management-related coarse sediment inputs by preventing or minimizing accelerated coarse sediment production from mass wasting and reducing coarse sediment production from roads and culvert failures.

The effects of the alternatives on coarse sediment production from mass wasting and roads were evaluated in subsection 4.4 (Geology, Soils, and Erosional Processes). Mass wasting was evaluated by comparing the strategies used in defining and detecting unstable slopes and landforms during the forest practices application review process and by comparing the measures used in avoiding and mitigating management-related mass wasting. Coarse sediment production from roads was analyzed by qualitative evaluation of road management practices under the alternatives.

4.8.2.2 Fine Sediment

High levels of fine sediment in streams can be detrimental to the survival of eggs and fry incubating in redds (Iwamoto et al. 1978; Chapman 1988; Chapman and McLeod 1987;

Gregory and Bisson 1997). Increases in fine sediment can also affect stream morphology, which can affect water temperature (subsection 4.8.2.8) (Rashin et al. 1999; Sullivan et al. 1990). Sources of fine sediment include hillslope erosion, surface erosion from roads, streambanks, mass wasting, and culvert failure (Furniss et al. 1991; Chamberlin et al. 1991; Swanson et al. 1987). Vegetation in RMZs provides filtering of fine sediments from upslope areas and stability to streambanks. Overbank sediments are trapped by roughness elements such as vegetation and downed woody debris (Johnson and Ryba 1992; FEMAT 1993; Belt et al. 1992; Gregory et al. 1991).

The effect of the alternatives on hillslope erosion and bank stability was evaluated in subsection 4.4 (Geology, Soils, and Erosional Processes). Hillslope erosion was evaluated by comparing the percent of riparian vegetation that is protected under the different management prescriptions for the different stream types and regions using the sediment equivalent buffer area index. The bank stability evaluation was based upon the percentage of the riparian area that is protected by different management prescriptions.

Improperly constructed and maintained forest roads can also be an important source of fine sediment (Furniss et al. 1991; Chamberlin et al 1991; Spence et al. 1996). Furthermore, stream crossings can be the location of direct delivery of fine sediment to streams (Furniss et al. 1991; Swanson et al. 1987). Numerous factors can affect the production and delivery of fine sediment from roads including the number of road miles, the construction materials, road drainage structures, the level of use and maintenance, and the number of stream crossings (subsection 4.4, Geology, Soils, and Erosional Processes) (Furniss et al. 1991; Swanson et al. 1987).

4.8.2.3 Hydrology

The amount of timber harvest in a watershed and the forest road density can affect the hydrologic regime of a stream. Particularly in rain-on-snow regions, immature forest stands and high road densities can result in higher frequency and higher magnitude peak flows (Spence et al 1996; Chamberlin et al. 1991). This issue was evaluated for the alternatives in subsection 4.5.2 (Surface Water Quantity) by considering the effect of the alternatives on the percentage of a watershed that can be harvested and on limiting road densities.

4.8.2.4 Large Woody Debris

LWD is one of the most important components of high quality fish habitat affecting nutrients, food, cover, and channel morphology (Dolloff and Warren 2003; Zalewski ~~and Lapinska~~ et al. 2003; Bilby and Bisson 1998; Spence et al. 1996; Beechie and Sibley 1997; Gregory et al. 1991). The effects of the alternatives on LWD recruitment have been evaluated previously in the Riparian Processes subsection (subsection 4.7.1) using the LWD equivalent buffer area index as a comparative tool.

4.8.2.5 Leaf/Needle Litter Recruitment

Harvest within or near riparian zones can affect the recruitment of leaf and needle litter, an important nutrient source for forested streams (Bilby and Bisson 1992). Effects of the alternatives on leaf and needle litter recruitment have been evaluated previously in the

Riparian Processes subsection (subsection 4.7.1) using 0.5 site potential tree height as a criterion for protecting most leaf and needle litter inputs to streams.

4.8.2.6 Floodplains, Off-channel Areas, and the Hyporheic Zone

Floodplains and off-channel areas are an important component of aquatic habitat and include side channels, backwater alcoves, ponds, and wetlands. These areas are often associated with significant hyporheic zones, as they commonly occur with alluvial conditions that are often found in floodplains and off-channel areas (Edwards 1998; Naiman et al. 2000). Hyporheic zones are the saturated sediment region under and along streams. As noted in subsection 3.8.4.6 (Floodplains, Off-channel Habitats, and Hyporheic Zones), hyporheic zones often connect between groundwater and surface water and often supply important habitat for hyporheic organisms such as insects, bacteria, and fungi (Edwards 1998; Naiman et al. 2000). The effects of the alternatives on floodplain and off-channel areas were evaluated in the subsection 4.4 (Geology, Soils, and Erosional Processes), and, in the case of the hyporheic zone, in subsection 4.5.3.2 (Groundwater). Evaluations were based upon a qualitative analysis of the different prescriptive features of the alternatives.

4.8.2.7 Lakes, Reservoirs, and Nearshore Marine Areas

Lakes, reservoirs, and nearshore marine areas have some common features that need to be maintained to ensure protection of native anadromous and freshwater fishes. Lakes and reservoirs supply rearing, spawning, and migratory habitat for many fishes, while nearshore marine areas are primarily of importance as habitat for juvenile salmonids and baitfish (Wydoski and Whitney 2003; Groot and Margolis 1991; Emmett et al. 1991). The shallow water regions of all these areas may include rearing habitat for juvenile species and, in some cases, spawning (e.g., for kokanee or sockeye in some lakes) (subsection 3.8.2, Life History of Affected Species; FPHCP Chapter 3).

The recruitment of LWD to all these areas contributes organic input to the system but also influences the development of habitat structure for potential fish rearing habitat. The rate and type of sediment accumulation in the shallows also influences habitat, foodwebs, and production (Simenstad et al. 1979). The maintenance of estuarine habitat through sediment and LWD inputs is important. For example, Collins et al. (2002) reported that large wood jams in major Puget Sound estuaries historically influenced intertidal channel formation, pool depth, and sediment distribution. Also, excessive sedimentation in lakeshores has been found to adversely affect spawning sockeye salmon (McHenry et al. 1996). The criteria used to evaluate the effects of the alternatives on these areas is the degree to which each alternative protects LWD recruitment, especially in the larger fish-bearing streams and lake shores, and how well each controls sediment input.

4.8.2.8 Water Temperature

As described in subsection 3.8.1 (Fish and Fish Habitat, Introduction), Pacific salmon and trout require cool, clean water to thrive (subsection 3.8.2, Life History of Affected Species) (Washington Department of Ecology 2002a; Bjornn and Reiser 1991). Stream shade is important in regulating stream temperatures (subsection 4.5.1, Surface Water

Quality). The effect of the alternatives on shade levels has been evaluated in the Riparian Processes subsection (subsection 4.7.1.2) by comparing the retention of riparian vegetation under the different management prescriptions for the different stream types and regions.

4.8.2.9 Forest Chemicals

Presence of pesticides used to control undesirable plants, insects, and fungi may also affect fish production and water quality (Spence et al. 1996). Pesticide use is an important management tool for speeding reforestation by reducing competition and disease. Pesticide use under each alternative is described and evaluated in subsection 4.5.1 (Surface Water Quality) and subsection 4.5.3 (Groundwater). For evaluation of this water quality component, minimum buffer widths along surface waters were used as the evaluation criterion (Note: The reader is reminded that forest chemical activities are not included as a proposed covered activity in the State's application for incidental take authorization).

4.8.2.10 Dissolved Oxygen

High and consistent dissolved oxygen levels are critical for all life stages of salmon and trout (Spence et al. 1996). Acceptable dissolved oxygen levels vary by life stage, but one of the most critical areas for maintaining dissolved oxygen levels is in the stream gravels during egg deposition and intergravel development and growth of alevins and fry. Generally, higher levels in the water column are needed to ensure adequate levels are present in the gravel for egg and alevin development (Hicks 2002). Factors reducing dissolved oxygen concentration include increased sediment deposition (for intergravel concentrations), increased stream temperature, and substantially increased nutrient levels or high amounts of easily decaying organic debris (Welch ~~et al. 1998~~and Lindell 1980; Spence et al. 1996). Alternatives that maintain these parameters at low or acceptable levels would most likely maintain adequate dissolved oxygen levels. Evaluation of the alternatives was tied to likelihood of increased fine sediment inputs and stream temperatures.

4.8.2.11 Fish Passage

Barriers to fish passage from road crossings affect the ability of fish to access available habitat (U.S. General Accounting Office 2001; Furniss et al. 1991; Palmisano et al. 1993). Historical road building under much less protective forest practices rules is thought to have led to many fish barriers and associated habitat loss. Current fish distribution is generally recognized to be more limited than historical distribution. Criteria for construction of stream crossing structures are currently based, in part, on whether a stream is fish-bearing (WAC 222-24-040). For example, culverts must have a minimum diameter of 24 inches for streams with anadromous fish and a minimum diameter of 18 inches for streams with resident game fish. Therefore, the assumptions made in determining if a stream is fish-bearing are critical for the construction of new stream crossings and for evaluating whether existing stream crossings meet current Washington Forest Practices Rules.

Fish passage also can be affected by stream flow, water temperature, and suspended and bedload sediment delivery and routing through streams (subsection 3.8.4.10, Fish Passage). However, these effects are temporally and spatially difficult to assess as affected by forest practices.

Evaluation of the potential effects of the alternatives on fish passage will be based primarily on how the rules modify stream typing assumptions and the effect this will have on new stream crossing construction and treatment of existing structures. The measure to be utilized will be the proportion of stream miles that are considered fish-bearing versus non-fish-bearing stream miles. In addition, a qualitative comparison will be made of alternative programs for decommissioning and maintaining roads and replacing problem culverts.

4.8.3 Evaluation of Alternatives

As with the other resources, expected effects on fish and their habitats can most readily be compared if the alternatives are discussed in three distinct alternative groups since the most pronounced differences are based on management of riparian buffers, which do not vary among all alternatives. The three groups are: 1) No Action Alternative 1-Scenario 2; 2) No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3; and 3) Alternative 4. This subsection presents a synthesis of the results of the alternative evaluations for each issue as they relate to the fish resource. The effects of the alternatives on the 11 fish and fish habitat issues identified above, are analyzed in this subsection.

In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, No Action Alternative 1) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on each of these issues are likely to fall between these two scenarios. With respect to Alternative 4, the level of resource protection provided depends on the rate at which landowners convert forestland to other uses. These other uses would most likely result in negative impacts to fish and their habitat. However, the following discussion of impacts on fish and their habitat resulting under Alternative 4 focuses on the benefits to fish from more protective Forest Practices Rules, because the rate of forestland conversion is difficult to predict.

4.8.3.1 Coarse Sediment

Overview of Effects

The effects of the alternatives on coarse sediment delivery are analyzed in this subsection. It is important to note that, from an historical perspective, coarse sediment delivery to streams has been substantially reduced over time because of improvements in road construction methods, the frequency of maintenance, and the implementation of BMPs (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). Therefore, compared to baseline conditions, coarse sediment delivery and the resulting effects on fish habitat is not expected to increase under any of the alternatives, although the rate of reduction would vary substantially. The following paragraphs address the degree to which each alternative would affect coarse sediment delivery.

No Action Alternative 1-Scenario 2 would result in a moderate likelihood of coarse sediment delivery from harvest and road-related mass wasting events. The likelihood would be somewhat reduced where Watershed Analysis occurs due to the development of management prescriptions that address coarse sediment inputs. Relative to the other alternatives, No Action Alternative 1-Scenario 2 would have the highest rate of coarse sediment input.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, would all result in a low to moderate likelihood of coarse sediment delivery due to wider buffers and improved harvest and road maintenance practices relative to No Action Alternative 1-Scenario 2. However, existing roads would have a moderate likelihood of coarse sediment delivery in the short term since RMAP implementation would not be complete until 2016. Higher levels of protection would result in less streambed aggradations resulting from forest practices and a reduction in the likelihood of habitat degradation from pool filling and modified channel capacity.

The likelihood of coarse sediment delivery would be low for Alternative 4, because it includes extensive no-harvest buffers, an accelerated schedule for implementing RMAPs, and no net increase in road densities. Relative to all other alternatives, Alternative 4 would have the lowest rate of coarse sediment input. A detailed analysis of the alternatives is presented in the following subsection.

Detailed Effects Analysis

Coarse sediment delivery to streams primarily originates from two sources: 1) mass wasting and 2) streambank erosion (Spence et al. 1996; Swanston 1991). Mass wasting can deliver large, but infrequent inputs of coarse and fine sediment to streams (Swanston 1991; Swanson et al. 1987). In contrast, streambank erosion can be a chronic problem resulting from changes in riparian root-strength and/or hydrology (Swanston 1991; FEMAT 1993; Montgomery and Wohl 20034). Mass wasting is a natural phenomenon that occurs in watersheds without any major land-use activities. Both mass wasting (including debris flows) and streambank erosion are natural processes and can be important sources of coarse sediment and LWD to streams (Swanston 1991; Reeves et al. 2003; Benda et al. 2003; Swanson et al. 1987). However, forest practices have been shown to increase the frequency of mass wasting and the level of streambank erosion.

The two main management-related factors that contribute to increased mass wasting and streambank erosion are timber harvest and roads (Swanston et al. 1987; Chamberlin et al. 1991; Furniss et al. 1991; Spence et al. 1996). Timber harvest on unstable slopes can increase the potential for mass wasting by reducing tree root strength that helps maintain soil cohesion. Forest roads can increase mass wasting by reducing the structural strength of soil materials, concentrating water drainage in high hazard areas, and creating conditions that result in culvert failures. Because the initiation point of road-related mass wasting can occur at stream crossings, adverse effects to streams from a large quantity of sediment and debris over a short period is often more severe than hillslope mass wasting that does not directly enter streams, or only does so gradually.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the rate of harvest-related and road-related mass wasting events under the Washington Forest Practices Rules in effect on January 1, 1999 is expected to continue, and the likelihood of mass wasting would be considered moderate (subsection 4.4, Geology, Soils, and Erosional Processes). New roads crossing unstable slopes require Class IV-Special permits, but no standardized method is currently in use for identifying unstable slopes. Currently, to the extent possible, unstable slopes are identified in Watershed Analysis and through forest practices application review. Existing roads would only be upgraded following Watershed Analysis or as part of a forest practices application. Infrequently used roads greater than 10 years old and orphaned roads would continue to be at high likelihood of failure in some areas.

Streambank stability is also likely to be periodically reduced along all westside and eastside streams subject to adjacent harvest. Fish-bearing streams (Types 1 to 3) would have some protection provided by RMZs, but selective harvest within the RMZs would result in less than full protection. In addition, Type 4 and 5 waters would have no protection resulting from RMZs. Depending on tree species, loss of root strength and decline of streambank stability after timber harvest can take as long as 5 years while restoration of stability from new tree and vegetation growth may take more than 12 years.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Relative to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would offer greater protection from harvest-related mass wasting because a more-refined and uniform screening method would be implemented. Greater success in identifying high hazard slopes should result in more Class IV-special applications, greater environmental review, and implementation of more restrictive harvest prescriptions for these areas. Overall, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are rated as having moderate potential for harvest-related mass wasting.

Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, substantial improvements would occur in the planning and construction of new roads. Relative to No Action Alternative 1-Scenario 2, more new roads planned for potentially unstable slopes (based upon new Washington DNR hazard maps) would require a Class IV-special application that would result in greater environmental review. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would also require the preparation of RMAPs. RMAPs would require inventories of roads and schedules and plans for correcting identified problems. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would also require road upgrades to new standards within 10 to 15 years. Relative to roads, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are considered to have low to moderate likelihood of adverse effects. Some coarse sediment delivery to streams from forest roads would likely occur regardless of management activities; however, the frequency and magnitude of events should be substantially reduced.

Under both harvest prescription options, No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 would provide substantial streambank protection compared to No Action Alternative 1-Scenario 2, but would not provide full protection. Changes in the stream typing system (See Fish Passage information below) and the presence of no-harvest core zones would substantially increase the number of Type F and S stream miles that receive a relatively high level of protection. However, up to 50 percent of Type N_P stream reaches and all Type N_S reaches would receive no protection from harvest, but would have Equipment Limitation Zones. Consequently, a moderate likelihood of coarse sediment delivery due to accelerated streambank erosion would exist for Type N streams.

Alternative 4

Alternative 4 has higher protection to streams from harvest-related mass wasting events compared to both scenarios of No Action Alternative 1 and Alternatives 2 and 3 because it includes wider no-harvest buffers on all streams and greater restrictions on activities on unstable slopes. Alternative 4 also requires a cap on road densities at current levels. Alternative 4 would provide for complete bank stability (erosion) functions of riparian vegetation for nearly all streams. The RMZ widths proposed under this alternative are at least 70 feet and exceed the criterion for full protection of streambank stability (i.e., 0.3 site potential tree height) under most situations. In addition, the RMZs would include a no-harvest prescription. Consequently, Alternative 4 is rated as having a low likelihood of coarse sediment delivery due to accelerated streambank erosion, compared to No Action Alternative 1-Scenario 1 and No Action Alternative 1-Scenario 2.

4.8.3.2 Fine Sediment

Overview of Effects

The effects of the alternatives on fine sediment delivery are analyzed in this subsection. It is important to note that, from a historical perspective, fine sediment delivery to streams has been substantially reduced over time because of improvements in road construction methods, the frequency of road maintenance, and the implementation of BMPs (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). Therefore, compared to baseline conditions, the amount of fine sediment delivery and resulting effects on fish habitat is not expected to increase under any of the alternatives although the rate of reduction would vary substantially. The following paragraphs address the likelihood of fine sediment delivery and associated effects by alternative in a comparative manner

Considering both harvest-related and road-related management prescriptions (See below), No Action Alternative 1-Scenario 2 would result in a high likelihood of fine sediment delivery and associated adverse effects relative to all other alternatives.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in a low to moderate likelihood of fine sediment delivery and associated adverse effects primarily because of the requirements for RMAPs and road upgrades. However, there is a high degree of uncertainty regarding the effectiveness of protection measures along Type N streams under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Although No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide substantial improvements over No Action Alternative 1-Scenario 2, none of the alternatives would be expected to eliminate all management-related fine sediment delivery.

Alternative 4 would result in a low likelihood of fine sediment delivery and associated effects because no-harvest buffers would be more extensive, RMAP implementation would be accelerated, and because it includes a “no net increase” clause for road density. Otherwise, protections are similar to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. The likelihood for sediment delivery would be reduced relative to all other alternatives, but not eliminated. A detailed analysis of the alternatives is presented in the following subsection.

Detailed Effects Analysis

Fine sediment loading to streams affects the quality and quantity of spawning and rearing habitat by filling in the spaces between gravels and cobbles and by filling pools (Hicks et al. 1991; Everest et al. 1987; Cedarholm and Reid 1987). Similar to coarse sediment loading, fine sediment production is related to both timber harvest and road management practices (Furniss et al. 1991; Spence et al. 1996). Vegetation in riparian zones is important for filtering and retaining fine sediment eroding from hillslope areas (Naiman et al. 1998). Similar to coarse sediment, some fine sediment is delivered to streams during infrequent mass wasting events (Furniss et al. 1991). In addition, roads can be a chronic source of fine sediment from surface erosion, and harvest activities can contribute to increases in hillslope erosion (Furniss et al. 1991; Hicks et al. 1991; Everest et al. 1987).

The sediment equivalent buffer area index was calculated for the proposed management prescriptions under the three alternative groupings. The sediment equivalent buffer area index values are standardized as percentages with the maximum equivalent buffer area index of 100 percent defined for a no-harvest condition and a clearcut providing a 60 percent value (Figures 4.4-1 and 4.4-2).

Many watersheds are currently at road densities considered too high for a properly functioning aquatic ecosystem (less than 2 miles/mile^2 , NMFS 1996a; less than 1 mile/mile^2, USFWS 1998a). Information on existing road density is contained in subsection 3.4.2.2 (Forest Practices Effects on Erosion and Sedimentation) and DEIS

Appendix D (Road Density). Increases in road density have been negatively correlated with the occurrence of and number of bull trout redds of bull trout (Baxter et al. 1999; Ripley et al. 2005). However, road density criteria should be viewed with caution because the functional relationship between road density and effects to the aquatic ecosystem can vary among different watersheds depending upon watershed characteristics (soil, climate, and topography) and characteristics of the road system (age, usage, and level of maintenance). Nevertheless, road density can be a useful descriptor to enhance understanding of the overall level of disturbance to a watershed. Road density is one of 19 physical indicators recommended by the Services to assess a properly functioning aquatic ecosystem, including several that evaluate road effects more directly (e.g., sediment and channel condition).

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the equivalent buffer area index for sediment was calculated at 65 to 78 percent of the maximum equivalent buffer area index (full protection) for all westside streams and at 67 to 76 percent for all eastside streams. This is dependent upon the buffer width criteria that is assumed to fully filter fine sediment from hillslope surface erosion (i.e., 30 feet or 200 feet) (DEIS Appendix B). Consequently, No Action Alternative 1-Scenario 2 would result in a high likelihood of fine sediment delivery resulting from hillslope erosion.

Under No Action Alternative 1-Scenario 2, the approach to road management is based primarily upon the implementation of BMPs that were approved by Ecology and described in the January 1, 1999 Washington Forest Practices Rules and the Washington Forest Practices Board Manual (Washington Forest Practices Board 2001c, 2002; Washington Forest Practices Board 2001b). In addition, many of the rules include discretionary language by encouraging, but not requiring, certain activities. A study on the effectiveness of these BMPs found that many practices were ineffective even when implemented according to standards and guidelines (Rashin et al. 1999). Other activities, such as preparation of an RMAP or additional maintenance on culverts only occur when required by Washington DNR. However, there are no descriptions of specific triggers that would prompt Washington DNR to require these activities. Under the Washington Forest Practices Rules for No Action Alternative 1-Scenario 2, there is little incentive for landowners to abandon (i.e., close and remediate) roads. Consequently, many roads would remain in an inactive status with minimal maintenance. Roads built before 1974 and unused since 1974 have been termed “orphan” roads. The Washington Forest Practices Rules under No Action Alternative 1-Scenario 2 would have no policies directed towards management of orphan roads. Consequently, No Action Alternative 1-Scenario 2 is considered to pose a high likelihood for fine sediment delivery from roads.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

The sediment equivalent buffer area index (Figures 4.4-1 and 4.4-2) suggests that No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide about 73 to 91 percent protection relative to no-harvest for westside streams and 71 to 88 percent for eastside streams, depending on the evaluation criterion (i.e., buffer width of 30 feet or 200 feet). No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide a relatively high level of sediment filtering capacity. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide substantially more sediment filtering protection than No Action Alternative 1-Scenario 2.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would require large forest landowners to fully implement RMAPs by December 2016 if Watershed Analysis has not been completed within that watershed; and upgrades identified in the RMAPs must also be completed by 2016. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, corrections of problem orphan roads would begin after all large landowner RMAPs have been submitted, the hazard reduction statute RCW Chapter 76.09.300 has been evaluated, and determination of need for public funding for repair or abandonment of orphan roads has taken place. Small landowners would also be required to prepare RMAPs, but would not be required to submit them until they file a forest practices application with Washington DNR.

An important component to RMAP preparation is review. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, RMAPs would be open to review by WDFW, tribal entities, and Ecology. However, the authority to require changes to an RMAP would be held solely by Washington DNR. Thus, the requirements to address roads and sediment delivery under No Action Alternative 1-Scenario (and Alternatives 2 and 3) would result in low to moderate likelihood of fine sediment delivery and associated adverse effects primarily because of the requirements for RMAPs and road upgrades; a substantial improvement over No Action Alternative 1-Scenario 2.

Alternative 4

Under Alternative 4, the sediment equivalent buffer area index would be 91 to 100 percent for the westside and 94 to 100 percent for the eastside. The sediment index suggests that Alternative 4 would provide at or near the maximum level of sediment filtering capacity; more than No Action Alternative 1-Scenario 1, and substantially more than No Action Alternative 1-Scenario 2.

In contrast to No Action Alternative 1-Scenario 1, Alternative 4 would require that activities to fix problem orphan roads occur on the same schedule as other roads. In addition to scheduling differences, Alternative 4 would require a no net increase in road density within an ownership or watershed. Alternative 4 also provides an important, added level of protection over No Action Alternative 1-Scenario 1 by capping road densities at current levels, and by requiring upgrades by 2011. Thus, Alternative 4 has the lowest potential for streams to be adversely affected by the delivery of fine sediment from roads due to the "no net increase" road density clause and accelerated improvement schedule.

4.8.3.3 Hydrology

Overview of Effects

The effects of the alternatives on hydrology, as affected by harvest practices and road density, are analyzed in this subsection. Relative to historical practices (prior to the Washington Forest Practices Rules in effect on January 1, 1999), which have modified hydrologic conditions via road construction and maintenance and harvesting, all alternatives would facilitate recovery of hydrology as roading and harvest practices that could affect hydrology would improve. Therefore, compared to baseline conditions, flow alterations (peak and low flows), and effects on fish habitat are not expected to increase under any of the alternatives, although the rate of recovery would vary slightly. The following paragraphs address the likelihood of hydrologic change by alternative in a comparative manner.

No Action Alternative 1-Scenario 2 would result in a moderate likelihood of peak flow increases. Watershed analysis would reduce the likelihood in areas where it is conducted.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would also result in a moderate likelihood of peak flow increases. Compared to No Action Alternative 1-Scenario 2, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 may have fewer watershed analyses performed. However, these reduced protections would likely be offset by improvements in riparian protection and the construction, maintenance, and abandonment of roads under these alternatives.

Alternative 4 would result in a low likelihood of peak flow increases because it addresses cumulative watershed harvest by limiting the size of clearcuts in the rain-on-snow zone, and has a "no net increase" clause for road density.

Detailed Effects Analysis

Forest roads and timber harvest can affect the hydrologic regime of a stream. High road densities and immature forest stands, particularly in rain-on-snow zones, can produce larger and more frequent peak flows. Roads influence stream hydrology by routing water collected on the road surface. The primary negative effect of peak flows on salmonids occurs while eggs incubate in redds, but other effects include accelerated bank erosion and changes in channel morphology. Peak flows can result in scour that disturbs the highly sensitive eggs and causes increased mortality (subsection 3.5.2, Surface Water Quantity, and subsection 4.5.2, Surface Water Quantity).

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the likelihood for peak flow increases is reduced in areas that have undergone Watershed Analysis. Washington DNR is required by State law to conduct Watershed Analysis within all non-agricultural watersheds of the State with more than 1,000 acres of forestland and less than 80 percent Federal ownership. A Watershed Analysis can be conducted voluntarily by a private landowner. Under No Action Alternative 1-Scenario 2, Watershed Analysis provides landowners with increased certainty about the prescriptions that would be required on their lands. No Action Alternative 1-Scenario 2 would result in a moderate likelihood of peak flow increases because Watershed Analysis would provide more restrictive prescriptions where peak-flow effects are probable, but not all watersheds are likely to undergo analysis.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would have a slightly higher likelihood of effects on peak flows in the near-term, relative to No Action Alternative 1-Scenario 2, because fewer watershed analyses are likely to be performed by private landowners. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, Watershed Analysis would have more modules that would make them more costly to conduct. Consequently, many of the benefits of Watershed Analysis would likely be delayed until the Washington DNR conducted the analyses and incorporated the results during its review of forest practices applications.

Alternative 4

In the long-term, Alternative 4 would likely provide the lowest likelihood of peak flow increases relative to either scenario of the No Action Alternative 1 because it includes rules limiting the amount of hydrologically immature forest cover within the rain-on-snow zone, and Watershed Analysis would incorporate a new eastside hydrology module. The differences in the alternatives relative to potential effects on peak flows are more apparent in westside watersheds than eastside watersheds because rain-on-snow is a more common peak flow generating process on the westside.

Road-related effects on peak flows in forested watersheds are relatively minor compared to harvest-related effects. Alternative 4 has similar road prescriptions to No Action Alternative 1-Scenario 1 that would provide only slight improvements relative to No Action Alternative 1-Scenario 2 for addressing peak flow issues. Although Alternative 4 does not require reductions in road density over current levels, it does provide a cap on road density at current levels reducing the road-related effects on peak flow in the long-term compared to both scenarios of the No Action Alternative 1.

4.8.3.4 Large Woody Debris

Overview of Effects

An overview of the effects of the alternatives on LWD recruitment is presented in this subsection. As noted below, LWD is a key component of fish habitat providing cover and pools, and influencing sediment distribution and storage, forming floodplain and offchannel habitats, and serving as food and habitat for aquatic organisms. For perspective, LWD in streams has been greatly reduced in nearly all streams within the State due to historical logging practices, but also other land use practices (e.g., agriculture, urbanization) (subsection 3.7.1.6, Historic Protection of Riparian Areas, and subsection 3.7.1.7, Current Condition of Riparian Areas). However, the current Washington Forest Practices Rules, as well those in effect on January 1, 1999, would provide substantially more LWD than was provided under historical harvest practices, especially along fish-bearing streams. Therefore, the amount of LWD produced within riparian zones on covered forestlands is increasing due to tree growth and because the

Washington Forest Practices Rules under any of the alternatives would result in the retention of more trees along fish-bearing streams that could become LWD, especially relative to historical practices. However, in the near-term LWD in streams would continue to decrease, especially in larger streams, as LWD supplied by older forest stands naturally declines due to the decay of trees and transport. LWD supplied from the riparian area along fish-bearing streams, in the long term, would increase under any of the alternatives, relative to baseline riparian conditions. Along non-fish-bearing streams, the amount of LWD would likely reduce (from natural decay and transport) under all alternatives in the short term but in the long term would remain close to baseline conditions or increase depending on the alternative. Since some LWD in fish-bearing streams is supplied from upstream non-fish-bearing channels, those alternatives that do not provide RMZs on non-fish-bearing streams would reduce future supply to fish-bearing streams. Increases in LWD due to tree growth would be very slow to occur and represent long-term improvements. The following paragraphs summarize the degree to which the alternatives affect LWD recruitment. A more detailed conclusion is included at the end of this subsection.

No Action Alternative 1-Scenario 2 would likely reduce the quantity and quality of fish habitat due to inadequate recruitment of LWD in both eastside and westside forests. Because of the many important functions of instream LWD, this would ultimately reduce fish habitat quality including reduced pools, sediment retention, food sources, channel formation, and floodplain habitat development. Minimal inputs of LWD to non-fish-bearing streams would adversely affect LWD, food, and sediment supply in fish-bearing streams.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in a low to moderate likelihood of diminished LWD but would likely provide adequate LWD inputs to fish-bearing streams. These alternatives would supply much more LWD to fish-bearing streams than No Action Alternative 1-Scenario 2. However, it is uncertain whether No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide adequate protection of LWD recruitment from non-fish-bearing streams to fish-bearing streams, but inputs would be much greater than under No Action Alternative 1-Scenario 2.

Active wood placement strategies, which are an option under these alternatives, are important for meeting near-term LWD needs in many fish-bearing streams. Streams with low existing levels of LWD and early- to mid-seral riparian stands may require active placement to meet adequate LWD levels over the near term (the next 30 or more years).

Alternative 4 would result in a low likelihood of diminished LWD recruitment in both fish-bearing and non-bearing streams due to the extensive RMZs on nearly all streams. The effect would be greater assurance of improving and maintaining important habitat features (e.g. pool, channel formation) compared to the other alternatives, especially relative to No Action Alternative 1-Scenario 2.

Detailed Effects Analysis

Instream LWD is considered to be one of the most important habitat components lacking in most streams categorized as "not properly functioning" (~~Cullins~~ Collins et al. 2002; Montgomery 2004; Be~~a~~echie and Sibley 1997). LWD levels have declined since the advent of timber harvesting for a number of reasons including splash dams, logjam removal, removal at dam trashracks, removal for firewood, removal from marine areas, and low recruitment from due to past forest practices (Maser and Sedell 1994; Bisson and Bilby 1998; Spence et al. 1996). This portion of the assessment evaluates the level of protection and enhancement the alternatives provide for instream LWD using the equivalent buffer area index described in the subsection 4.7 (Riparian and Wetland Processes) and DEIS Appendix B (Riparian Modeling). As a reference point, the analysis assumed that a no-harvest buffer width that was one site potential tree height would provide full protection. Consequently, all LWD equivalent buffer area index values for the alternatives were relative to the full protection equivalent buffer area index value (i.e., 0 percent is no protection, 100 percent is full protection). LWD equivalent buffer area index analyses were conducted based on both the 100-year site potential tree height and 250-year site potential tree height (subsection 4.7.1, Riparian Processes, for details of LWD recruitment assessment).

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the January 1, 1999 Washington Forest Practices Rules would continue to regulate RMZ widths. Westside RMZ widths would range from 25 feet to 100 feet for fish-bearing streams (Types 1 to 3) depending upon the stream type and width. Similarly, in eastside forests, RMZ widths would range from 30 feet to 300 feet for fish-bearing waters depending upon the harvest prescription (partial versus even-aged) in the adjacent harvest unit. RMZs would not be required along non-fish-bearing streams (Types 4 and 5), except occasionally along the lower 1,000 feet of Type 4 waters to protect water quality. In addition to the RMZ widths, the January 1, 1999 Washington Forest Practices Rules specify the number of leave trees required within the RMZs.

The LWD equivalent buffer area index suggests that fish-bearing streams on the eastside would receive about 67 percent of full protection compared to a no-harvest buffer based on the 100-year site potential tree height and about 53 percent of full protection based on the 250-year site potential tree height. All typed waters combined would receive about 46 to 57 percent of full protection (Tables 4.8-1 and 4.8-2). Consequently, No Action Alternative 1-Scenario 2 is considered to have a high likelihood of inadequate LWD recruitment. Westside fish-bearing streams would have about 60 percent of full protection while all typed waters combined would have about 30 percent of full protection based on the 100-year site potential tree height. Fish-bearing streams would have about 37 percent of full protection and all streams combined would have about 19 percent of full protection, based on the 250-year site potential tree height (Tables 4.8-1 and 4.8-2). Under No Action Alternative 1-Scenario 2 there is a high likelihood of reduced LWD recruitment potential.

Table 4.8-1. Percentage of Full Protection for LWD Recruitment to Streams under a 100-year Site Potential Tree Height Assumption Based upon the LWD Equivalent Buffer Area Index Analysis.

Region/Stream Type	No Action Alternative 1-Scenario 2	No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 [2/]	Alternative 4
Westside-Non-Fish-bearing Seasonal	0	0	92
Westside-Non-Fish-bearing Perennial	0	51	98
Westside-Fish-bearing	60	93	100
Westside-All Streams	30	52	97
Eastside-Non-Fish-bearing Seasonal	18	18	99
Eastside-Non-Fish-bearing Perennial	18	43	100
Eastside-Fish-bearing	67	91[1/]	100
Eastside-All streams	57	77[1/]	100

[1/] Does not include additional potential protection within the bull trout overlay.
[2/] Average of Option 1 and 2 characteristics.

Table 4.8-2. Percentage of Full Protection for LWD Recruitment to Streams under a 250-year Site Potential Tree Height Assumption Based upon the LWD Equivalent Buffer Area Index Analysis.

Region/Stream Type	No Action Alternative 1-Scenario 2	No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 [2/]	Alternative 4
Westside-Non-Fish-bearing Seasonal	0	0	86
Westside-Non-Fish-bearing Perennial	0	44	96
Westside-Fish-bearing	37	90	100
Westside-All Streams	19	50	96
Eastside-Non-Fish-bearing Seasonal	18	18	93
Eastside-Non-Fish-bearing Perennial	18	38	97
Eastside-Fish-bearing	53	82[1/]	100
Eastside-All streams	46	69[1/]	99

[1/] Does not include additional potential protection within the bull trout overlay.
[2/] Average of Option 1 and 2 characteristics.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the water typing system would change and new rules for RMZ widths and harvest prescriptions would be implemented. Total RMZ widths for fish-bearing streams would range from 90 feet to 200 feet on the westside and 75 feet to 130 feet on eastside depending upon the site class (Chapter 2, Alternatives). Unlike No Action Alternative 1-Scenario 2, perennial, non-fish-bearing streams (Type N_p) would have RMZs along at least 50 percent of their lengths and would have protection of sensitive areas. As described earlier, RMZs along fish-bearing streams would incorporate three smaller zones, a no-harvest core zone, an inner zone, and an outer zone. On the westside, landowners would have two harvest prescription options for inner zones that meet stand requirements: Option 1, which allows thinning in the inner zone to accelerate riparian tree growth; or Option 2, which requires harvest in the inner zone to be concentrated at its outer edge. On the eastside, harvest prescriptions would be dependent upon the timber habitat type and the basal area of the stand in the inner zone. On both sides of the Cascades, outer zones would have leave tree requirements that may be dispersed or clumped.

The LWD equivalent buffer area index indicates that No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide considerably more protection than No Action Alternative 1-Scenario 2 based on both the 100-year and 250-year site potential tree height. On the westside, these alternatives would provide a high level of protection to Type S and F streams (90 to 93 percent of full protection) (Tables 4.8-1 and 4.8-2), but for all streams, the level of protection would be much lower (about 50 to 52 percent of full protection).

Non-fish-bearing perennial streams would have a much greater LWD supply than under No Action Alternative 1-Scenario 2, due to the RMZs along much of their lengths, with an LWD equivalent buffer area index of 51 and 44 percent for westside streams based on the 100- and 250-year site potential tree heights, respectively. Non-fish-bearing seasonal streams on the westside would have equivalent buffer area indexes of 0 percent (Tables 4.8-1 and 4.8-2). The actual LWD supplied to these non-fish-bearing seasonal streams may be greater than estimated due to unstable slopes protection (i.e., protective buffers) that often occurs adjacent to these channels. While LWD in these streams is much less frequently a source of LWD for fish-bearing streams than that adjacent to fish-bearing streams, in areas with a high frequency of mass wasting, LWD from non-fish-bearing streams can be significant. This is because trees from the smaller non-fish-bearing streams can be transported downstream during flood or debris flow events and become functional for the creation of fish habitat. In some areas, these processes can contribute substantially to the total wood load.

In coastal Oregon, 11 to 49 percent of the LWD in second and third order streams was derived from debris flows (Gresswell and May 2000). Reeves et al. (2003) found that about 65 percent of wood pieces in a fourth order watershed in Oregon coast came from upslope sources. Benda et al. (2003) recently modeled wood source areas in a Southwest Washington stream system and estimated that over the long term, debris flows would provide about 16 percent of the total wood load.

While debris flows are not restricted to stream channels, high-gradient headwater channels are noted as being common sources of these types of flows (Benda et al. 2003). But Martin and Benda (2001) estimated in a southeast Alaska watershed that only about 1 percent of LWD originated from debris flows. So some of the wood that enters non-fish-bearing streams will contribute to habitat formation in fish-bearing streams, but the actual contribution is highly variable and not well quantified. Thus, the scientific literature does not provide clear guidance that buffers on Type N streams under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would be sufficient for providing LWD to fish-bearing streams. But the presence of buffers may ultimately contribute LWD to fish-bearing channels in some stream systems (subsection 4.7.1, Riparian Processes). Overall, this suggests that under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, most streams on the westside currently lacking wood should eventually return to at least a moderate level of function. Depending upon site-specific conditions and the harvest Option chosen by the landowner, LWD function could be even higher. Further, the functions provided by LWD in non-fish-bearing streams such as sediment trapping, nutrient processing, and energy dissipation would be compromised because of reduced LWD recruitment.

On the eastside, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide substantial improvements over No Action Alternative 1-Scenario 2. For fish-bearing streams, the equivalent buffer area index would range from 82 to 91 percent of full protection (Tables 4.8-1 and 4.8-2). Non-fish-bearing perennial streams, due to the RMZ along much of their length, would have much higher LWD recruitment than No Action Alternative 1-Scenario 2, with 43 and 38 percent for eastside streams based on the 100- and 250-year site potential tree heights. Non-fish-bearing seasonal streams on the eastside streams had 18 percent of full protection (Tables 4.8-1 and 4.8-2). However, the actual LWD supplied to these N streams would be greater than estimated due to unstable slopes protection that often occurs adjacent to these channels. LWD recruitment to fish-bearing channels on the eastside would be the same as described for the westside.

One aspect of LWD recruitment that the equivalent buffer area index does not reflect is the growth rate and future size of trees in the RMZ following harvest (subsection 4.7.1, Riparian Processes). The tree growth model in the Riparian Aquatic Integration Simulator indicated that thinning increases the growth rate of residual trees (Washington Forest Practices Board 2001a, Appendix D). Larger streams require larger pieces of LWD to function adequately (Abbe and Montgomery 2003; Bilby and Ward 1989; Hyatt and Naiman 2001; Abbe and Montgomery 1996; Beschta and Robinson 1990; Beechie and Sibley 1997). Consequently, for larger streams and rivers, the equivalent buffer area index would underestimate the protection provided under Option 1 in western Washington. In situations where the riparian stand is characterized by numerous, but smaller trees, Option 1 (removing smaller trees throughout the inner zone) would accelerate the development of stands with fewer, but larger trees. These larger trees would have a higher potential to be functional LWD once recruited to the stream, than those developed under Option 2. However, the Riparian Aquatic Integration Simulator model suggests that stands with trees of functional size range from 80 to 150 years depending upon stream size and site class. Consequently, the benefits of inner zone thinning would only become realized over the long-term.

In addition to future stand conditions, the equivalent buffer area index does not account for instream wood placement strategies that can be implemented when existing stream-adjacent roads limit the stands' capacity to meet basal stand requirements. Under these situations, a landowner may design an LWD placement strategy in cooperation with the WDFW. The LWD placement plan can include removing up to 10 trees per acre in the outer zone as an incentive for landowners to implement the plan. Specifications for LWD strategies are currently under development.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 include an option for converting hardwood dominated stands to conifers in cases where stands meet specific requirements (Chapter 2, Alternatives). The hardwood conversion rule is intended to improve inner zone stand conditions over the long-term in areas that cannot meet stand requirements because of the predominance of hardwood trees. These areas must also have evidence that conifers have historically been established on the site. The rule provides for harvest of no more than 10 percent of the conifers 8 to 20 inches dbh, and no-harvest of larger trees. In terms of LWD, the hardwood conversion rule is considered a long-term benefit to these riparian areas even though it may reduce function in the short term. Alternative 4 also includes a hardwood conversion option.

Similar to No Action Alternative 1-Scenario 2, downstream movement of LWD can be restricted at culverts. However, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 include the preparation of RMAPs. These plans include culvert size requirements based on the 100-year flood. All new culverts and culverts that currently degrade resources would be required to meet the new standard. Larger culverts would be more likely to pass larger pieces of wood as well as floodwaters. However, culverts would not be capable of passing all wood, and some wood may build-up on the upstream side of a culvert. To the extent practicable without significant soil disturbance, RMAPs would be required to include measures for moving accumulated LWD from above to below culverts during standard road maintenance. Consequently, both No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in less potential to limit LWD redistribution than No Action Alternative 1-Scenario 2.

Alternative 4

Alternative 4 would result in a low to very low likelihood of reduced LWD recruitment. Under Alternative 4, all streams would receive from 96 to 100 percent of full LWD recruitment based on the 250-year and 100-year site potential tree heights, on both the westside and the eastside, as a result of 70- to 200-foot no-harvest RMZs. The RMZs under Alternative 4, even on small streams, would result in non-fish-bearing channels also having high LWD recruitment ranging from 86 to 100 percent (Tables 4.8-1 and 4.8-2). Notably, heavily stocked stands with small trees near large streams would have less opportunity for thinning to accelerate stand growth and average tree size. Under Alternative 4, thinning can only be done to convert hardwood-dominated stands to conifers and to accelerate development of 200-year-old stand characteristics. However, these prescriptions would require SEPA review, and harvested trees could not be removed unless monitoring determined that the prescriptions were effective. These requirements would provide little incentive for landowners to pursue the thinning option.

Alternative 4 does not provide any incentives or mechanisms for implementing instream wood placement strategies. Consequently, streams that have the potential for instream LWD placement under No Action Alternative 1-Scenario 1 could require more time for recovery under Alternative 4. For LWD-poor streams surrounded by early- to mid-seral stage riparian stands, recovery could require 40 or more years on the westside and 60 or more years on the eastside. The relatively high supply of LWD to non-fish-bearing streams relative to other alternatives would ensure that debris flows originating in non-fish-bearing streams would contribute to fish-bearing streams at a higher rate than under the other alternatives, and that other LWD functions such as sediment storage and nutrient processing would be fully maintained.

Large Woody Debris: Conclusion

Overall, instream LWD levels would be expected to gradually increase under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4. In the absence of RMZ management, Alternative 4 is likely to provide the highest level of long-term protection and is considered to have the lowest likelihood of LWD-related habitat effects. On the westside, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are considered to have a low to moderate likelihood of inadequate LWD recruitment over the long-term as stands develop and are more capable of providing functional LWD. These alternatives provide incentives for landowners to implement instream LWD placement plans and to accelerate the recovery of over-stocked riparian zones through thinning. The moderate likelihood of inadequate recruitment applies where LWD inputs are largely derived from Type N streams. On the eastside, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are considered to have a moderate likelihood of inadequate LWD recruitment. No Action Alternative 1-Scenario 2 would provide the lowest level of LWD recruitment and would likely further degrade fish habitat.

All alternatives would restrict downstream movement of LWD at stream crossings to some degree. However, No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would include RMAPs and requirements that would increase the likelihood of wood passage. Blockages at culverts can result in fish passage problems and culvert failure.

The RMZ prescriptions under all of the alternatives would have a greater effect on instream conditions over the mid- to long-term (westside: 20 to 60 years; eastside: 50 to 100 years) than over the short-term (westside: less than 20 years; eastside: less than 50 years). Currently, most stands along fish-bearing streams are in early-seral stages (64 percent on westside; 60 percent on eastside) (Table 3-18). Assuming that these conditions are representative of nearby upslope stands, new rules many not be applied for many years along most streams because timber stands will be too young for commercial harvest. In addition, the rate of natural recruitment of functional LWD will initially be low but will increase as riparian stands mature. The recovery of instream LWD loads will take decades to centuries (Bilby and Ward 1989).

Only No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 provide incentives for instream LWD placement. LWD placement would provide short term benefits by providing more complex habitat structure, nutrient input, and substrate for invertebrate colonization, all of which would benefit fish habitat. These benefits may improve current conditions until riparian stands can develop to the point that they provide sustainable inputs of functional LWD. Many Washington streams currently have low levels of instream LWD, and adjacent riparian stands are in early- to mid-seral stages. Thus, LWD placement may be effective in supplementing instream LWD levels over the next 30 or more years.

The development of methods for placing LWD is fairly advanced (Oregon Department of Forestry and Oregon Department of Fish and Wildlife 1995), and there would be no substantial negative effects to fish from the placement strategies outlined in the Washington Forest Practices Board Manual (Washington Forest Practices Board 2001b, Section 26). The incentive program under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would allow landowners to place wood in stream channels in exchange for removal of additional trees from the outer zone, which has a relatively low probability of providing LWD recruitment to streams. The improvement in current habitat conditions would outweigh the potential reduction in LWD recruitment from the outer zone over time. The recruitment of wood from the outer zone would be a very small percentage of total recruitment and would not provide the same benefits of direct placement of wood. The major risk of LWD placement is to the transportation infrastructure, including culverts and bridges, which could be damaged or removed if wood is mobilized and transported during flood flows.

All of the alternatives would allow yarding corridors through RMZs. Yarding corridors provide landowners flexibility in accessing and harvesting timber when a road, stream-crossing, or helicopter yarding would otherwise be required. Requirements for leaving or removing trees cut for yarding corridors would be different under the three alternatives, and these differences would be more important for wildlife habitat than aquatic species. Yarding across fish-bearing streams requires a Hydraulic Project Approval from the WDFW. Hydraulic Project Approvals provide a regulatory mechanism for requiring mitigation for the yarding corridor and an opportunity for LWD enhancement.

All of the alternatives would result in a small reduction in LWD recruitment relative to unmanaged conditions from existing and future stream crossings and existing stream-adjacent parallel roads. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 also include less restrictive rules for exempt 20-acre parcels that would reduce LWD recruitment in areas with high densities of qualifying parcels. Forest landowners who qualify for the exemptions are estimated to own approximately 0.5 to 5 percent of the private forestlands in the State and an even smaller percentage of the total land base (including State and Federal lands) (See subsection 4.7.2.7, 20-Acre Exemption Rule). Existing roads in RMZs and rule exemptions provide a small increase in the overall likelihood of reduced LWD recruitment relative to unmanaged conditions, but this does not change the relative rankings among the three alternative groupings.

All of the alternatives are expected to result in RMZ blowdown along clearcut unit edges (subsection 4.7.1, Riparian Processes). Blowdown levels would be expected to decrease after about 5 years following harvest (when trees are most susceptible to blowdown). Streams with low levels of LWD may benefit in the short-term from increased blowdown rates, but this would also reduce the standing stock of trees available for future recruitment. Streams with narrower buffers would likely have a higher proportion of fallen trees that become instream LWD because the unit edge would be closer to the stream.

4.8.3.5 Leaf and Needle Recruitment

Overview of Effects

The effects of the alternatives on leaf and needle recruitment are analyzed in this subsection. Leaves and needles, along with other biological inputs to streams from riparian vegetation, supply nutrients and food for aquatic organisms (Gregory et al. 1991; Richardson 1992). Compared to pre-management conditions, leaf and needle supply has been substantially reduced as a result of past harvest activities. Under all alternatives, future leaf and needle inputs would increase as riparian stands develop over the long term. Therefore, compared to baseline conditions, the amount of leaf and needle delivery and resulting effects on fish habitat are expected to improve under any of the alternatives. The following paragraphs address the degree to which the alternatives affect leaf and needle recruitment.

No Action Alternative 1-Scenario 2 would result in a high likelihood of reduced leaf and needle recruitment. However, negative effects on food and nutrient supply, especially for fish, would be less likely as increases in other food sources may compensate for reductions in leaf and needle inputs.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in a moderate likelihood of reduced leaf and needle recruitment, but like No Action Alternative 1-Scenario 2, increases in other food sources would somewhat compensate for those reductions, reducing the potential for negative effects on fish. However, No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) would have greater assurance of food contribution from non-fish-bearing streams through RMZ retention along Type N_p streams.

Alternative 4 would result in a very low likelihood of reduced leaf and needle recruitment due to extensive RMZs on most streams.

Detailed Effects Analysis

The likelihood of reduced leaf and needle recruitment under each alternative differs from that of LWD recruitment. This is because small headwater streams, including seasonal streams that usually flow when litterfall inputs are at their highest level, have a greater influence on leaf and needle recruitment to fish-bearing streams than on LWD recruitment because leaf and needle litter is more easily transported in smaller streams. Furthermore, a large proportion of stream miles on forested land are smaller, non-fish-bearing streams (Type N or Type 4 and 5). However, the effects of reduced leaf and needle production on aquatic resources, particularly fish, are likely to be much less than the reduction in supply from tree removal along seasonal channels.

Unlike LWD, other sources of food and nutrients often augment or replace that lost from reductions in former leaf and needle supplies. Some studies have found that autochthonous production (i.e., algae growth) may increase following riparian harvest, increasing usable food sources to downstream areas following harvest (Bisson and Bilby ~~2001~~1998; Bilby and Bisson 1992; Gregory et al. 1987; Murphy and Hall 1981). Although, if nutrients remain low, primary production and benthic macroinvertebrates may not increase substantially in streams adjacent to clearcuts (Culp and Davies 1983). Terrestrial food sources for fish may also be higher from some deciduous riparian forests that regenerate in riparian areas following harvest of old growth (Wipfli 1997). Also, some tree types that replace conifers (e.g., alder) in the short term may enhance downstream food sources for fish (Wipfli 1997; Piccolo and Wipfli 2002). But intermediate age coniferous stands do produce less exported detritus than old-growth stands, and also may result in lower terrestrial insect food sources (Piccolo and Wipfli 2002; Gregory et al. 1991). So the overall effects of reduced leaf and litter recruitment are not likely to be as detrimental to aquatic resources downstream as suggested by the model used to estimate reductions in leaf and needle supply. Furthermore, short-term gains in food supply and growth of fish may be offset by a lack of instream structure and reduced fish survival (subsection 3.8.4.5, The Aquatic Food Chain).

In summary, No Action Alternative 1-Scenario 2 is expected to result in a high likelihood of reduced leaf and needle recruitment, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are expected to result in a moderate likelihood of reduced recruitment, and Alternative 4 is expected to result in a very low likelihood (subsection 4.7.1, Riparian Processes, Leaf and Needle Litter Production).

4.8.3.6 Floodplains, Off-channel Areas, and the Hyporheic Zone

Overview of Effects

The effects of the alternatives on maintaining floodplain and off-channel habitats and hyporheic zones are analyzed in this subsection. Historically, floodplains and off-channel habitat have been modified or reduced from forest practices and other land use practices (e.g., agriculture, urbanization), and these habitats remain in greatly modified conditions. All alternatives would maintain or improve the condition of these habitats relative to historical management. Therefore, compared to baseline conditions, these habitats would be maintained or improved under any of the alternatives, although the location and degree of improvement would vary. The following paragraphs address the degree to which each alternative would maintain floodplain and off-channel habitat and the hyporheic zones (subsection 4.5.3, Groundwater).

No Action Alternative 1-Scenario 2 would be less likely to maintain floodplains, off-channel habitats, and hyporheic zones than all other alternatives. Lack of protection of the Channel Migration Zone, where these habitats most often occur, is one of the main reasons for the low likelihood.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would protect Channel Migration Zones and provide greater riparian protection, increasing the likelihood that floodplains, off-channel habitats, and hyporheic zones would be maintained relative to No Action Alternative 1-Scenario 2.

In addition to protecting the Channel Migration Zone, Alternative 4 would also protect Beaver Habitat Zones and Channel Disturbance Zones on certain streams, which are important fish habitats or contributors to fish habitats, resulting in a high likelihood that floodplains, off-channel habitats, and hyporheic zones would be maintained relative to all other alternatives. The likelihood that these habitat features would be maintained is much higher than under No Action Alternative 1-Scenario 2 and slightly higher than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3.

Detailed Effects Analysis

As described earlier, floodplains and off-channel areas include side channels, backwater alcoves, ponds, and wetlands connected at least seasonally to flowing waters. Hyporheic zones are the saturated areas beneath and beside these features. Off-channel areas provide important habitat seasonally or to particular life stages (Brown and Hartman 1988; Peterson and Reid 1984; Spence et al. 1996; Bjornn and Reiser 1991). Off-channel areas may have shallow, low velocity water that is important during fry rearing periods. These areas can also provide protection from high water velocities during flood flows. Some backwater alcoves and ponds result from groundwater and hyporheic water seeps and may have higher shade levels and lower temperatures than the main channel. These areas provide cool-water refugia during high summertime temperatures. They also may supply spawning areas where groundwater or hyporheic waters emerge (Edwards 1998).

Off channel habitat occurs most often in low gradient (less than 4 percent) reaches (Lunetta et al. 1997), but occasionally occur in streams with gradients up to 8 percent (Groot and Margolis 1991; Wydoski and Whitney 2003). Hyporheic waters are poorly understood (Edwards 1998), but are known to be largest in alluvial channels where large volumes of coarse sediment accumulate; these are often associated with floodplains and larger stream channels. The hyporheic zone represents a connection between groundwater and surface water and can influence stream temperature, nutrient supply, stream water quality, and possibly invertebrate production. New off-channel habitats are naturally created within the Channel Migration Zone, which the current Washington Forest Practices Rules define as the area where the active channel is prone to move and the movement results in a near-term loss of riparian function and associated habitat adjacent to the stream (WAC 222-16-010). It is likely that most of the hyporheic zone outside of the active stream channel would be contained within the Channel Migration Zone. This subsection assesses the level of protection the alternatives afford off-channel habitat through protection of Channel Migration Zones and groundwater source areas.

No Action Alternative 1-Scenario 2 would provide very little direct protection to channels that are prone to migration. Widths of riparian buffers would be based entirely on the current location of the active channel. Consequently, any new off-channel habitat that develops after RMZ harvest prescriptions were implemented would potentially have reduced riparian protections. For example, if a new side channel were to develop 25 feet from a Type 2 stream with an average buffer width of 50 feet, the RMZ width to that side channel would effectively be reduced to 25 feet. The hyporheic environment may also have low protection under this alternative due to lack of Channel Migration Zone protection and potential riparian groundwater and its connection to the hyporheic zone, although literature is not available to confirm this groundwater assessment (subsection 4.5.3, Groundwater).

Under No Action Alternative 1-Scenario 1, and Alternatives 2 and 3, RMZs would be measured from the edge of the Channel Migration Zone (if present) or the bankfull channel edge. Consequently, existing and potential off-channel habitat would receive high levels of protection under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 compared to No Action Alternative 1-Scenario 2. The greater protection for Channel Migration Zones under this group of alternatives should result in a high likelihood for adequate hyporheic zone protection (subsection 4.5.3, Groundwater).

Under Alternative 4, RMZs are also measured from the edge of the Channel Migration Zone (if present) or the bankfull channel edge. In addition, Alternative 4 RMZs would also provide protection for potential beaver habitat. The presence of beaver ponds can be particularly important to coho salmon production (Cederholm et al. 2001). Consequently, existing and potential off-channel habitat under Alternative 4 would receive slightly higher levels of protection than under No Action Alternative 1-Scenario 1 because of the added protection for potential beaver habitat. The greater protection for Channel Migration Zones under Alternative 4 should result in a high likelihood for adequate hyporheic zone protection (subsection 4.5.3, Groundwater).

4.8.3.7 Lakes, Reservoirs, and Nearshore Marine Areas

Overview of Effects

The effects of the alternatives on lakes, reservoirs, and nearshore marine areas are analyzed in this subsection. It is important to note that, from an historical perspective, these environments have been modified as a result of past forest practices. Also, other activities have played a greater role in the modification of many of these habitats, including extensive shoreline (freshwater and marine) and estuarine development from commercial and urban activities. Therefore, compared to baseline conditions, the quality of these environments is not expected to decrease as result of these alternatives, although specific locations may vary. The following paragraphs address the ~~likely~~ possible effects of each alternative on lakes, reservoirs, and nearshore marine areas.

No Action Alternative 1-Scenario 2 has a low likelihood of maintaining lakes, reservoirs, and nearshore marine environment functions primarily because this alternative would provide the lowest level of recruitment of LWD, a primary structural element that maintains functions, compared to all other alternatives (See LWD discussion above). Also, sediment inputs influence the quality of habitat in these areas, and this alternative is not expected to substantially reduce management-related sediment inputs (See Coarse and Fine Sediment discussion above).

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide higher levels of LWD recruitment and reduced management-related sediment inputs relative to No Action Alternative 1-Scenario 2. As a result, this group of alternatives has a moderate likelihood of maintaining lakes, reservoirs, and nearshore marine environments.

Alternative 4 would not likely adversely affect lakes, reservoirs, and nearshore marine habitats because of high LWD recruitment and reduced management-related sediment inputs.

Detailed Effects Analysis

Lakes and nearshore marine areas are critical for many life stages of salmonids and other fish. Reservoirs may also be important to salmonids; however, human-altered reservoirs may also have detrimental effects on salmonids. Many factors influence these areas. The primary factors relative to forest practices are LWD input and sediment supply. LWD in lakes and reservoirs provide cover for fish and substrates for plants and animals (e.g., algae, benthic macroinvertebrates) (Moring et al. 1986; Moring et al. 1989; France 1997; Christensen et al. 1996). LWD in lakeshore areas along undeveloped shorelines can be very high (over 500 pieces per kilometer (802 pieces per mile)), and reductions in wood recruitment can greatly reduce in-lake LWD (Christensen et al. 1996).

The role of LWD in the nearshore marine and estuaries is not fully understood, but its role is not likely similar to its function and importance in river systems (Simenstad et al. 2003). In some cases wood has been found to be used as fish habitat in estuaries (Van de Wetering 2001, as cited in Simenstad et al. 2003) while in another no correlation between fish abundance and benthic production to wood in estuary channels was found (Wick 2002, as cited by Simenstad et al. 2003). However, historic wood abundance in estuaries was high and is believed to play a role in delta habitat formation (Simenstad et al. 2003). Without more specific information, (as noted in the Evaluation Criteria subsection above) the assessment of LWD, especially as it relates to fish-bearing streams, and the assessment of sediment are used to assess the likelihood of adverse effects to these areas. Although LWD may be delivered to the aquatic environment from banks and slopes adjacent to lakes, reservoirs, and nearshore marine areas, the relative supply of LWD from fish-bearing streams to these habitats is used as the primary evaluation criteria to analyze environmental effects. This is because streams would be the primary sources of wood that would reach lakes and the nearshore marine areas (especially of the larger pieces that would play a major role in habitat for fish and aquatic insects).

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the supply of LWD from fish-bearing streams on the westside would likely be low (See LWD Assessment discussion in subsection 4.7.1, Riparian Processes). Under this alternative the westside LWD equivalent buffer area index for fish-bearing streams is only 60 or 38 percent based on the 100-year and 250-year site potential tree height, respectively, indicating a moderate to high likelihood of inadequate LWD supply for lakes, reservoirs, and nearshore marine areas. The eastside LWD supply would be greater at 70 and 57 percent of full protection based on the 100-year and 250-year site potential tree height. This would result in a moderate likelihood of inadequate LWD supply for eastside lakes and reservoirs.

This alternative has a moderate likelihood of continued management-related coarse sediment inputs and a high likelihood of continued management-related fine sediment inputs (subsection 4.7.1, Riparian Processes, Coarse Sediment, and Fine Sediment). This could have adverse effects on nearshore conditions in lakes and reservoirs, especially spawning areas. For nearshore marine areas the overall effect may be less pronounced as these habitats have often been heavily affected by many other actions especially those associated with removal of sediment (e.g., channel dredging in major estuaries), and other nearshore modifications, and active LWD removal for other uses to protect property or to abate navigational hazards. Overall, No Action Alternative 1-Scenario 2 would have a moderate likelihood of adverse effects to lakes, reservoirs, and nearshore marine areas since these areas are less affected by actions that occur in streams and rivers, than are the stream systems themselves.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

The likelihood for adverse habitat effects in lakes, reservoirs, and nearshore marine areas from an LWD standpoint would be low to very low in western Washington under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Under this group of alternatives, the LWD equivalent buffer area index for westside fish-bearing streams was 95 or 82 percent based on the 100-year and 250-year site potential tree height, respectively. Results would be similar in eastern Washington with LWD equivalent buffer area indexes of 94 or 87 percent based on the 100-year and 250-year site potential tree height, respectively. Some LWD reduction to these systems could occur under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 because LWD inputs to non-fish-bearing streams could be low, but these sources would likely be of lower importance to these areas. However, LWD inputs under this group of alternatives are expected to be higher than LWD inputs under No Action Alternative 1-Scenario 2. The overall benefit of increased LWD recruitment may not be realized as these habitats have often been heavily affected by many other actions, especially those associated with removal of sediment (e.g., channel dredging in major estuaries), other nearshore modifications, and active LWD removal for other purposes (e.g. personal use, property protection, and abatement of navigational hazards).

Sediment supply to lakes, reservoirs, and nearshore areas would primarily be moderate under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 (subsection 4.7.1, Riparian Processes, Coarse Sediment and Fine Sediment). The sediment equivalent buffer area index is 91 percent for 30-foot buffers, but only 73 percent for 200-foot buffers, suggesting a moderate likelihood for continued management-related sediment inputs (DEIS Appendix B). RMAPs would reduce the likelihood of fine sediment inputs from roads under this group of alternatives.

Alternative 4

Protection of LWD-related habitats would be highest under Alternative 4 with an LWD equivalent buffer area index of 100 percent for all fish-bearing streams based on both site potential tree heights on both sides of the State. Alternative 4 would have a very low likelihood of management-related sediment inputs as its sediment equivalent buffer area index exceeds 90 percent for all streams, and it also has a “no net increase” in road density requirement. Alternative 4 would have a very low likelihood of adversely affecting these areas because of high LWD recruitment and low management-related sediment inputs.

4.8.3.8 Water Temperature

Overview of Effects

An overview of the effects of the alternatives on temperature is presented in this subsection. For perspective, it is important to note that factors important in controlling temperature (primarily stream shade) have already been greatly diminished along many streams within the State due to historical logging practices, as well as other land use practices (e.g., agriculture, urbanization) (subsection 3.7.1.6, Historic Protection of Riparian Areas, and subsection 3.7.1.7, Current Condition of Riparian Areas). However, the current Washington Forest Practices Rules, as well as those in effect on January 1, 1999, provide for substantially more temperature protection by requiring greater shade retention, especially along fish-bearing streams, than has been provided in the past. Therefore, the amount of shade within riparian zones on covered forestlands is increasing due to tree growth and because the Washington Forest Practices Rules under any of the alternatives would result in the retention of most canopy cover along fish-bearing streams during harvest operations. Along non-fish-bearing streams, the amount of shade would likely remain close to baseline conditions or increase depending on the alternative. Note that increases in shade due to tree growth would be very slow to occur and represent long-term improvements. Changes in shade due to greater retention during harvest operations can have positive effects over the short-term as well as long-term. The following paragraph summarizes the likelihood of temperature effects by alternative.

Because of the shade rule, No Action Alternative 1-Scenario 2 has a moderate likelihood of temperature increases along fish-bearing streams. The lack of a shade rule or other forms of significant tree retention along non-fish-bearing streams would result in a very high likelihood of increased temperatures along these streams. However, other factors such as changes in groundwater temperatures from adjacent clearcuts (subsection 4.5.1, Surface Water Quality) may affect stream temperatures and the survival and production of fish in some systems.

The reduction of summer high temperatures along fish-bearing streams would be slightly enhanced under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 relative to No Action Alternative 1-Scenario 2. Therefore, the likelihood of elevated temperatures in fish-bearing streams would be low relative to No Action Alternative 1-Scenario 2. As a result of riparian buffers along N_p streams and due to the presence of unstable landforms and other sensitive sites, shade retention and related temperature control along non-fish-bearing streams would be greatly enhanced under No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 compared with No Action Alternative 1-Scenario 2 reducing the likelihood of elevated summer temperatures.

Under Alternative 4, the recovery and/or maintenance of stream temperatures would be more likely relative to No Action Alternative 1-Scenario 1, but only slightly more so along fish-bearing streams (since most shade would already be retained under these alternatives). The degree of recovery and/or maintenance provided by Alternative 4 would be even greater compared with No Action Alternative 1-Scenario 2 because of wider RMZs provided under Alternative 4.

The general rankings among the alternatives described in the preceding paragraphs, would hold true for both west and eastside streams. A detailed analysis of the alternatives is presented in the following subsections.

Detailed Effects Analysis

Maintenance of natural water temperature regimes is important for all salmonids. As described earlier, changes in water temperatures can have both lethal and sub-lethal effects that can affect the species long-term fitness (Bjornn and Reiser 1991; Washington Department of Ecology 2002a). Of the salmonids considered in this document, bull trout have the lowest water temperature requirements and appear the most sensitive to increases in temperature (Wydoski and Whitney 2003).

All of the alternatives have some potential for reduced shade and increased water temperatures related to blowdown, yarding corridors, existing and future stream crossings, and existing stream adjacent parallel roads. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 include slightly lower levels of shade retention for exempt 20-acre parcels, which may increase the potential for elevated water temperatures in some areas. These effects are described in more detail in subsection 4.7.2.1 (Evaluation of Alternatives, 20-Acre Exemption Rule). The effects of roads and yarding corridors are expected to be relatively small, but are difficult to quantify.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, RMZ widths for the eastside and westside do not generally meet the 0.75 site potential tree height shade evaluation criterion for Type 1, 2, or 3 streams based on the 100-year and 250-year site potential tree heights. No Action Alternative 1-Scenario 2 includes a shade rule that includes minimum shade levels by elevation and water quality class (subsection 4.5.1, Surface Water Quality), but tree retention requirements would be limited to the maximum RMZ width. Type 4 and 5 streams would not receive any protection except under limited circumstances, and RMZs would be much smaller than needed for full shade protection.

The effects of increased stream temperatures in Type 4 and 5 streams on fish-bearing stream temperatures are not clear (subsection 4.5.1, Surface Water Quality). Adverse water temperature effects are generally more common in eastside watersheds because the climate is warmer, and forest types are generally more open compared to the westside. Overall, No Action Alternative 1-Scenario 2 is expected to have a moderate likelihood of not meeting salmonid temperature requirements on the east and westside.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

For No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, RMZs for Type S and F streams would be wider relative to No Action Alternative 1-Scenario 2 and would include both no-harvest and selective harvest zones. Under some site class situations (e.g., Option 2 with Site Class III, IV, or V), the no-harvest portions of the RMZs would provide complete shade protection based on the 100 year site potential tree height. Under some situations, Option 1 could provide slightly less protection than Option 2 because thinning in the inner zone could remove some shade-producing trees closer to the stream. However, under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, RMZs must maintain minimum canopy closure under the shade rule, regardless of the riparian management option chosen by the landowner.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 also provide additional protection for eastside streams within the bull trout overlay by protecting all trees that provide shade within 75 feet of the channel. The bull trout overlay includes those portions of eastern Washington containing bull trout habitat as identified on the WDFW's bull trout map (WAC 222-16-010).

The shade rule protects trees that currently provide shade, but does not account for the future growth of trees that might eventually provide shade. Consequently, there is some uncertainty about the extent to which these rules would result in adequate protection, given the silvicultural prescriptions to be implemented in the inner zones. Overall, the likelihood of adverse temperature effects under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are considered low for Type S and F westside streams, moderate for eastside streams outside the bull trout overlay, and low for eastside streams within the bull trout overlay, which includes most of the project area on the eastside (subsection 4.5.1.2, Evaluation of Alternatives). Overall, temperature conditions and therefore protection of fish resources are expected to improve relative to current conditions under these alternatives because shade levels in previously harvested riparian areas would continue to increase as tree growth continues into the future. Areas scheduled to be harvested in the future would be provided greater protection than what was previously required.

The bull trout overlay does not apply to the westside, although bull trout are present in many westside watersheds. Under Option 1, the largest trees, which likely have the greatest potential to provide shade, would be retained in the inner zone. Under Option 2, the lack of the bull trout overlay would have no effect because no-harvest buffers would be 80 to 100 feet wide depending upon stream width, which are wider than the 75 feet width that applies in the bull trout overlay. Overall, the effect of not implementing the "all available shade" rule on the westside is expected to be small.

On both the east and the westsides, protection of seeps and springs that provide cold water is important for bull trout, which have lower temperature requirements compared to other salmonids (subsection 3.8.3.1, Pacific Salmon and Trout – General, *Bull Trout*). Sensitive sites (headwall seeps, side-slope seeps, and headwater springs) are provided 56-foot radius, no-harvest patch buffers under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 that would provide some thermal protection. In addition, Ecology is considering revisions to Washington State temperature standards (Chapter 5, Cumulative Effects). These revisions are likely to include species- and life stage-specific standards to be applied to stream reaches where bull trout are present or are expected to be present.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide RMZs for at least 50 percent of the length of Type N_p stream reaches. Based on observed harvest practices, additional Type N_p and N_s protection results from the application of the unstable slopes rules, which often leads to the retention of no-harvest buffers along more than 50 percent of Type N_p streams (Jeff Grizzel, Personal Communication, Washington DNR April 6, 2004). In some cases, these buffer requirements would include groundwater seeps and hyporheic zones that provide cool water. However, no RMZs are required on Type N_p streams on exempt 20-acre parcels.

Partial protection to small Type N_P streams may occur within about 10 years of harvest due to the growth of overhanging shrubs and young trees. Some increases in water temperature within Type N_p streams are expected following adjacent timber harvests. Nevertheless, there is still high uncertainty regarding the influence Type N_p streams on downstream temperatures in Type S and F streams. Type N_s streams would not receive any direct protection, but this should generally not affect fish because these streams usually do not contain water during the summer low-flow period.

Overall, No Action Alternative 1-Scenario 1and Alternatives 2 and 3 are considered to have a low to moderate likelihood of adverse temperature effects. Most westside regions would have a low likelihood while a moderate likelihood applies to areas where Option 1 would be implemented and in lower elevation basins (less than 1,640 feet) where water temperatures are more sensitive to changes in shade. A moderate likelihood also applies to the eastside in areas outside the bull trout overlay.

One area of moderate uncertainty is the effect of nearby clearcuts on air temperatures surrounding streams, even in the presence of RMZs. Substantial increases in air temperatures could lead to negative effects on water temperatures, but the relationship is not well understood. Another area of uncertainty involves the effects of nearby clearcuts on groundwater temperature. Evidence of a cause-and-effect relationship between groundwater temperatures and surface water temperatures is not available, but has been hypothesized by Brosofske et al. (1997).

Alternative 4

Alternative 4 would include no-harvest RMZs for all streams. With the exception of streams greater than 30 percent gradient, the widths of the RMZs are expected to provide full shade protection relative to the 0.75 site potential tree height criterion. Consequently, Alternative 4 has a very low likelihood of adverse temperature effects. Alternative 4 also has some uncertainty concerning the effects of upslope clearcuts on stream temperature. However, since RMZs would be wider under Alternative 4, the likelihood of adverse effects is lower than under No Action Alternative 1-Scenario 1 and substantially lower than under No Action Alternative 1-Scenario 2.

4.8.3.9 Dissolved Oxygen

Overview of Effects

The effects of the alternatives on maintaining instream dissolved oxygen levels are analyzed in this subsection. Maintaining high dissolved oxygen levels is critical to most aquatic organisms. From an historical perspective, forestry-related occurrences of low dissolved oxygen concentrations (particularly in sediment where they often have adverse effects incubating salmonid eggs), have been reduced over time (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation, and subsection 4.5.1, Surface Water Quality). Therefore, compared to baseline conditions, the dissolved oxygen concentrations are not expected to decrease under any of the alternatives, although specific locations may vary. The following paragraphs address the likelihood of reduced oxygen concentrations by alternative in a comparative manner.

No Action Alternative 1-Scenario 2 would have a moderate likelihood of maintaining adequate dissolved oxygen levels. The likelihood is moderate because there is an increased chance of elevated water temperatures and continued management-related sediment inputs, which could reduce dissolved oxygen levels. Lack of adequate protection of dissolved oxygen has the potential to negatively affect developing salmon and trout eggs.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide greater protection of sediment inputs and stream temperatures, reducing the likelihood of low dissolved oxygen levels.

Alternative 4 has a very low likelihood of adversely affecting dissolved oxygen levels due to greater temperature and sediment-related protections than other alternatives.

Detailed Effects Analysis

Maintenance of sufficient levels of dissolved oxygen is critical for all fish species and especially salmon and trout (Spence et al. 1996). Reduced levels can affect growth and development of all stages, swimming ability, and juvenile and adult migration success. For salmonids, oxygen levels of 8 to 9 mg/l are generally needed to ensure normal physiological function of salmonids (Bjornn and Reiser 1991, as cited in Spence et al. 1996). Current State dissolved oxygen water quality criteria for Class AA and A streams are 9.5 and 8.0 mg/l, respectively. However, even higher levels may be needed for incubating eggs (Hicks 2002).

One of the most critical areas to maintain dissolved oxygen levels is incubating salmonid eggs in the gravel as concentrations in the gravel are often less than those in the stream water column (Hicks 2002). Dissolved oxygen concentration and supply are related to stream temperature and fine sediment (Chapman and McLeod 1987). Low dissolved oxygen has a negative effect on fish and aquatic insects. Fine sediment within the streambed can restrict dissolved oxygen from reaching incubating eggs (Iwamoto ~~and Salo~~et al. 1978). Generally, the effects of the alternatives on dissolved oxygen would be tied to how well the alternatives protect stream temperature and, most importantly, addition of fine sediment. While other factors such as addition of stream nutrients and highly biodegradable organic matter can affect dissolved oxygen levels in water systems, these are usually of minor concern in forest streams (Spence et al. 1986; Hicks et al. 1991), and would have very low likelihood of affecting dissolved oxygen levels under any alternative.

No Action Alternative 1-Scenario 2

No Action Alternative 1-Scenario 2 would have the highest likelihood of management-related fine sediment inputs and elevated stream temperatures of any of the alternatives. This is primarily due to its relatively low equivalent buffer area index for sediment. The low sediment equivalent buffer area index stems from narrower RMZs and greater soil disturbance allowed near non-fish-bearing streams relative to the other alternatives. Overall the likelihood for elevated stream temperatures is considered moderate while the likelihood for continued management-related sediment inputs is high on both the east and westsides of the State. The resulting overall likelihood of low dissolved oxygen levels is considered to be moderate. The lower rating for dissolved oxygen is based on the fact that dissolved oxygen, while very important for all aquatic life, is less often noted as being a concern for salmonids from forest practices (Spence et al. 1996; Hicks et al. 1991) and is not reported as being as frequent of a water quality concern in State streams as temperature, as indicated by the relative frequency of 303(d) listed streams.

No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide better protection of sediment input and stream temperatures than No Action Alternative 1-Scenario 2. The likelihood of management-related fine sediment inputs is moderate, and the likelihood of adequate temperature protection is moderate to high, due primarily to: 1) increased buffer widths on S and F streams, 2) shade rules on the westside and the bull trout overlay for most streams on the eastside, and 3) moderate RMZs on all non-fish-bearing streams. Based on the relative rating of these two factors and the relative potential for dissolved oxygen problems in streams as noted in No Action Alternative 1-Scenario 2, the likelihood of low dissolved oxygen levels is low to moderate for this group of alternatives.

Alternative 4

Alternative 4 would have a lower likelihood of low dissolved oxygen levels relative to No Action Alternative 1-Scenario 1 and even lower likelihood relative to No Action Alternative 1-Scenario 2. This is mainly due to adequate protection for stream temperatures and management-related sediment inputs. The equivalent buffer area index for sediment is considered at 100 percent of maximum, and other factors would reduce sediment inputs and, therefore, reduce the potential for low dissolved oxygen levels in the substrate, where salmonid eggs may be developing. Alternative 4 also has a "no net increase" clause requirement for roads, which is not found in other alternatives. Since roads are often the main source of fine sediment input to streams from timber operations (Furniss et al. 1991) this would further reduce the potential for sediment inputs, and its related effects on dissolved oxygen, relative to other alternatives. With large buffers on all streams, the likelihood of elevated temperatures would be very low across the State.

4.8.3.10 Forest Chemicals

Overview of Effects

The effects of the alternatives on forest chemical entry into streams are analyzed in this subsection. Relative to historical chemical use, all alternatives represent an improvement. Compared to baseline conditions, the amount of chemicals likely to enter streams where aquatic organisms may be affected is expected to decrease under any of the alternatives. While the Washington Forest Practices Rules under each alternative govern the application of forest chemicals, other laws regulate the licensing of chemicals and the individuals who apply them (subsection 4.5.1, Surface Water Quality). The following paragraphs address the degree to which each alternative prevents forest chemical entry to surface waters and wetlands.

There is a moderate likelihood that forest chemicals would enter surface waters and wetlands under No Action Alternative 1-Scenario 2. The moderate likelihood is based on the more limited spray buffers required by the Washington Forest Practices Rules under this alternative.

There is a low to moderate likelihood that forest chemicals would enter surface waters and wetlands under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. The low likelihood is based on the wider spray buffers provided to fish-bearing waters under these alternatives, however, some direct entry to dry, non-fish-bearing channels could occur that could ultimately reach fish-bearing streams when flow returns. The moderate likelihood applies to these situations.

There is a low likelihood that forest chemicals would enter surface waters and wetlands under Alternative 4. This is because a minimum 50-foot no-spray buffer would be present on all streams.

Detailed Effects Analysis

The application of forest chemicals commonly occurs on commercial forestlands to decrease disease from fungal and insect pests and to decrease competition from undesirable vegetation (Washington Forest Practices Board 2001a, Appendix J). Of these categories of forest chemicals, herbicides are the most commonly used. Application techniques include hand, machine, and aerial spraying. Improper application of forest chemicals that result in delivery to fish-bearing streams can result in direct acute losses of fish and chronic reductions in fitness through disease, stress, or reduced feeding (Norris et al. 1991; Spence et al. 1996).

It should be recognized that evidence of acute or chronic negative effects of forest chemical use to fish under the Washington Forest Practices Rules in effect on January 1, 1999 (No Action Alternative 1-Scenario 2) is generally lacking. However, it is also clear that many of the commonly used chemicals have severe effects under laboratory conditions and if improperly used, applied during adverse conditions, or otherwise are allowed to enter fish-bearing waters at toxic concentrations, these effects could be realized in the environment. Consequently, the use of many forest chemicals requires a Class IV-Special permit (WAC 222-16-070) under all alternatives.

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, flowing streams and other areas with surface water would have a 25-foot or 50-foot buffer that would exclude machine and aerial spraying, respectively. However, no buffers are required for hand spraying. Based on required buffer widths, No Action Alternative 1-Scenario 2 is considered to have low to moderate likelihood of negative effects to fish.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Based on required buffer widths, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are expected to have a low likelihood of negative effects to fish. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, buffers for aerial application would include RMZ inner zones for fish-bearing waters plus an additional buffer (up to 325 feet) and offset (up to 50 feet) dictated by wind conditions and application height. Type N streams with flowing water would have buffers ranging from 50 to 100 feet depending upon wind conditions and application height. However, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would allow spraying directly over seasonal streams when water is not present. Consequently, persistent forest chemicals could be delivered to fish-bearing streams when flow returns. Some uncertainty is present under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 because implementation of buffer widths relies entirely on the skill and professional judgment of the pilot applying the chemical. Implementation of the buffers requires that pilots accurately judge wind speed, wind direction relative to the stream, and distance from the stream. In addition, direct spraying is allowed on Type N_s streams when no surface water is present, and persistent chemicals could eventually be transported to fish-bearing waters.

Alternative 4

Alternative 4 requires that no forest chemicals be used within 50 feet of all typed streams, including hand spraying, and that all plants with cultural value be protected from pesticides. Alternative 4 would offer very high protection compared to both scenarios of No Action Alternative 1 because chemical application would not occur within 50 feet of all streams. The requirement under Alternative 4 that plants with cultural value be protected is problematic for implementation of the prescription. It is unclear which plants are considered to have cultural value and how they would be identified and protected in the field. Consequently, in areas where extensive field surveys would be required to protect plants of cultural value, aerial pesticide spraying may be eliminated as a practical application technique.

4.8.3.11 Fish Passage

Overview of Effects

The effects of the alternatives on fish passage at roads and in streams are analyzed in this subsection. Proper fish passage is essential to ensure that both adult and juvenile fish can access suitable habitat. From an historical perspective, blockages to fish passage have been substantially reduced over time because of increased requirements to provide fish passage at culverts, improvements in road construction methods, the frequency of maintenance, and the implementation of BMPs (subsection 3.4.2.3, History of Forest Practices Affecting Erosion and Sedimentation). Therefore, compared to baseline conditions, fish passage is expected to increase under any of the alternatives. The following paragraphs address the effects of the alternatives on fish passage in a comparative manner.

Fish passage can be adversely affected by: 1) high suspended or bedload sediment; 2) high stream temperatures; 3) improper installation of culverts on fish-bearing streams; 4) improper identification of fish-bearing streams; and 5) loss of pool structures in high-gradient streams, due to the loss of LWD or as a result of channel scour (Bjornn and Reiser 1979; Spence et al. 1996; Palmisano et al. 1993; Murphy 1995).

Fish passage requirements for newly installed culverts would be similar among the four alternatives for new roads because all crossings require Hydraulic Project Approvals from WDFW, which would determine the requirement for acceptable fish passage and would approve installation methods. Under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4, changes in stream crossing standards specific to anadromous fish passage (WAC 222-24-040) are deleted from the Washington Forest Practices Rules, and standards are deferred to WDFW as part of a Hydraulic Project Approval as defined in the Hydraulic Code (WAC 220-110). Hydraulic Project Approvals are also required under No Action Alternative 1-Scenario 2. Consequently, the alternatives are essentially equivalent for new road construction.

However, the alternatives vary in the level and schedule for repairs of previously installed culverts that were installed improperly, without authorization, or that have subsequently become barriers to fish passage. The differences in water typing among the alternatives also affect which culverts must be fish-passable.

Substantial differences are present among the alternatives for identifying and modifying or replacing existing culverts that are passage barriers. As mentioned earlier, criteria for the construction of stream crossing structures under the January 1, 1999 Washington Forest Practices Rules are based, in part, on whether a stream is fish-bearing (WAC 222-24-040). For example, culverts must be a minimum diameter of 24 inches for streams with anadromous fish and a minimum diameter of 18 inches for streams with resident game fish. Therefore, the assumptions made in determining a fish-bearing stream are critical for evaluating whether existing stream crossings meet the Washington Forest Practices Rules.

The likelihood of correcting barriers to fish passage under No Action Alternative 1-Scenario 2 is low. This is because continued management-related inputs of coarse sediment are likely to produce aggraded channel conditions in some locations. Further, it is because the water typing system is less likely to properly identify fish-bearing streams, and the lack of RMAPs would not ensure all road-related barriers to fish passage are corrected.

The likelihood of correcting barriers to fish passage under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 is high. This is because these alternatives would reduce management-related inputs of coarse sediment that could aggrade channels, improve the identification of fish-bearing waters through the development and implementation of a new water typing system, and correct all road-related barriers to fish passage by 2016 through the implementation of RMAPs.

The likelihood of correcting barriers to fish passage under Alternative 4 is slightly higher than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, and substantially higher than under No Action Alternative 1-Scenario 2 because it accelerates the schedule for implementing RMAPs and requires a cap on road densities. Like No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, it also reduces management-related inputs of coarse sediment that could aggrade channels and implements a new water typing system.

Detailed Effects Analysis

Concerns for fish passage on commercial forestlands usually refer to passage through culverts at stream crossings. Culverts as barriers to fish passage are also a well-documented problem on Federal lands in the Pacific Northwest (U.S. General Accounting Office 2001). Reduced fish passage or complete blockages at culverts are usually the result of undersized culverts or culverts with water velocities too high for their length, sub-optimal placement relative to stream gradient and vertical drop, and lack of downstream holding pools (Hicks et al. 1991). However, other factors such as blockages caused by elevated stream temperatures, aggraded channel conditions, high suspended sediment levels, and loss of step-pool habitat can also restrict fish passage (Furniss et al. 1991; Washington Department of Ecology 2002a).

Historically, concerns were raised about large log jams and excessive stream loading from logging slash and debris that was left in streams, affecting fish passage that led to stream cleaning programs in some western states (Maser and Sedell 1994). However, the concerns over passage at log jams were minimized, and some stream cleaning programs were found to be detrimental. Consequently, resource agencies are now more careful about permitting or requiring LWD removal from streams.

Salmon and trout have a powerful instinctual desire to move upstream during spawning migrations, which leads them to pass seemingly insurmountable obstacles such as waterfalls. However, biological and physical limitations can restrict their movements. These limitations include burst swimming speed and duration, leaping ability, and water velocities and depth (Furniss et al. 1991; Bjornn and Reiser 1991; Dane 1978). Factors that affect burst swimming speeds and duration include fish size and condition. Larger fish can swim faster and fish approaching senescence have reduced capacity or require longer rest periods between bursts (Bjornn and Reiser 1991; Powers and Orsborn 1985). Leaping ability is a combination of swimming speed and the availability of suitably sized pools from which to leap. Optimally sized pools allow fish to reach maximum speed at the proper angle to make the leap (~~Watts 1974;~~ Baker and Vatapka 1990; Powers and Orsborn 1985). Swimming speeds and water velocities determine the length of pipe through which a fish can successfully maneuver (Washington Department of Fish and Wildlife 1999a; Baker and Vatapka 1990).

Culverts become barriers when their physical characteristics exceed the capacity of fish biology. Barriers can occur to both juveniles moving upstream and downstream and adults moving upstream. Common problems include perched outlets with unsuitable leaping pools, culverts that become dry during summer months, culverts that are too long, culverts with high gradients resulting in high water velocities, and culverts with inadequate resting places (Furniss et al. 1991; Baker and Vatapka 1990). In addition, undersized or poorly constructed culverts that blowout during peak flows can become obstacles until fixed.

Also, debris flows are considered the primary blockage of upstream passage on streams when they trap large amounts of sediment (Bryant 1983). Debris flows caused either from culvert outwash, road failure, or hillslope debris slides could cause this type blockage. High bed sediment load in streams has also been found to cause areas to go dry during some flows restricting migration at least temporarily (Hartm~~e~~an et al. 1996~~5~~). High temperatures or high suspended sediment loads also can cause temporary blockages (Newcombe and MacDonald 1991; Whitman et al. 1982; Lloyd 1987; Hicks 2002; Washington Department of Ecology 2002a).

As noted earlier, the assumptions used in deciding whether a stream is fish-bearing are critical in evaluating whether existing stream crossings are adequate to supply fish passage. The stream classification system used among the alternatives would affect this determination.

No Action Alternative 1-Scenario 2

The January 1, 1999 Washington Forest Practices Rules water classification system would be used under this alternative. It had the five follwing categories:

- Type 1: All waters inventoried as "Shorelines of the State"; highly productive fish-bearing waters
- Type 2: Highly productive fish-bearing waters not designated as Type 1 streams
- Type 3: Fish-bearing waters with moderate to slight fish use
- Type 4: Perennial non-fish-bearing streams
- Type 5: Generally seasonal non-fish-bearing streams

Numerous additional water typing criteria based upon channel width, gradient, flow, size of impoundment (if present), and level of domestic use are utilized to categorize a stream

(WAC 222-16-030). Recent checking of this classification system has shown that many fish-bearing waters were untyped or mistyped as non-fish-bearing waters. However, the interim typing system in the current Washington Forest Practices Rules, which accounts for much of this mistyping, is assumed to continue even under No Action Alternative 1-Scenario 2.

Under No Action Alternative 1-Scenario 2, the interim water typing criteria would continue to be used, and there would be no systematic upgrade of culverts with fish passage problems. Some culverts would be identified and fixed as part of Watershed Analysis, but Watershed Analysis is voluntary for private landowners. Consequently, problem culverts could remain barriers until a forest practices application was received for a nearby harvest, or the State identified the problem through a State-sponsored Watershed Analysis. Based upon the forest practices application or Watershed Analysis, Washington DNR could then require repair or replacement of problem culverts. WDFW could also require correction of blocking culverts under its own Hydraulic Project Approval authority, or work cooperatively with landowners and funding entities to correct problem culverts.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would require new stream typing systems that would increase the accuracy of fish-bearing stream identification and would expedite correction of fish passage problems.

Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 a new stream typing system would be implemented for State and private forestlands (DEIS Appendix B). The new system would include:

- Type S: All waters inventoried as “Shorelines of the State”
- Type F: Waters not classified as Type S, which contain fish habitat
- Type N: Waters not classified as Type S or F, which do not contain fish habitat and are either perennial streams (Type N_p) or seasonal (Type N_s)

Identification of Type F waters would occur using a model, currently under development, that is likely to be based on stream gradient, drainage size, and other factors. Type F waters are likely to include all streams currently categorized as Type 2 and Type 3, plus a portion of Type 4 streams. Errors in stream types from the model can be corrected based upon field observations. Implementation of the new model is expected to substantially increase the total miles of streams classified as fish habitat and would thus, necessitate that fish passage is provided for all life stages of fish on those streams, a substantial improvement over No Action Alternative 1-Scenario 2.

Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, landowners would be required to upgrade road networks to current standards by 2016, and large forest landowners must prepare an RMAP for their entire property by December 2005. Included in the Washington Forest Practices Board Manual are flow criteria for a given culvert length and fish species, and specific requirements for prioritizing roadwork based upon fish passage (Washington Forest Practices Board 2001b). Passage criteria for fish through culverts appear adequate for most species and life stages when compared to criteria reported by Powers and Orsborn (19854). However, water velocity criteria for trout are 50 to 100 percent higher than criteria reported in Powers and Orsborn (1984). Consequently, passage protection may not be adequate under all circumstances for trout. In combination, the new plan, passage criteria, and stream-typing system should result in substantial improvements in fish passage within the next 15 years under No Action Alternative 1-Scenario 1 compared to No Action Alternative 1-Scenario 2. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 do not require upgrades to all culverts. Upgrades would be required based upon the effect of a culvert on public resources. If no negative effects are present from a culvert, then the culvert would not require replacement until the end of its life.

Alternative 4

Alternative 4 would also require new stream typing systems that would increase the accuracy of fish-bearing stream identification and would expedite correction of fish passage problems. Alternative 4 would implement a new stream typing system based upon geomorphic characteristics:

- Type 1: Less than 20 percent gradient; all fish-bearing streams and other channels are considered important for fish
- Type 2: 20 to 30 percent gradients; channels are considered important for coarse sediment storage and as sources of LWD
- Type 3: Greater than 30 percent gradient; channels are considered prone to channelized landslides and as sources of LWD

Alternative 4 also includes road plans, but upgrades would be required by 2011. In combination, the new plan, passage criteria, and stream-typing system should result in substantial improvements in fish passage within the next 10 years under Alternative 4, with the largest amount of restoration occurring in eastside forests.

Alternative 4 does not require upgrades to all culverts. Upgrades would be required based upon the effect of a culvert on public resources. If no negative effects are present from a culvert, then the culvert would not require replacement until the end of its life.

In summary, as noted above, while culverts are the major factor potentially affecting fish passage related to forest practices, other factors including suspended and bedload sediment, and high water temperatures may affect fish passage or migration. Generally the relative rank of the alternatives for passage would follow that for coarse sediment, fine sediment, and water temperatures. Those alternatives with the highest likelihood of reducing management-related inputs of these parameters would be expected to have the highest likelihood for correcting fish passage barriers. The result would be that No Action Alternative 1-Scenario 2 would have the lowest likelihood for improvement while Alternative 4 would have the highest likelihood for improving fish passage conditions. No Action Alternative 1-Scenario 1 and Alternative 2 and 3 would be intermediate between these two.

4.8.4 Synthesis by Analysis Region

This subsection is designed to provide a regional perspective of the alternatives and a discussion of how they might affect the status of covered fish species found in the analysis regions. Numerous factors, including forest practices, affect the abundance and distribution of Pacific salmon and trout (Spence et al. 1996; Palmisano et al. 1993; NMFS 2000; Federal Caucus 1999). Other factors such as urbanization, agriculture, fish harvest, hatchery management practices, ocean conditions, and dams for hydroelectricity, flood abatement, irrigation, and drinking water all contribute in varying degrees to the current status of listed fish species. NMFS suggest that human-influenced changes in all of these factors (except perhaps ocean conditions) will be required to progress towards a regional recovery of these species (NMFS 2000; NMFS 1996b; NMFS 1998). Depending upon the watershed, each of the factors will have more or less influence on the recovery of any listed species in that watershed. Consequently, in any individual watershed, the Washington Forest Practices Rules may have a range of effects from slight to substantial on the salmonids in that watershed. Covered and other species were considered in the same manner as listed species, since factors affecting listed species would generally have similar effects on other species of concern. Special characteristics of these other species were considered and are noted in this evaluation where appropriate (FPHCP, Chapter 3, Biological Data on and Factors Affecting Covered Species).

The analysis in this subsection is based upon the assumption that factors unrelated to forest practices may prevent attainment of robust, harvestable populations of salmonids even if the prescriptions in the FEIS alternatives are fully effective in providing adequate habitat conditions. This assumption is necessary because integration of all the various factors and their range of possible future outcomes is highly speculative and would require a level of detail and site-specificity far beyond the scope of this analysis.

The forestlands subject to Washington Forest Practices Rules cover about 51 percent (approximately 8,005,000 acres) of all lands on the westside and about 12 percent (approximately 3,365,000 acres) of all lands on the eastside of Washington State (Tables 3-2 and 3-3). This is a significant amount of land for both portions of the State. Analysis regions containing larger amounts of forestland and forest practices activities should have proportionately larger effects on listed salmon and trout. However, this simple relationship is complicated by mixed ownerships and mixed management objectives in most parts of the State.

Relative to existing conditions within all regions, implementation of No Action Alternative 1-Scenario 2 would likely improve habitat conditions due to recovery of riparian function (Table 3-17) from past riparian harvest and other past associated forest practices in some forested regions. However, protection levels under No Action Alternative 1-Scenario 2, relative to other alternatives, would be low. In contrast, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 are considered to have moderate to high protection, and Alternative 4 is considered to have high to very high protection. One major difference under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 is that Channel Migration Zones would be recognized and protected, and RMZs would begin at the edge of Channel Migration Zones rather than from the ordinary high water mark as would be the case under No Action Alternative 1-Scenario 2.

Alternative 4 would implement the widest no-harvest buffers, includes an accelerated schedule for RMAPs, and provides a cap on road densities. Consequently, it would have the highest level of long-term protection among the four alternatives. However, in contrast to No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, Alternative 4 does not provide incentives to landowners to accelerate habitat recovery through active LWD placement strategies or thinning of over-stocked riparian stands. These strategies are allowable under Alternative 4 provided the landowner obtains a Class IV–special permit and a Hydraulic Project Approval, but there is little to no economic incentive to implement these strategies.

All of the alternatives would include some level of Watershed Analysis. No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would improve upon current Watershed Analysis methods by adding modules for cultural resources and stream restoration, and make improvements in the hydrology and water quality modules. Alternative 4 would also include a module for monitoring watershed conditions and prescription effectiveness. A major difference is that No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would eliminate the prescriptive phase of the riparian function module while the phase would continue under Alternative 4. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the prescriptive phase would not be needed, based upon the assumption that standard Washington Forest Practices Rules would be effective in preventing cumulative watershed effects.

While these alternatives do not include a direct watershed level perspective, the Washington Forest Practices Rules that would be implemented under these alternatives were based on extensive watershed analyses conducted from 1991 to 1996. So the practical benefit of the Watershed Analysis inclusion may only be slight. While Watershed Analysis is included in these alternatives, it is not likely to be implemented since it is dependent on State funding. Since adoption of the current Washington Forest Practices Rules very few new watershed analyses have been completed, and it appears that there is little incentive for Watershed Analysis to be done (Personal Communication, Darin Cramer, Washington DNR, April 9, 2004). The most common problem areas found during watershed analyses—riparian buffers, roads and unstable slopes—were the priority issues addressed in the Forests and Fish Report and the subsequent revised Washington Forest Practices Rules. Further, through the FPHCP, the State of Washington is pursuing incidental take coverage of aquatic species for the Washington Forest Practices Rules. Therefore, much of the benefit from and incentive to perform Watershed Analysis has likely been realized, or no longer exists, respectively.

Under Alternatives 2 and 3, effectiveness monitoring under the adaptive management program would result in a better understanding of the effects of forest practices on watershed processes and aquatic habitat. The adaptive management program is also assumed to implement any changes in prescriptions that are needed to maintain adequate levels of protection. Failure of these assumptions could be detrimental to the recovery of listed species even if individual prescriptions appear adequate. If standard Washington Forest Practices Rules provide all the necessary certainty to landowners concerning activities on their lands, the benefits of voluntary Watershed Analysis may not outweigh the costs to private landowners.

Because prescriptions are generally equivalent or more conservative under Alternative 4, the likelihood of voluntary completion of Watershed Analysis by landowners is probably about the same under this alternative as it is under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Nevertheless, Watershed Analysis may eventually be completed for all watersheds, but will likely require a longer period of time for completion since the analysis will be voluntary. Watershed analysis, when implemented, would continue to be important for obtaining and organizing baseline information needed for monitoring.

Changes in the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would have a greater influence on the long-term recovery of species than the short-term recovery. However, the reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate], Alternative 4 [low]) in evaluating effects (subsection 4.1.5, Adaptive Management). Improvements in road management practices and road upgrades should be apparent first, particularly related to fine sediment that influences the survival of incubating salmon and trout eggs. Increased fish passage through culverts would also be realized relatively quickly as RMAPs would be implemented by 2011 (Alternative 4) or 2016 (No Action Alternative 1-Scenario 1 and Alternatives 2 and 3). A reduction in the frequency and magnitude of mass wasting events that deliver coarse sediment to streams should become apparent. However, some streams may require many years to recover from historical management-related inputs of coarse sediment (20 to 100 years or more). Similarly, the recovery of LWD recruitment is a long-term process. Moderate levels of recovery may require 80 years or more in riparian areas dominated by early-seral stage stands. Some stands will require longer periods to achieve key piece-size trees without some form of management such as thinning or removal of hardwoods. Consequently, in severely degraded forested areas, it is unlikely that fish habitat conditions will improve substantially in the near-term (less than 20 to 40 years) without enhancement.

Many factors have contributed to the decline of the listed fish species in the Pacific Northwest. The term for these factors has sometimes been referred to as the “four H’s.” The H’s refer to effects of habitat, harvest, hatcheries, and hydropower on these fish (Federal Caucus 1999, see also the archive for all Federal Caucus documents, http://www.salmonrecovery.gov/Archive_chronological.shtml). For recovery of listed fish species and protection of many other species, actions in all of these areas are needed. The actions being considered in this document would affect only the habitat “H” in each region. But the overall effect on covered species not only depends on the effectiveness of these actions, but also on what is occurring to habitat from other land use practices (i.e., agriculture, urbanization), as well as the harvest, hatcheries, and hydropower factors in each region. The following paragraphs include a region-based synthesis of how the alternatives may potentially affect covered species in light of the four H's in each of these regions. Hatchery effects will be discussed in more detail in Chapter 5, Cumulative Effects.

4.8.4.1 North Puget Sound

A high proportion of this Region is designated as forestlands (78 percent or 3,427,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a small portion, about 24 percent (1,075,000 acres) of lands, which includes 31 percent of all forestlands in the Region. Washington DNR also manages an additional 11 percent of all lands (14 percent of all forests), primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, account for a large part of the Region, primarily associated with the North Cascades National Park and other designated wilderness areas, including about 37 percent of all lands (48 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 5 percent of all lands (7 percent of all forests).

The amount and location of streams and forested lands affected by forest practices has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative amount of streams is high in this Region (28,653 stream miles), having 11 percent of all State stream miles. This Region also has a relatively low portion of all stream miles (26 percent) subject to the Washington Forest Practices Rules, and ranks as the lowest among western Washington regions. Exempt 20-acre parcels comprise about 0.7 percent of the forestlands and about 1.5 percent of the forestlands subject to the Washington Forest Practices Rules in the North Puget Sound Region (Rogers 2003).

Chinook salmon and bull trout are listed as threatened in the Region, and seven other species with State or Federal status are present, including coho salmon, coastal cutthroat trout, Pacific lamprey, river lamprey, Salish sucker, eulachon, and green sturgeon (subsection 3.8.4, The Freshwater Aquatic Ecosystem).

Habitat, hydropower, hatcheries, and harvest are the major factors affecting fish populations. Each of the four H's has been cited as contributing to the listing of the species. While many lowland areas of the Region are highly urbanized, some having dense population centers (e.g., Bellingham, Everett), the urban environment is less than 2 percent of the Region. The major rivers have all had extensive floodplain and estuarine modification. Lower mainstem river modifications have included extensive diking along the Skagit, Stillaguamish, and Nooksack Rivers. Better timber management over the past three decades has improved habitat to a greater degree than in urban and agricultural areas (DEIS Appendix). In this Region, mass wasting has been a historical timber management problem (DEIS Appendix A). The Skagit and Snohomish River systems have hydroelectric and/or drinking water dams and reservoirs.

Overall, ongoing improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have low to moderate benefit to the recovery of the listed species due to the relatively small portion of streams that would be affected. Also, because non-forest related activities have a large effect on these species, changes in Washington Forest Practices Rules, by themselves, are unlikely to lead to the recovery of these species.

Changes in the Washington Forest Practices Rules would likely have the largest effect on bull trout and cutthroat trout because they are predominantly found in forested areas and are influenced less by marine factors, harvest, hatcheries, and urbanization (subsection 3.8 2, Fish Status in Washington). No Action Alternative 1-Scenario 2 could reduce chances of recovery in this Region because of relatively low protection of fish habitat. However, conversion of forestland to land development would reduce the benefits of any alternative for covered species, but especially under Alternative 4, which would likely have the highest conversion rate while Alternative 2 would have the lowest rate (subsection 4.2.3.2, Forestland Conversion). The abundance of urban areas would contribute to conversions in this Region relative to most other regions.

Protection for the other seven representative covered species (those with lesser Federal or State status) in this Region would be affected in a similar manner, by the alternatives, as the listed stocks. Generally most would be less directly affected by the considered forest management regulations. Coho salmon and coastal cutthroat trout would be affected in a manner similar to the listed stocks as both species rely on many of the same habitat features. Neither species is likely to be as affected to the degree bull trout would likely be, as they are not as dependent on very cold water conditions found in headwater streams. Sea-run and other migratory life history forms of cutthroat often use high gradient, small tributaries; however they have a broader habitat use encompassing low elevation streams, and sea-runs frequently use estuaries (subsection 3.8.3.1, Pacific Salmon and Trout - General). The other representative covered species are less associated with forested mountainous regions where many of the managed forests occur.

Green sturgeon are rarely present in any the streams in of this Region and would only be found in the lowest reaches of major rivers where other land practices (e.g., diking, estuary modification, water quality) have more dominant habitat effects (subsection 3.8.3.2, Green Sturgeon). Differences among alternatives are unlikely to significantly affect this species.

Eulachon is also primarily found in the lower reaches of major rivers (e.g., Nooksack River) and are likely most affected by lower river land use practices. However, improved overall stream conditions related to flow, sediment, and large wood would be of benefit and would result more from No Action Alternative 1-Scenario 1, Alternatives 2 and 3, and mostly by Alternative 4.

Salish suckers mostly utilize lower velocity areas of larger streams and ponds (subsection 3.8.2.10, Mountain Sucker and Salish Sucker). These areas are again, less directly affected by the alternatives being considered, but also would benefit from improved habitat conditions that would be provided by all but No Action Alternative 1-Scenario 2.

Both Pacific and river lamprey would be more restricted to the larger streams and adjacent low gradient tributaries. Both require clean gravel conditions for spawning, and juveniles rear for several years in fine sediment in tributaries and rivers. Warm temperatures, sediment in gravels, and upstream migrations barriers are believed to be limiting factors for these species (Close et al. 1995). Improved forest practices, as included in all but No Action Alternative 1-Scenario 2, would benefit these fish species, but other in-basin activities (e.g., agriculture, urbanization, floodplain diking) would play a major role in maintaining these stocks. No marked differences among alternatives relative to their marine life cycle are expected, as they are not reported to rely on estuary conditions as adults, which are where alternatives may differ slightly in their effects (subsection 4.8.2, Nearshore Marine Areas, and subsection 3.8.3.3, Pacific and River Lamprey).

4.8.4.2 South Puget Sound

A high proportion of this Region is designated as forestlands (70 percent or 1,532,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a moderate portion, about 45 percent (970,000 acres) of lands, which includes 63 percent of all forestlands in the Region. Washington DNR also manages an additional 7 percent of all lands (10 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, include about 13 percent of all lands (19 percent of all forests). Also Federal and tribal forestlands, available for timber harvest, equal about 6 percent of all lands (8 percent of all forests). Exempt 20-acre parcels comprise about 0.6 percent of the forestlands and about 0.8 percent of the forestlands subject to the Washington Forest Practices Rules in the South Puget Sound Region (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative amount of stream miles is moderate in this Region (13,832 stream miles), having 5 percent of all State stream miles (about half that of North Puget Sound). But this Region has the second highest portion of all stream miles (52 percent) protected under the Washington Forest Practices Rules among the 12 regions.

Chinook salmon and bull trout are listed as threatened in the South Puget Sound Region. Six of the same seven species (not eulachon) with lesser State or Federal status, identified for North Puget Sound, are present in South Puget Sound plus the Olympic mudminnow and pygmy whitefish.

Effects on fish in this Region differ from North Puget Sound primarily in the very large portion of the Region that is commercial or residential uses. This Region has the largest portion of urbanized area of any region in the State at about 17 percent of the total regional area (Table 3-2); it includes Seattle, Tacoma, and Olympia as major urban centers. Similar to North Puget Sound, most major rivers systems have had major estuarine development and diking, with the only exception being the Nisqually River. Dams constructed for hydropower and water storage have had a major effect on available habitat in the Region. Dams are located on the Cedar, Green, White, Puyallup, and

Nisqually Rivers. These developments include some blockages of historical spawning and rearing areas. Landslide potential is of concern in some of the subbasins within this Region (DEIS Appendix A).

Lack of agricultural and urban buffers are considered one of the major limiting factors in the Region. The forested riparian corridors are mostly in early-seral stages and will need many years before they contribute to LWD recruitment. Recovery of LWD recruitment is slow, and instream LWD is often removed inappropriately. However, over the last 30 years, improved riparian management has resulted in improvements in forest areas relative to the urban areas (DEIS Appendix A).

The improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have moderate benefits to the recovery of listed species due to the relatively high portion of streams that would be affected. However, changes in Washington Forest Practices Rules, by themselves, are unlikely to lead to the recovery of these species. This is especially true for the large habitat alterations that are likely to remain in the lower floodplain area from the commercial/industrial development. As noted for North Puget Sound, the largest benefit would likely be for bull trout because they are predominantly found in forested areas and are influenced less by marine factors, harvest, hatcheries, and urbanization. No Action Alternative 1-Scenario 2 could reduce chances of recovery in this region because of relatively low protection of fish habitat. Conversion of forestland to non-forest uses would reduce the benefits of any alternative for covered species. Conversions are likely be the highest in this Region under any alternative, but especially under Alternative 4 which would likely have the highest conversion rate while Alternative 2 would have the lowest rate (subsection 4.2.3.2, Forestland Conversion).

Protection to the other representative covered species would be similar to the protection noted for similar species in North Puget Sound. Pygmy whitefish are primarily found in cold mountain lakes and, when in streams, require clear, cold water. They are susceptible to sedimentation and increased temperature (subsection 3.8.3.5, Pygmy Whitefish). Benefits from the alternatives for this species may be similar to that of bull trout because its habitat is more affected by forest practices. The Olympic mudminnow would likely experience relatively lower benefits from implementation of any of the alternatives because they are more often found in lowland low-gradient streams that, in this Region, are generally more prone to industrial, agricultural, or urban developments.

4.8.4.3 West Puget Sound

A very high proportion of this Region is designated as forestlands (88 percent or 1,522,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a moderate portion, about 40 percent (700,000 acres) of lands, which includes 46 percent of all forestlands in the Region. Washington DNR also manages an additional 10 percent of all lands (11 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, include about 36 percent of all lands (4 percent of all forests). Federal and tribal forestlands, available for timber harvest, also equal about 1 percent of all lands (2 percent of all forests). Exempt 20-acre parcels comprise about 2.2 percent of the forestlands and about 3.8 percent of the forestlands subject to the Washington Forest Practices Rules in the West Puget Sound Region (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative number of stream miles is low in this Region (9,114 stream miles), which includes about 3 percent of all State stream miles. This Region also has a high portion of all stream miles (43 percent) protected under the Washington Forest Practices Rules.

Chinook salmon and bull trout inhabit this Region, which are federally listed as threatened, plus a threatened summer run of chum salmon that occurs in northern Hood Canal and the eastern Strait of Juan de Fuca. Six of the same seven species (not eulachon) with lesser State or Federal status as North Puget Sound are present here, plus the Olympic mudminnow.

The Region has a mix of land uses that may affect fish habitat. There are moderate amounts of residential/commercial development (4 percent) and agriculture land uses (3 percent). The effects of the four H's have been less severe here than in the remainder of Puget Sound. However, effects have included a major blockage of the Elwha River, including nearly the entire pristine portion of the watershed; substantial portions of the Skokomish River in south Hood Canal are also blocked. Most streams, however, are relatively small, other than the Dungeness and Elwha Rivers, with many drainages extending into the Olympic National Park.

Private timber harvest area includes much of the lowland areas of the Kitsap Peninsula, which has a high rate of land conversion (See below for effects). With the presence of the National Park and other protected areas, much of the forestland is not managed for timber production (Table 3-3). An additional portion has protections under the State Trust Lands HCP (Washington DNR 1997d). The Olympic Peninsula has naturally high rates of debris avalanches that contribute large amounts of sediment and organic debris to streams. Due to their small size, almost no streams have naturally large estuaries and thus, other than the Skokomish River, have not undergone large modifications like other major rivers in Puget Sound. With improvements in riparian management over the last 30 years and much of the upper portions of riparian areas protected, streams in the Region are recovering and have the advantage of relatively low impacts from activities relative to other Puget Sound regions.

The riparian buffers under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have moderate benefits to the recovery of listed species. However, the high portion of exempt 20 acre parcels (DEIS Appendix A) may reduce the overall benefits of No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 due to less protective riparian buffers on these parcels. The relatively good environmental conditions, lack of large non-forest related impacts (relative to other Puget Sound regions), and high portion of forests that are under the Washington Forest Practices Rules, contributes to this recovery benefit. As with other areas, bull trout would benefit most from implementation of these alternatives among the listed species due to its preference for low stream temperatures and its lack of influence by hatcheries or commercial effects relative to the two other listed species (subsection 3.8.5.3, West Puget Sound). No Action Alternative 1-Scenario 2 could reduce chances of recovery in this region because of relatively low protection of fish habitat. Conversion of forestland to non-forest uses would reduce the benefits of any alternative for covered species, but especially under Alternative 4, which would likely have the highest conversion rate. Alternative 2 is expected to have the lowest rate of conversion (subsection 4.2.3.2, Forestland Conversion). The expansion of urban area would contribute to conversions in this Region relative to most other State regions.

Protections to the other seven representative covered species would be similar to those noted for North Puget Sound for the same species. Protections for the Olympic mudminnow would be as described for the South Puget Sound Region.

4.8.4.4 Islands

A high proportion of this Region is designated as forestlands (73 percent or 180,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a moderate portion, about 63 percent (154,000 acres) of lands, which includes 86 percent of all forestlands in the Region. Washington DNR also manages an additional 4 percent of all lands (6 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, include about 5 percent of all lands (7 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 2 percent of all lands (2 percent of all forests). Exempt 20-acre parcels comprise about 1 percent of the forestlands and about 1.1 percent of the forestlands subject to the Washington Forest Practices Rules in the Islands Region, based on an analysis done only in the San Juan WRIA by Rogers (2003).

The proportion of total stream miles in the State contained within the Islands Region is very low (1,009 stream miles or less than 1 percent). However, this Region has a high portion of all stream miles (47 percent) protected under the Washington Forest Practices Rules.

No listed or other representative covered species are present in the Island Region, but coho salmon and searun cutthroat are present. The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of these fish to varying degrees.

Agricultural areas (17 percent) and growing commercial/residential areas (6 percent) comprise a relatively high proportion of total land area in the Region, especially for western Washington. Habitat modification has been the major impact in this Region, as the other four H's have had relatively minor effects. Most streams are generally ephemeral and do not provide adequate flow for salmonid use. However, where habitat is present, access may be the greatest limiting factor (e.g., culverts, tidegates) (DEIS

Appendix A). The major concern for the Islands Region is conversion of shoreline forest to residential land use and shoreline hardening (DEIS Appendix A). These factors could affect major salmon runs from rivers adjacent to this Region (e.g., Nooksack, Skagit, and Snohomish Rivers) that use marine shoreline areas during early rearing and adult migration.

Overall, ongoing improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have no effect to slight benefits on the recovery of the listed species due to the fact that there is no freshwater habitat use by currently listed fish species. No Action Alternative 1-Scenario 2 would also have no effect on recovery because of a lack of habitat use by listed species in the region. Also, a relatively small portion of freshwater fish habitat may be affected by these actions. Additionally, non-forestland uses (e.g., conversion of shoreline areas to housing) are likely to have a larger effect on listed species and other covered species that may use marine shoreline areas than implementation of the alternatives. Changes in the Washington Forest Practices Rules by themselves are unlikely to lead to the recovery of regional listed species or local representative covered species.

4.8.4.5 Olympic Coast

This Region has the highest proportion of lands designated as forestlands of any region in the State (95 percent or 1,671,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a low portion, about 26 percent (451,000 acres) of lands, which includes 27 percent of all forestlands in the Region. Washington DNR also manages an additional 18 percent of all lands (18 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest (mostly National Forest and National Park at higher elevations), include about 39 percent of all lands (41 percent of all forests). Also Federal and tribal forestlands, available for timber harvest, equal about 13 percent of all lands (14 percent of all forests). Exempt 20-acre parcels comprise about 0.3 percent of the forestlands and about 0.7 percent of the forestlands subject to the Washington Forest Practices Rules in the Olympic Coast Region (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of these fish to varying degrees. The relative number of stream miles is moderate in this Region (14,959 stream miles), representing 6 percent of all State stream miles. This Region also has a moderate portion of all stream miles (29 percent) protected under the Washington Forest Practices Rules.

The Olympic Coast Region contains Lake Ozette sockeye salmon and Coastal-Puget Sound bull trout, which are both listed as threatened within this Region. Other representative covered species found in this Region include coho salmon, coastal cutthroat trout, Pacific and river lamprey, Olympic mudminnow, and eulachon.

Of the four H's, habitat appears to be the primary factor affecting bull trout. Unlike regions discussed above, hydroelectric facilities are not considered a major issue in general, although one or more dams may be important in specific basins. No hatcheries are stocking bull trout in the Region. This Region has the largest proportion of the total land area in forest and the smallest proportion of commercial/residential (0.1 percent) and agricultural areas (0.3 percent of all lands). Total stream miles in this Region are substantial; however, a relatively small portion of these streams are protected under the Washington Forest Practices Rules.

Past timber harvest has been accelerated the rate of shallow rapid landslides, and forest roads have added substantial sediment to streams (DEIS Appendix A). Because timber harvest occurred more recently in this Region relative to other areas of the State, riparian recovery is in the early conifer and hardwood stages of development. Consequently, improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have a moderate effect on the recovery of listed or potentially listed species, particularly bull trout. No Action Alternative 1-Scenario 2 could reduce chances of recovery of listed or potentially listed fish in this region because of relatively low protection of fish habitat. Other protection and recovery programs in the Region could also have a substantial influence.

The distribution of listed sockeye salmon is restricted, and the NMFS status review (Waples ~~et al.~~ and Johnson 1991) cited several major non-forestry related factors (e.g., non-native introductions, ocean conditions, and harvest affecting their status) affecting the species. Nevertheless, Nehlsen et al. (1991) also indicated forest practices in the 1940s and 1950s may have contributed to their decline. Consequently, improvements in the Washington Forest Practices Rules, for all alternatives except No Action Alternative 1-Scenario 2, could have a positive effect on the recovery of sockeye salmon in this Region.

The effects on most other covered species would similar to the effects described for the Puget Sound regions. However, the Olympic mudminnow would likely experience a higher relative benefit than was noted for the South Puget Sound Region for all alternatives except No Action Alternative 1-Scenario 2, due to the fact that they are more often found in low-elevation, low-gradient streams that are more often subject to forest management practices, relative to the South Puget Sound Region where lowlands are often in industrial, agricultural, or urban areas (DEIS Appendix A).

4.8.4.6 Southwest

A very high proportion of this Region is designated as forestlands (89 percent or 2,058,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a high proportion of lands, (70 percent or 1,619,000 acres) which includes 79 percent of all forestlands in the Region. Washington DNR also manages an additional 13 percent of all lands (14 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, include about 6 percent of all lands (7 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal less than 1 percent of all lands (less than 1 percent of all forests). Exempt 20-acre parcels comprise about 0.8 percent of the forestlands and about 0.8 percent of the forestlands subject to the Washington Forest Practices Rules in the Southwest Region (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of these fish to varying degrees. The Region contains a large number of stream miles (28,607 stream miles), which comprises 11 percent of all stream miles in the State. This Region also has the highest portion of all stream miles (74 percent) protected under the Washington Forest Practices Rules.

Bull trout is the only federally listed species in the Region, but coho salmon is a Federal species of concern. Additional representative covered species present in the Region are similar to North Puget Sound including coastal cutthroat trout, green sturgeon, Pacific and river lamprey, Olympic mudminnow, and eulachon.

Similar to the Olympic Coast Region, habitat degradation appears to be the leading factor influencing listing of species in the Region (DEIS Appendix A). A few hydroelectric projects are present in the Region, but they are not a major fisheries issue (DEIS Appendix A), and no hatcheries stock bull trout. But unlike the Olympic Coast, this Region has substantial agricultural areas (6.2 percent), and residential/commercial areas are increasing (1.3 percent of the land). The agricultural and residential/commercial land base is associated primarily with the towns of Aberdeen and Hoquiam, and located at the mouth of the Chehalis River, and at the upper Chehalis River basin.

Delivery of fine sediment to streams is considered a key limiting factor to instream habitat in the Willapa Hills, and the Region has a high proportion of unstable slopes and landforms (DEIS Appendix A). Urbanization and agricultural practices, especially in the Chehalis River valley, have also had adverse habitat and water quality effects (DEIS Appendix A). Two large estuaries, Grays Harbor and Willapa Bay, are present in this Region. While Grays Harbor has had substantial development (about 30 percent of the intertidal area has been lost), Willapa Bay is the least developed large estuary in the State (DEIS Appendix A).

Consequently, the relatively high portion of forested land in the Region protected under the Washington Forest Practices Rules suggests that improvements to the rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 are likely to have a large effect on the recovery of listed or potentially listed species. Other land uses are likely to have only a moderate effect on species recovery. No Action Alternative 1-Scenario 2 could reduce chances of recovery because of relatively low protection of fish habitat. Effects of the alternatives on the other representative covered species would be as discussed for the Puget Sound Regions and the Olympic Coast Region for Olympic mudminnow.

4.8.4.7 Lower Columbia River

A very high proportion of this Region is designated as forestlands (85 percent or 2,616,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private holdings on a moderate portion of lands (about 43 percent or ~~1,619,000~~ 1,320,000 acres), which includes ~~51~~ 50 percent of all forestlands in the Region.

Washington DNR also manages an additional 10 percent of all lands (12 percent of all forests) primarily under its State Trust Lands HCP (Washington DNR 1997d). Federal- and State-protected forestlands, not managed for timber harvest, include about 23 percent of all lands (~~28~~ 27 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 9 percent of all lands (10 percent of all forests). But unlike the Southwest Region, where the Washington Forest Practices Rules affect most of the area, only about half of the area in the Lower Columbia Region is regulated under the rules. Forestland comprises a very high proportion of this Region relative to other regions in western Washington. The proportion of area in residential/commercial (2~~.1~~ percent) and agricultural (6 percent) land uses is moderate. Exempt 20-acre parcels comprise about 1.4 percent of the forestlands and about 2.3 percent of the forestlands subject to the Washington Forest Practices Rules in the Lower Columbia Region (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative number of stream miles is high in this Region (29,645 stream miles), accounting for 11 percent of all State stream miles. This Region also has a very high proportion of all stream miles (51 percent) protected under the Washington Forest Practices Rules.

The Lower Columbia River Region includes four federally listed fish populations (i.e., Evolutionarily Significant Units [ESU] or Distinct Population Segments [DPS]). Additional listed populations migrate through the Region to the Willamette, upper Columbia, and Snake Rivers in other regions (Table 3-20). Federally listed chinook salmon, chum salmon, and steelhead are present downstream of Mossyrock Dam and Merwin Dam on the Cowlitz and Lewis Rivers, respectively, plus other tributaries and the mainstem Columbia River. Bull trout are listed as threatened throughout the Region where they are present while Coho salmon is a Federal candidate species. The list of other representative covered species differs slightly from that of Puget Sound and Coastal Regions and includes coastal cutthroat trout, green sturgeon, Pacific and river lamprey, leopard dace, eulachon, mountain sucker, and sandroller.

Each of the four H's has been cited as affecting one or more of the listed species and likely to affect other representative covered species. Hydropower development has had the largest impact on the Lower Columbia Region including total blockage of hundreds of stream miles (e.g., Cowlitz and Lewis Rivers) (DEIS Appendix A). The eruption of Mt. St. Helens in 1980 contributed substantial sediment to the Toutle, Cowlitz, and Columbia Rivers (DEIS Appendix A). Sediment input is considered to be a primary limiting factor in the Cascade foothills (DEIS Appendix A).

Urbanization and agricultural development have impacted most of the larger valleys, especially the Cowlitz River watershed. LWD is considered in low supply in much of this basin due primarily to past land use practices (DEIS Appendix A). Habitat in the Columbia River estuary has been greatly modified through diking, channelizing, dredging, and losses of nutrient and sediment sources trapped by upstream dams (DEIS

Appendix A). These activities have extended up the Columbia River mainstem. However because much of the Region is regulated under the Washington Forest Practices Rules, improvements in those rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have a slight to moderate effect on the recovery of listed or potentially listed species. No Action Alternative 1-Scenario 2 could reduce chances of recovery in this Region because of relatively low protection of fish habitat.

Protection for the other seven representative covered species (those with lesser Federal or State status) would be affected in a similar manner by the alternatives as the listed stocks. These other species would be affected in a way similar to those discussed for the Puget Sound regions for the same species. Even though green sturgeon are more common in the lower Columbia River than in Puget Sound regions, the Washington Forest Practices Rules are likely to have little influence on this species since many other factors (e.g., hydropower, water storage, dredging, diking, water quality, shoreline development, harvest) have a greater influence on habitat conditions in the lower Columbia River.

The mountain sucker is sensitive to high temperatures and sediment in spawning habitat, and possibly absence of preferred food. They also mostly utilize lower velocity areas of larger streams (e.g., Cowlitz and Toutle Rivers) and ponds (subsection 3.8.3.10, Mountain Sucker and Salish Sucker). These larger streams are less directly affected by forest practices, but would benefit from improved habitat conditions that would be provided by all but No Action Alternative 1-Scenario 2. No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would have positive effects on maintaining these populations because of potential improved habitat conditions (e.g., temperature, sediment) in streams on forestlands.

Leopard dace distribution is spotty but the species is likely to occur in pools and medium velocity waters of streams and rivers (Wydoski and Whitney 2003). The formation of reservoirs, water level fluctuations (likely hydro-induced), and increased sedimentation are more likely limiting conditions. Improved protection from sediment delivery under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would likely provide greater benefits than No Action Alternative 1-Scenario 2 because of potential improved steam habitat conditions (e.g., LWD aiding pool formation) on forested lands.

The sandroller is often secretive and is found in quiet backwaters with cover, such as rootwads, undercut banks, and deep pools in the Columbia River (Wydoski and Whitney 2003). Increased LWD, primarily in tributary streams, would enhance survival of this species.

4.8.4.8 Middle Columbia River

A moderate proportion of this Region is designated as forestlands (~~47~~41 percent or 2,691,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private and State lands on a low proportion of lands (15 percent or 944,000 acres), which includes 35 percent of all forestlands in the Region. Federal- and State-protected forestlands, not managed for timber harvest, include about 14 percent of all lands (33 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 13 percent of all lands (32 percent of all forests). Exempt 20-acre parcels comprise less than 0.1 percent of the forestlands and about 0.2 percent of the forestlands subject to the Washington Forest Practices Rules in the Middle Columbia Region (Rogers 2003).

The amount and location of streams and land affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative number of stream miles is high in this Region (32,878 stream miles), having 12 percent of all State stream miles. However, this Region has a low proportion of all stream miles (20 percent) protected under the Washington Forest Practices Rules.

Six federally listed fish populations spawn and rear within this Region, and other populations (e.g., sockeye) migrate through to Snake and Columbia River tributaries. Chinook and chum salmon are listed in the westernmost potions of this Region as part of the lower Columbia River ESU, and steelhead are listed as threatened throughout the Region except for the White Salmon River. Bull trout are listed as threatened throughout the Region. Other representative covered species present in the Region include westslope cutthroat, interior redband trout, Pacific and river lamprey, pygmy whitefish, Umatilla and Leopard dace, mountain sucker, and sandroller.

Each of the four H's has been cited as contributing to the listing of one or more of the species. Residential areas comprise a relatively small proportion of all lands in the Region (about 1.2 percent). Agriculture is an important land use within the Region accounting for 18 percent of all lands, particularly within the Yakima Valley, and irrigation diversions have been cited as a major fish concern in the Region relating to fish barriers, water quality, instream flow, and fish predation (DEIS Appendix A). Several major hydroelectric dams are also present in the Region (e.g., Bonneville, The Dalles, John Day) and as well as irrigation dams (e.g., Cle Elum, Kachees, Keechelus, Rosa) and have contributed to habitat loss, reduced survival, and blockage of fish passage. Grazing and, to a lesser degree, urban development impact fish resources and their habitat based on relative amount of the Region affected (DEIS Appendix A).

Extensive road networks in some basins have accelerated sediment inputs (DEIS Appendix A). High temperatures in many areas (e.g., Yakima mainstem and Naches, Teanaway Rivers) have contributed to limited spawning and rearing in the system (DEIS Appendix A). Consequently, improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have a moderate effect on the recovery of listed or potentially listed species. No Action Alternative 1-Scenario 2 could reduce chances of recovery or decrease the rate of recovery in this Region because of relatively low protection of fish habitat.

Improvements in the Washington Forest Practices Rules would likely be a major factor in the recovery of bull trout in the Region because they are predominantly found in forested areas and are influenced less by marine factors, commercial harvest, and urbanization (Fed. Reg. Vol. 63, No.111, June 10, 1998: 31647-31674). Improvements in the Washington Forest Practices Rules would be important for the recovery of chinook salmon and steelhead; however, successful recovery will also likely require improvements in other land use practices. Other covered species would also benefit in a similar manner. Effects would be similar to those noted for the Lower Columbia Region for the same species.

The benefits to westslope cutthroat, redband trout, and pygmy whitefish would be similar to those for bull trout because of their more typical reliance on higher elevation forested streams (primarily coldwater lakes for pygmy whitefish) and limited use of larger mainstem rivers that are more heavily affected by non-forestry activities.

The Umatilla dace may benefit from the noted alternatives, but little difference would likely exist among them. One of the main limiting factors for Umatilla dace appears to be adequate flow needed for maintenance of interstitial habitat in large substrate in the lower reaches of larger rivers (Wydoski and Whitney 2003). This condition would more often be affected by irrigation and hydroelectric practices than forest practices in this Region (DEIS Appendix A)

4.8.4.9 Snake River

A very low proportion of this Region is designated as forestlands (8 percent or 376,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private, Washington DNR, and other State holdings, on a very low portion, about 3 percent (132,000 acres) of all lands, which includes 35 percent of all forestlands in the Region. Federal- and State-protected forestlands, not managed for timber harvest, include about 2 percent of all lands (25 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 3 percent of all lands (40 percent of all forests). Exempt 20-acre parcels comprise less than 0.5 percent of both the total forestlands and the forestlands subject to the Washington Forest Practices Rules in the Snake River (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish to varying degrees. The relative amount of stream miles in the Snake River Region is moderate (19,488 stream miles), which includes 7 percent of all State stream miles. This Region also has a very low proportion of total stream miles (5 percent) protected under the Washington Forest Practices Rules.

Chinook salmon, sockeye salmon, steelhead, and bull trout are present in the Region. However, sockeye salmon do not spawn or rear in the Region but use the mainstem Snake River as a migration corridor. Chinook, steelhead, and bull trout are listed as threatened within the Region. Other representative covered species present in the Region include westslope cutthroat, interior redband trout, Pacific and river lamprey, margined sculpin, and sandroller.

Each of the four H’s has been cited as contributing to the listing of one or more of the species. However, the Region is relatively arid with agricultural land uses (52 percent) and shrublands (29 percent) accounting for most of the land. Forestlands comprise only 8 percent of the Region, and only a moderate amount of that area is regulated under the

Washington Forest Practices Rules. Irrigation diversions have had a large effect on habitat in many of the river basins (e.g., Walla Walla River Basin), causing reduced flows and higher water temperatures in many reaches, as well as historically delaying or preventing migration of juveniles. High sedimentation is a problem from both agriculture and grazing, but past logging and road development have also contributed substantial sediment inputs in some drainages (e.g., Asotin Creek) (DEIS Appendix A).

Large areas of riparian forest have been converted to agriculture, and streams have been channelized and diked. The headwater areas (mostly forested) are the only remnants of undisturbed habitat within much of this Region. A substantial portion of the fish habitat upstream in Idaho is unavailable to listed anadromous species because of impassable dams on the Snake River (e.g., Dworshak, Hells Canyon Complex). Four other major hydroelectric dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) are present along the lower Snake River and are considered by many to be a major influence on the status of chinook salmon, sockeye, and steelhead in the Region (NMFS 2000; NMFS 1998; NMFS 1996b; Schaller et al. 1999).

Consequently, riparian buffers under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 would represent a minor contribution towards the overall recovery of listed species in the Region. However, within those areas that do have forest practices, riparian buffers should provide benefits to species that utilize those areas from improved stream habitat conditions (e.g., increased stream complexity from increased LWD), which would include bull trout in the Asotin and Tucannon basins. No Action Alternative 1-Scenario 2 could reduce chances of recovery within the limited forested areas covered in this region because of relatively low protection of fish habitat.

The other covered species would also benefit in a similar manner. Effects would be similar to those noted for the Lower Columbia Region for the same species occurring there. Known margined sculpin distribution in Washington is limited to tributaries of the Walla Walla and Tucannon Rivers. The species uses moderate-sized streams in pools and glides, and is often associated with salmon, rainbow, and bull trout. Because of improved habitat conditions (e.g., increased LWD to help maintain pools) in the future, it is likely that benefits would be similar to those for the bull trout as a result of the alternatives.

4.8.4.10 Columbia Basin

The Columbia Basin Region has the lowest proportion of lands designated as forestlands of any region in the State (less than 1 percent or 13,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private and State land, on a very small portion of all lands (less than 1 percent or 13,000 acres), but essentially all of the forestlands in the Region. Federal- and State-protected forestlands, not managed for timber harvest, include less than 1 percent of all lands (less than 1 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal less than 1 percent of all lands in the Region (less than 1 percent of all forests). No exempt 20-acre parcels were identified in the Columbia basin (Rogers 2003).

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources. The relative number of stream miles is moderate in this Region (14,157 stream miles), and encompasses 5 percent of all State stream miles. But the Region also has the lowest proportion of all stream miles protected under the Washington Forest Practices Rules (less than 1 percent).

While the Washington Forest Practices Rules influence essentially all forestlands within this Region, the lack of nearly all representative covered species, the general arid nature of this Region, and the presence of forested streams in only scattered areas of the Crab Creek-Wilson Creek basins suggest that implementation of any alternative would have minimal to no effect on covered fish species.

4.8.4.11 Upper Columbia River downstream of Grand Coulee Dam

A moderate proportion of this Region is designated as forestlands (43 percent or 2,774,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private and State land on a very low proportion of lands (7 percent or 472,000 acres), which includes 17 percent of all forestlands in the Region. Federal- and State-protected forestlands not managed for timber harvest include about 20 percent of all lands (46 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 16 percent of all lands (37 percent of all forests). Exempt 20-acre parcels about 0.3 percent of the forestlands and about 1.5 percent of the forestlands subject to the Washington Forest Practices Rules in the Upper Columbia-Downstream Region (Rogers 2003).

The amount and location of stream miles and lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources. The relative amount of stream miles in this Region is the highest in the State (38,869 stream miles), comprising 15 percent of all State stream miles. However, the Region has a low portion of all stream miles protected under the Washington Forest Practices Rules (11 percent).

Four anadromous salmonid populations are found in this Region including three that are federally listed: chinook salmon (endangered), sockeye salmon, and steelhead and bull trout, both of which are federally endangered. The same nine representative covered species found in the Middle Columbia Region are also present here.

Each of the four H's has been cited as contributing to the listing of one or more of the species. This Region has a high portion of agricultural land use (about 9 percent) plus substantial grasslands (17 percent), much of which is suitable for grazing. However, the primary limiting factor for most anadromous species in the Region is the hydroelectric dams on the mainstem Columbia River (i.e., Rocky Reach, Wanapum, Priest Rapids, Rock Island, Wells, Chief Joseph, and four others mainstem Columbia River dams downstream of this Region), which have reduced mainstem habitat and impeded passage (DEIS Appendix A).

In upstream reaches, limiting factors have included harsh winters, high temperatures, and reduced flow. Land conversion to agriculture within riparian areas in the lower part of the basin, as well as road construction, has contributed to habitat degradation (DEIS Appendix A). Water diversion for irrigation also reduces instream habitat in this Region. In several of the drainages sedimentation and elevated temperatures from grazing, agriculture, and forestry limit fish production (DEIS Appendix A).

Consequently, the improvements to the Washington Forest Practices Rules under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4 could have a low to moderate effect on the recovery of listed species because of the limited degree to which they can be influenced. However, the effect of improved the Washington Forest Practices Rules on listed species could be moderate within watersheds with substantial private and State forestlands because of future improved stream habitat conditions relative to existing conditions. Changes in the Washington Forest Practices Rules for the listed species would likely have the largest effect on bull trout because they are predominately found in forested areas and are not affected by marine factors and urbanization in this Region (U.S. Federal Register, Vol. 63, No. 111, June 10, 1998, pages 31647-31674). No Action Alternative 1-Scenario 2 could reduce chances of recovery or slow the rate of recovery in this Region because of relatively low protection of fish habitat.

The other covered species would also benefit in a similar manner as bull trout under these same alternatives. Effects would be similar to those noted for the same species occurring in the Middle Columbia Region because of similar habitat benefits associated with the alternatives.

4.8.4.12 Upper Columbia River Upstream of Grand Coulee Dam

Because all upstream passage of anadromous fish is blocked at Grand Coulee dam, the only federally listed species present in this Region is bull trout, which is listed as threatened. In addition, six of the nine other representative covered species found in the Middle Columbia Region (no lamprey species or leopard dace), as well as the lake chub are present here.

The amount and location of streams and forested lands affected by forestry activities has the potential to influence production and survival of fish and other aquatic resources to varying degrees. The relative amount of stream miles in this Region (33,913 stream miles) is second only to Upper Columbia Downstream of Grand Coulee Dam Region, and encompasses 13 percent of all stream miles in the State. This Region also has a moderate proportion of all stream miles (31 percent) protected under the Washington Forest Practices Rules. Exempt 20-acre parcels comprise less than 0.5 percent of the forestlands and close to 0.5 percent of the forestlands subject to the Washington Forest Practices Rules in the Upper Columbia-Upstream Region (Rogers 2003).

A high proportion of this Region is designated as forestlands (71 percent or 4,084,000 acres). The Washington Forest Practices Rules regulate commercial timber activities for private and State land on a moderate proportion of lands (31 percent or 1,804,000 acres), which includes 44 percent of all forestlands in the Region. Federal- and State-protected forestlands not managed for timber harvest include about 2 percent of all lands (3 percent of all forests). Also, Federal and tribal forestlands available for timber harvest equal about 38 percent of all lands (53 percent of all forests).

Hydroelectric and irrigation dams that have fragmented bull trout distribution and contributed to habitat degradation have been cited as major factors leading to the species' listing in this Region (Washington Conservation Commission 2003). This Region has a high proportion of agricultural lands (12 percent), but much lower grassland (7 percent) than the Upper Columbia Downstream of Grand Coulee Dam Region. Dams such as Albeni Falls and Box Canyon as well as U.S.-Canada boundary dams have contributed to fragmentation.

Forest practices have not been noted as major sources of mass wasting in this Region, although high road densities in some basins have contributed to increases in sediment delivery (DEIS Appendix A). Increased water temperatures in many areas, both from human-induced and natural conditions, limits bull trout distribution (Washington Conservation Commission 2003) (DEIS Appendix A). Past timber practices have reduced LWD levels and increased sediment in some watersheds. Agriculture and grazing have also degraded habitat (DEIS Appendix A).

Therefore, considering the relatively high proportions of bull trout habitat that can be affected by the Washington Forest Practices Rules, No Action Alternative 1-Scenario 1, and Alternatives 2, 3, and 4 could have a moderate effect on the recovery of bull trout in the Region. No Action Alternative 1-Scenario 2 could reduce chances of recovery or at least slow the rate of recovery in this Region because of relatively low protection of fish habitat.

The other covered species would also benefit in a similar manner as bull trout under these same alternatives. Effects would be similar to those noted for the same species inhabiting the Middle Columbia Region. Lake chub are only found in Cedar Lake in this Region (subsection 3.8.5.7, Middle Columbia River). Their preferred habitat includes clear, cool water and clean cobble and gravel (subsection 3.8.3.8, Lake Chub). These habitat types may be influenced by the Washington Forest Practices Rules but their common use of lakes, which would probably be little affected by rules, and their limited distribution, indicates benefits under any of the alternatives would be slight for this species.

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4.9 AMPHIBIANS AND AMPHIBIAN HABITATS

4.9.1 Evaluation Criteria

This subsection describes the two evaluation criteria that were chosen to evaluate how the proposed alternatives would impact amphibians and amphibian habitats. They are: 1) the degree of protection afforded to microhabitat variables that are important to the seven target species (i.e., humidity, air temperature, sedimentation, and downed wood); and 2) the degree of protection afforded to unique habitat types that are important to the seven target amphibian species (i.e., seeps, springs, and headwaters). These evaluation criteria are described in more detail below.

4.9.1.1 Microhabitat Variables Important to the Target Amphibian Species

Several riparian parameters influence amphibian habitat suitability. They include the character of the microclimate, the level of downed woody debris, and the degree of sedimentation.

Some important microclimatic parameters of riparian areas include solar radiation, soil temperature, soil moisture, air temperature, wind velocity, and air moisture or humidity (Dong et al. 1998; Chen 1991; Ledwith 1996). These microclimatic parameters are generally different in riparian versus upland areas. Riparian areas are usually lower in the landscape, nearer to water, and tend to be more complex in vegetation structure. These characteristics contribute to a cooler, moister microenvironment for amphibians. Timber harvest activities can alter the microclimatic gradient between upland and riparian areas (subsection 3.7.1.5, Microclimate) (Dong et al. 1998; Chen 1991; Blaustein et al. 1995; Bury and Corn 1988; Hallock and McAllister 2002). For instance, timber harvest can expose riparian areas to increased solar radiation, thus potentially increasing the ambient air and water temperatures in that area and reducing the relative humidity and soil moisture. Brosofske et al. (1997) found that no-harvest riparian buffers between 148 feet and 984 feet in width were needed to maintain unaltered microclimatic gradients near streams. Based on this study and other studies referenced above, many standard buffer widths now in use may not fully protect riparian microclimate.

Timber management activities can also change the quantity and size of sediment that is delivered to a stream. This can lead to stream channel instability, pool filling by coarse sediment, or introduction of fine sediment to spawning gravels. Increased sedimentation in headwater streams is thought to negatively impact some amphibian species by filling interstitial spaces in the stream substrate that are important for movement and larval development (Corn and Bury 1989; Diller and Wallace 1996). Riparian buffers in Washington have been shown to be effective in filtering overland sediment, with buffers of at least 30 feet identified as effective in some cases (Rashin et al. 1999).

Downed wood (coarse woody debris) is an important microhabitat feature for amphibians. Bury et al. (1991~~a~~) found that terrestrial salamander abundance was associated with the presence of coarse woody debris. Ensatina and western redback salamander abundance was positively correlated with coarse woody debris levels in western Washington forests (Aubry et al. 1988; Aubry and Hall 1991). Coarse woody debris provides moist sites where amphibians can avoid predators, forage on the soil surface while still maintaining body moisture, and breed. Nordstrom and Milner (1997) recommended that a minimum of five uncharred hard logs at least 12 inches in diameter and 23 feet long per acre, as well as all soft logs the same size, should be retained to provide suitable coarse woody debris for Dunn's and Van Dyke's salamanders. LWD in streams also provides cover for amphibians, as well as erosion control and substrate for egg deposition. Downed logs and woody debris may serve as important refuge and foraging habitat for the Dunn's salamander (Corkran and Thoms 1996; Leonard et al. 1993) and the Van Dyke's salamander (Nordstrom and Milner 1997; Petranka 1998) (subsection 3.7.1.2, LWD Recruitment).

All of these components are evaluated according to how well the alternatives prevent changes in watershed processes that would be detrimental to amphibians and their habitat. As described in subsection 4.7.2 (Evaluation Criteria, Microclimate), the results of Brosofske et al. (1997), Dong et al. (1998), and Chen (1991) indicate that a minimum of 147 feet is considered necessary to maintain most microclimatic gradients, buffer widths greater than 230 feet to maintain air temperature are required, and buffers of up to 787 feet are required to maintain humidity. Ledwith (1996) demonstrated that buffer widths of at least 100 feet between clearcuts and streams in northern California significantly reduce air temperature and increase relative humidity. Other studies have reported that 100-foot wide buffers between clearcuts and streams are sufficient to retain adequate shade on streams to maintain suitable stream temperatures (Brown and Krygier 1970; Brazier and Brown 1973; Steinblums et al. 1984), which would likely benefit amphibians. Retaining riparian buffers of at least 100 feet can also maintain most woody debris recruitment (Bottom et al. 1983; Harmon et al. 1986; Van Sickle and Gregory 1990).

Because of the variability in recommended buffer widths, the equivalent buffer area index values derived for sediment filtration (subsection 4.4.1.1, Surface Erosion Evaluation Criteria) and LWD recruitment (subsection 4.7.2, Evaluation Criteria, LWD Recruitment) are used as indicators of the relative value of the alternatives for protecting amphibian habitats. Target widths for sediment filtration and microclimatic parameters are chosen from FEMAT (1993), Brosofske et al. (~~1993~~1997), and Chen (1991) (See discussion above). Target guidelines for downed wood are difficult to determine. Amphibian species such as western red-backed salamander and ensatina appear more closely associated with downed woody debris than the target amphibian species. Nonetheless, at least one study recommends coarse woody debris retention in the range of 100 to 300 cubic meters per hectare (1,430 to 4,288 cubic feet per acre) to provide adequate cover for terrestrial salamanders (Butts and McComb 2000).

4.9.1.2 Unique Habitats Important to the Target Amphibian Species

Many unique habitats in the landscape provide refugia for the target amphibians. These include stream junctions, talus slopes, downed woody debris, seeps, and springs. These unique habitats were chosen as evaluation criteria because: 1) some of them are addressed separately in the proposed alternatives, and 2) some of the target amphibian species appear more closely associated with these unique habitats (subsection 3.9.2, Amphibian Distribution, Status, and Habitat, for discussion of target amphibian habitat requirements). These components are evaluated according to the degree to which they would be protected under the proposed alternatives.

In addition to the unique habitats listed above, protection of wetlands was also chosen as an evaluation criterion. None of the seven target amphibian species is directly associated with still water wetland habitats, but wetland buffers and other protection measures can provide some indirect protection for nearby unique habitats that may support populations of these species.

4.9.2 Evaluation of Alternatives

The effects of the alternatives on amphibian microhabitats and unique habitats are analyzed in the following subsections. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action alternative no ITPs or ESA Section 4(d) take authorization would be issued. This lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on amphibian microhabitat and unique habitats are likely to fall between these two scenarios.

4.9.2.1 Microhabitat Variables and Target Amphibians

Overview of Effects

The first evaluation criterion is the protection afforded to microclimate, sedimentation, and downed wood. The following paragraphs address the degree to which each alternative protects these variables.

No Action Alternative 1-Scenario 2 would provide the lowest level of protection for microclimatic variables, sedimentation, and downed wood when compared to the other alternatives. The likelihood for negative habitat effects is high for Type 1-3 waters and very high for Type 4 and 5 waters under this alternative for all three habitat components.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide a moderate level of protection for microclimate variables, sedimentation, and downed wood when compared to the other alternatives. The likelihood for negative habitat effects is moderate for Type S and F waters adjacent to high site classes and high for Type N waters relative to the maintenance of microclimate. The likelihood for negative effects is low for Type S and F waters and moderate for Type N waters relative to sedimentation and downed wood. This group of alternatives would provide higher levels of protection for all three habitat components when compared to No Action Alternative 1-Scenario 2 but lower levels of protection than Alternative 4.

Alternative 4 would provide a high level of protection for microclimate variables, sedimentation, and downed wood when compared to the other alternatives. The likelihood for negative habitat effects is low for all three habitat components for low-gradient channels and moderate for high-gradient channels. This alternative would provide the highest level of protection for all three habitat components when compared to all other alternatives. A detailed analysis of the alternatives is presented in the following subsections.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Under No Action Alternative 1-Scenario 2, the main prescription that applies to the maintenance of the three microhabitat variables mentioned above (microclimate, sedimentation, and downed wood) is the stream-shade requirement, which provides enough shade on Type 1, 2, or 3 streams to meet State water temperature standards (Washington Forest Practices Board 2001b, Section 1). In general, riparian buffers on Type 1 and 2 streams would be between 25 and 100 feet wide, buffers on Type 3 streams would be between 25 and 50 feet wide, and Type 4 and 5 streams generally would have no buffer requirements (subsection 4.7, Riparian and Wetland Processes).

Based on recommended riparian widths, the RMZs under No Action Alternative 1-Scenario 2 for Type 1-3 waters, which range between 25 and 100 feet, would not maintain complete microclimatic conditions, downed woody debris recruitment, and sediment filtration. Under the January 1, 1999 Washington Forest Practices Rules, RMZs were not required on Type 4 and 5 streams, except under special circumstances; therefore, maintenance of the microhabitat variables important to amphibians would not occur on these headwater streams. These conclusions are supported by the results of the equivalent buffer area index analyses (DEIS Appendix B).

No Action Alternative 1-Scenario 2 would produce an equivalent buffer area index for LWD of between 19 and 30 percent of the level needed for complete protection of LWD recruitment potential for all streams in western Washington and 46 to 57 percent for all streams in eastern Washington (subsection 4.7.1, Riparian Processes). The equivalent buffer area index for sediment filtration under No Action Alternative 1-Scenario 2 would range from 65 to 78 percent of the recommended equivalent buffer area index for complete protection for all streams in western Washington and 67 to 86 percent for eastern Washington. These results are explained primarily by the lack of riparian protection, and thus sediment filtration that would occur along Type 4 and 5 streams. Rashin et al. (1999) demonstrated that in most cases, the Washington Forest Practices Rules in effect on January 1, 1999 were ineffective in preventing sediment delivery to Type 4 and 5 streams. In a separate study, Sullivan et al. (1990) demonstrated that January 1, 1999 Washington Forest Practices Rules resulted in substantial increases in air temperature in riparian areas.

Some of the prescriptions in the January 1, 1999 Washington Forest Practices Rules partially mitigate the lack of protection for these parameters. These include: 1) clearcuts can be no larger than 240 acres, 2) yarding in RMZs must minimize damage to vegetation, 3) sidecast along skid trails is limited to above the 50-year floodplain, 4) no more than 30 percent volume removal every 10 years within 200 feet of a designated shoreline (usually Type 1 waters), 5) RMZ requirements are greater when the dominant stream substrate is gravel versus bedrock, and 6) hardwood to conifer ratios must be maintained.

In addition to the above protections, some protection would likely occur adjacent to riparian areas where unstable slopes are present; however, the Washington Forest Practices Rules in effect on January 1, 1999 did not explicitly identify specific landforms or features that may be susceptible to mass wasting or include minimum qualifications for persons assessing mass wasting potential. Although the presence of unstable slopes triggered a Class-IV-Special status application, it had to threaten a "public resource" to actually be protected.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would be more effective in maintaining microclimatic conditions than No Action Alternative 1-Scenario 2 due to more protective RMZs. These include a minimum no-harvest zone of 50 feet (i.e., the core zone), and selective harvest zones (with two options) up to a total of 200 feet beyond the bankfull width or Channel Migration Zone of all Type S and F streams on the westside (depending on site class), and a minimum no-harvest zone of 30 feet and selective harvest zones up to a total of 130 feet beyond the bankfull width or Channel Migration Zone of all Type S and F streams on the eastside. Furthermore, and perhaps more importantly for amphibians, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 provide a variety of protective measures for Type N streams, which are roughly equivalent to Type 4 and 5 streams under No Action Alternative 1-Scenario 2. Additional information on the relative differences between the above alternatives can be found in subsection 2.3 (Alternatives Analyzed in Detail).

The Type N protections differ slightly between western Washington and eastern Washington. In western Washington, Type N protections include: 1) a 30-foot Equipment Limitation Zone on all Type N streams, 2) a 50-foot no-harvest buffer applied to both sides of all Type N_p streams for the first 500 feet upstream of the intersection with a Type S or F stream, and 3) a 56-foot radius no-harvest patch buffer centered on the intersection of two or more perennial Type N streams. In addition to these prescriptions, landowners must use a variety of protective buffers to protect sensitive sites. These include: 1) no harvest within 50 feet of a soil zone perennially saturated from a headwall or side-slope seep, and 2) no harvest within 50 feet of headwater spring. Overall, at least 50 percent of the total length of Type N_p waters would receive 50-foot no-harvest buffers, but this percentage is likely substantially higher in areas where there is a high frequency of unstable slopes or landforms.

In eastern Washington, Type N protections include: 1) a 30-foot Equipment Limitation Zone on all Type N streams; 2) for partial cuts, the same basal area requirements must be followed as the basal area requirements for RMZ inner zone harvest on a Type 1 through 3 stream in the same timber type, and side-slope seeps must be protected with a 50-foot partial cut buffer that meets the basal area and leave tree requirements of the stand; and 3) for clearcuts, a 50 foot no-harvest buffer applied to both sides of the stream must be left at least equal in length to the clearcut buffer length, and the clearcut buffer cannot exceed 30 percent of the length of the stream reach in the harvest unit. In addition, harvest may not occur within 50 feet of an outer perimeter of a soil zone perennially saturated from a headwall seep; an outer perimeter of a soil zone perennially saturated from a side-slope seep; or the center of a headwater spring, an alluvial fan, or the center point of intersection of two or more Type N_p waters.

As described in subsection 4.7 (Riparian and Wetland Processes), both inner zone harvest options under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide improved LWD recruitment, particularly for fish-bearing streams. Under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3, the equivalent buffer area index for sediment filtration would be approximately 73 to 91 percent of the maximum protection for sediment filtration along western Washington streams and approximately 72 to 96 percent along eastern Washington streams.

In contrast to No Action Alternative 1-Scenario 2, total buffer widths for Site Classes I and II under these alternatives would approach or exceed the minimum buffer widths recommended for microclimatic parameters, at least on Type S and F streams. However, the no-harvest zones would not be wide enough to allow microclimatic conditions to reach unharvested levels in the inner and outer zones. Protection of microclimate parameters along Type N_p streams would likely provide additional suitable amphibian habitat in Type S and F streams. Corn and Bury (1989) found that amphibian diversity was greater in logged stands having uncut timber upstream. However, full maintenance of suitable microclimatic conditions along Type N streams may not be achieved, since at most, these streams are currently protected with a 50-foot no-harvest buffer, which is much smaller than the 147-foot buffer recommended by the literature for complete protection.

Microclimatic conditions would be maintained through 100-foot wide, no-harvest buffers that are proposed for Type S and F streams greater than 10 feet wide under Option 2. Option 2 results in the retention of substantially more trees per acre in the inner zone than Option 1. Although the proposed buffers would likely protect instream microclimatic conditions on Site Class I and II Type S and F streams, microclimatic conditions would approach upland levels near the outer edge of the buffers. This means that the buffer itself would not maintain ideal conditions. Semlitsch (1998) recommends a buffer zone of over 500 feet in width as more ecologically realistic to protect important terrestrial habitat. Similarly, Dodd and Cade (1998) state that regulatory buffers should consider the many types of amphibian migratory patterns in upland habitats to preserve habitat critical to all stages of the amphibians' life cycle.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 recommend the following downed wood guidelines associated with salvage logging in RMZs in western Washington:

Logs with a Solid Core	Less than 1-foot Diameter	1- to 2-foot Diameter	Greater than 2-foot Diameter	Total
Number of logs/acre	85	83	26	194

The above guidelines may be translated to a downed wood retention range of between approximately 1,744 and 5,818 cubic feet per acre assuming the following: 1) median diameters for each category above are 0.5, 1.5, and 2.5 feet; and 2) logs are either 6 feet or 20 feet long. These amounts cover the entire range recommended for amphibian habitat in the literature. Therefore, the minimum amount of downed wood required to be left outside the core zone of RMZs in western Washington may be adequate for amphibians if it exists prior to any salvage logging. This parameter would be expected to have relatively minor effects on the highly aquatic torrent salamanders, and more substantial effects on other, more terrestrial, salamanders and frogs.

Overall, compared to No Action Alternative 1-Scenario 2, the implementation of No Action Alternative 1-Scenario 1 or Alternative 2 or 3 would be expected to maintain suitable microclimatic, downed wood, and sediment delivery conditions for highly aquatic amphibians along Type S and F waters bordered by Site Classes I or II. These alternatives would substantially improve these same microhabitat conditions along other Type S and F streams, as well as along Type N_p streams. This improvement would be due in part to the water typing changes carried forward from the Forests and Fish Report (FFR) in the current Washington Forest Practices Rules. These changes included changing many streams that were classified as Type 4 streams to Type F streams, based on their gradient.

Microhabitat conditions in lower site class streams (i.e., III through V) and in the terrestrial habitat of the buffers would not be maintained at optimum levels for the target amphibian species. This would require wider buffers on Type N_p streams and buffering greater lengths of these streams than are currently in place under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Although the design of the current Washington Forest Practices Rules has resulted in substantially better protection for both individual amphibians and amphibian populations compared to No Action Alternative 1-Scenario 2, the proposed buffers would not provide the optimum amount of protection.

Although difficult to measure, additional riparian habitat protection occurs in areas of potentially unstable slopes and landforms. Current Washington Forest Practices Rules include reviewing all harvest plans and requiring a qualified person to investigate any areas with potentially unstable slopes. The harvest application becomes a Class IV-Special if harvest is planned for unstable slopes. Mitigation measures must be taken in areas where there is risk to a public resource or public safety. Although the current Washington Forest Practices Rules do not prohibit harvest on unstable slopes, many landowners forego harvest in these areas due to SEPA procedural requirements and the risk of operating on unstable slopes. As a result, many unstable slopes and landforms are protected by no-harvest buffers whose width and length are dictated by the extent of the unstable slope or landform. Because the spatial extent of unstable slopes and landforms is highly variable, the width of these buffers (measured from the stream edge) can range from as little as 15 feet to over 200 feet.

Alternative 4

Alternative 4 proposes similar riparian buffers on all streams on both the eastside and westside. The minimum buffer width is based on stream gradient. Streams with 0 to 20 percent gradient would receive a 200-foot no-harvest RMZ, 20 to 30 percent gradient would receive a 100-foot no-harvest RMZ, and greater than 30 percent gradient would receive a 70-foot no-harvest RMZ. Thinning would be allowed within these buffers, but only to improve riparian function and only after a landowner complied with required SEPA procedures. Additional buffers would be provided for Beaver Habitat Zones and Channel Disturbance Zones (areas within 30 feet of the lateral extent of an expected channelized landslide).

According to equivalent buffer area index analyses, Alternative 4 would provide from 94 to 100 percent of the recommended protection for LWD recruitment and sediment filtration on all streams in both western and eastern Washington. Alternative 4 would also protect approximately two times more riparian acreage on affected lands with riparian buffers compared with No Action Alternative 1-Scenario 1 (i.e., current Washington Forest Practices Rules) (Table 4.9-1). Alternative 4 would also provide wide enough buffers on low-gradient streams to maintain microclimatic conditions suitable for amphibians, unlike either No Action Alternative 1-Scenario 2, or No Action Alternative 1-Scenario 1. For example, a 200-foot buffer would be wide enough to provide temperature and moisture conditions approximately 30 feet beyond that which is assumed suitable for the target amphibian species. This aspect of Alternative 4 would be particularly beneficial for the more terrestrial amphibians, such as the tailed frog and Van Dyke's and Dunn's salamanders. Furthermore, Alternative 4 would provide additional buffers for beaver habitat. Since this buffer can apply on almost any small, low-gradient stream in the State, many streams could potentially have additional buffers added to them due to this provision.

Additional habitat protection relating to the protection of unstable slopes and landforms, beyond those described above, would occur under Alternative 4. For example, Alternative 4 would prohibit harvest on unstable landforms described under the current Washington Forest Practices Rules, require an additional 50-foot buffer around the perimeter of those landforms, and prohibit operations on planar slopes greater than 80 percent. These requirements would supplement existing riparian protections, especially for small streams.

Table 4.9-1. Estimate of Future Protection in Total Number of RMZ Acres Under All Alternatives for Western and Eastern Washington.[1/]

	Proposed Alternatives					
	No Action Alternative 1-Scenario 2		No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3		Alternative 4	
	Total RMZ Acres	Percent of Covered Lands (%)	Total RMZ Acres	Percent of Covered Lands (%)	Total RMZ Acres	Percent of Covered Lands (%)
Westside[2/]	630,916	10.0	1,321,992	21.0	2,695,361	42.9
Change Relative to No Action Alternative 1-Scenario 2	--	--	691,076	109.5	2,064,445	327.2
Eastside[3/]	196,312	5.8	373,958	11.1	870,622	25.9
Change Relative to No Action Alternative 1-Scenario 2	--	--	177,646	90.5	674,310	343.5

[1/] Westside forestlands included all private, city, and county forestlands, but do not include State forested lands because they are covered under the State Trust Lands HCP (Washington DNR 1997d). State forestlands on the eastside are included in the estimated RMZ acres.
[2/] Total land area of private/city/county forestland on westside forestland = 6,289,303 acres, with total land area of State forestland equal to 1,715,912 acres.
[3/] Eastside land area includes State-owned forested lands along with private/city/county forestlands and totals 2,619,736 acres, with State forestlands totaling 745,035 acres.

Based on the expanded primary and additional buffers, Alternative 4 would be expected to provide the greatest benefits to amphibians through protection of sediment delivery, downed wood, and microclimate. However, some variables, such as air temperature and humidity, would not likely be completely protected under the rules proposed for Alternative 4.

4.9.2.2 Unique Habitats and Target Amphibians

Studies have identified several unique habitat features that are important in maintaining healthy amphibian populations. These include stream junctions (i.e., confluences), Type N streams (e.g., non-fish-bearing channels), talus, and other refugia (subsection 3.9.2, Amphibian Distribution, Status, and Habitat, for additional habitat requirements). This subsection analyzes the degree to which each alternative protects these features. Some of the features (e.g., Type N streams) are often associated with wetlands or they represent wetland habitat (e.g., seeps, springs). Measures designed to protect wetland habitats may provide indirect protection to unique habitats that support target amphibians. Therefore, this subsection also analyzes the wetland protection measures under each alternative.

Overview of Effects

No Action Alternative 1-Scenario 2 would provide the lowest level of protection for unique habitats compared to all other alternatives. The likelihood of negative habitat effects is high for Type 1-3 waters and very high for Type 4 and 5 waters. This is because the January 1, 1999 Washington Forest Practices Rules did not recognize and protect many of the habitat features important for amphibians (e.g., seeps, springs, talus).

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide a moderate to high level of protection for unique habitats compared to the other alternatives. The likelihood of negative habitat effects is low for Type S and F waters adjacent to high site classes (i.e., I and II), moderate along buffered Type N_p waters and sensitive sites, and high along unbuffered Type N_p and N_s waters. These alternatives would provide more protection for unique habitats than No Action Alternative 1-Scenario 2 but less protection than Alternative 4.

Alternative 4 would provide a high level of protection for unique habitats compared to all other alternatives. The likelihood of negative habitat effects is low for low-gradient channels with 200-foot no-harvest RMZs and moderate for high-gradient channels with 70-foot no-harvest RMZs. Alternative 4 would provide substantially more protection for unique habitats than No Action Alternative 1-Scenario 2 and moderately more protection than No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. A detailed analysis of the alternatives is presented in the following subsections.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

Headwater streams, seeps, springs, and talus received little or no direct protection under the Washington Forest Practices Rules in effect on January 1, 1999. Protection of these unique habitats was largely indirect, occurring only to the extent that these habitats were associated with wetlands. Under the January 1, 1999 Washington Forest Practices Rules, Type A and B wetlands were delineated. Type A wetlands are non-forested wetlands with open water. Type B wetlands are non-forested wetlands other than Type A wetlands greater than 0.25 acre. The third category was forested wetlands. The January 1, 1999 Washington Forest Practices Rules did not provide protection for wetlands smaller than 0.25 acre. The largest average buffer provided for any wetland was 100 feet. This buffer was provided only on Type A wetlands larger than 5 acres in size. Smaller Type A wetlands and Type B wetlands larger than 5 acres received a 50-foot average buffer. Type B wetlands between 0.5 and 5 acres had an average buffer of 25 feet. Type B wetlands between 0.25 and 0.5 acres received no buffer. The later included areas such as seeps, springs, and headwaters, and were therefore, not protected.

The RMZs in the January 1, 1999 Washington Forest Practices Rules were much smaller than those recommended in the literature. Semlitsch (1998) recommended buffers of over 500 feet around wetlands based on studies of pond-breeding salamanders in numerous studies from the midwest and eastern United States. This large buffer was meant to encompass the terrestrial movements of 95 percent of the populations studied. Some of the more terrestrial of the target amphibian species, such as the Dunn's and Van

Dyke's salamanders, can spend considerable amounts of time in upland areas adjacent to riparian areas, usually within 150 to 300 feet from the stream (Gomez and Anthony 1996). Thus, the January 1, 1999 Washington Forest Practices Rules RMZs did not protect all habitat used by these amphibians in their daily movements.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

Note: The reviewer is reminded to consider the differences in effectiveness over time of the adaptive management program among this group of alternatives (No Action Alternative 1-Scenario 1 [low], Alternative 2 [high], Alternative 3 [moderate]) in evaluating the effects discussed below (subsection 4.1.5, Adaptive Management).

Measures provided under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide more protection to unique habitats than No Action Alternative 1-Scenario 2. Additional information on the relative differences between the above alternatives can be found in subsection 2.3 (Alternatives Analyzed in Detail). The increased RMZs along all Type S and F streams and the establishment of Channel Migration Zones along some Type S and F streams would increase the amount of protection for unique habitats. Furthermore, and perhaps more importantly for amphibians, No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide a variety of protective measures for Type N streams. Under the January 1, 1999 Washington Forest Practices Rules, most such streams were classified as Type 4 or 5 and received little or no protection. These protective measures are described above for No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 in subsection 4.9.2.1 (Microhabitat Variables and Target Amphibians).

Wetland buffers under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would not be substantially different from No Action Alternative 1-Scenario 2. However, increased RMZs and Channel Migration Zones would protect additional wetlands on the covered lands (Tables 4.7-4 and 4.7-5).

~~4.9.2.2.1.1~~ Alternative 4

Alternative 4 provides the highest potential benefits for amphibians based on its proposed protection for refugia. It provides the widest riparian buffers, ranging from 70-foot no-harvest RMZs on steep gradient streams (greater than 30 percent) to 200-foot no-harvest RMZs on low gradient streams (less than 20 percent). It also proposes the largest buffers on wetlands, including 200-foot buffers on Type A wetlands greater than 5 acres, 100-foot buffers on Type B wetlands, and snag and canopy retention standards around non-forested wetlands. These buffers are proposed as managed buffers, which mean that they are intended to allow thinning where it is benefits ecological function (Chapter 2, Alternatives).

These proposed buffers would provide protection to most of the important refugia thought to be used by torrent salamanders, such as the splash zone of Type N streams. It would also provide adequate buffers on isolated wetlands (200 feet for Type A), which would encompass most of the daily movements of salamanders and tailed frogs living in that environment. Despite these improvements relative to both scenarios of No Action

Alternative 1, Alternative 4 may not provide buffers wide enough to maintain all habitat requirements of amphibians using the refugia (Dodd and Cade 1998; Semlitsch 1998).

4.10 BIRDS, MAMMALS, OTHER WILDLIFE, AND THEIR HABITATS

4.10.1 Evaluation Criteria

The general criterion used to evaluate the effects of the alternatives on birds, mammals, and other wildlife is the degree of habitat protection afforded to the wildlife species discussed in this subsection. A component of this evaluation is the qualitative evaluation of effects on wildlife species that may be associated with riparian habitats for some of their life requisites by comparing the degree of protection afforded to various habitat components (e.g., snag availability, downed woody debris) important to some of the riparian-associated wildlife species identified in Table 3-24. This table is not meant to be inclusive of all wildlife species in Washington that are associated with riparian areas and upland areas. As discussed earlier, over 85 percent of Washington's native fauna use riparian areas for some portion of their life cycles. Instead, this subsection is limited to species with a listed status. Nonetheless, the discussion provides a general indication of the wide variety of species that could be affected by the proposed alternatives.

A general discussion of the effects of the alternatives on wildlife is presented in subsection 4.10.2.1 (General Effects). Following this, subsection 4.10.2.2 (Species-specific Discussion) presents a discussion of relevant aspects associated with key individual species. Current Washington Forest Practices Rules provide a variety of protections to wildlife species, particularly for species that are State or Federal listed as threatened or endangered. These critical habitat prescriptions are listed in WAC 222-16-080 of the existing Washington Forest Practices Rules. ~~These are described where appropriate in the following subsections.~~ As mentioned in subsection 2.3.1 (Alternative 1 [No Action]), these wildlife prescriptions would not change under any of the alternatives and are described in subsection 4.10 (Birds, Mammals, Other Wildlife, and Their Habitats) where appropriate. Therefore, for comparisons between alternatives, subsection 4.10 concentrates on the Washington Forest Practices Rules that were changed in 1999; these rules address riparian and aquatic habitats.

4.10.2 Evaluation of Alternatives

The effects of the alternatives on birds, mammals, and other wildlife are analyzed in the following subsections. In reading this analysis, it should be remembered from Chapter 2 (Alternatives) that under the No Action alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on wildlife are likely to fall somewhere in-between these two scenarios.

4.10.2.1 General Effects

Overview of Effects

The general criterion used to evaluate the effects of the alternatives on other wildlife is the degree of habitat protection afforded to the wildlife species discussed in this subsection. The degree of protection afforded to various habitat components (e.g., snag availability, downed woody debris), and to some degree, the potential to use riparian areas as travel corridors was used. The following paragraphs address the likelihood of impacts to the various habitat components by alternative in a comparative manner.

Overall, No Action Alternative 1-Scenario 2 would result in a higher likelihood of impacts to other wildlife species. Although none of the alternatives would provide optimum habitat for most bird and mammal species, No Action Alternative 1-Scenario 2 would do little to limit loss of habitat for the species discussed in this subsection and, therefore, the relative impacts to species habitat would be expected to be high. However, specific prescriptions in the Washington Forest Practices Rules (WAC 222-16-080) for species such as the bald eagle, marbled murrelet, and northern spotted owl, would not change.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide low to moderate likelihood of impacts to birds, mammals, and other wildlife species. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would continue to substantially increase the acreage of riparian habitat protected by no-harvest buffers, provide protection for riparian habitat along headwater (Type N) streams, and continue to provide improved wetland protection due to better mapping techniques and protection of seeps and springs connected to Type N streams.

Alternative 4 would provide the lowest likelihood of impacts on wildlife species and their habitat. These proposed measures would provide the most protection and potential habitat improvement for other riparian-associated species of any of the alternatives, but the extent of the benefits is unknown. Approximately twice as many acres of riparian habitat would be protected on both westside and eastside forested lands than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Larger buffers should provide increased snag densities and amounts of down woody debris for cavity-nesting birds and mammals, as well as increased substrate for various prey species. In addition, wider riparian buffers under this alternative would provide wider travel corridors for many upland wildlife species; however, it is unlikely that riparian buffer acres alone would contribute substantially to the recovery of some species in Washington State. A detailed analysis of the effects of the alternatives on other riparian habitat-associated wildlife is presented in the following subsections.

Detailed Effects Analysis

No Action Alternative 1-Scenario 2

The January 1, 1999 Washington Forest Practices Rules for riparian buffers were previously noted (subsection 2.3.2.2, Washington Forest Practices Rules and Program-Specific Description, No-Action Scenario 2) to be inadequate for the target amphibian species, and would likewise not provide the level of protection needed for other riparian-associated wildlife species. Some of the species, such as the Oregon spotted frog, and Columbian white-tailed deer currently have extremely limited distributions. While this makes them very vulnerable to extinction, it is unlikely that private forest practices would impact these species substantially because site-specific management plans are in place for most of the extant populations (McAllister and Leonard 1997; Larsen 1997). Some of the more widely distributed species, including Cascades frog and the red-legged frog, use aquatic and riparian habitats for breeding, but are usually found in more upland habitats for the rest of their life cycle.

Under No Action Alternative 1-Scenario 2, riparian buffers would most likely be inadequate for other amphibian species not already discussed in subsection 4.9 (Amphibians and Amphibian Habitats). Many of these species are likely to occur in small, temporary wetlands, many of which are not currently protected if they are less than 0.5 acre in size. Cascades frogs can be very abundant in small, isolated high elevation wetlands (Larsen 1997). As recommended by Dodd and Cade (1998), buffers of over 600 feet may be necessary to adequately protect all habitat required for the migratory patterns of amphibians in these small wetlands.

As for many of the bird species listed in Table 3-23, RMZ prescriptions associated with the Washington Forest Practices Rules in effect on January 1, 1999 do not attempt to protect all of their habitat requirements. The bald eagle receives specific protections for its critical habitat requirements due to its Federal threatened status (WAC 222-16-080). These special provisions protect large buffers around known nest sites.

As for other avian species, No Action Alternative 1-Scenario 2 would do little to minimize negative impacts to these species from human activities because of buffer widths that would be less than habitat needs for these species (subsection 2.3.1, Alternative 1 (No Action)). For instance, 100-foot buffers along streams occupied by nesting harlequin ducks are recommended because that is the recommended distance to recruit LWD for loafing, and most nests are usually found in a hollow, rock crevice among boulders, a rock cavity in a cliff face, or in a tree cavity within 100 feet (30 meters) of water (Cassirer et al. 1993). Even larger buffers (164 feet [50 meters]) have been recommended to protect suitable nesting habitat (Cassirer and Groves 1990; Thomas et al. 1993).

Similar to the birds mentioned above, the mammals listed in Table 3-23 require very large buffers. Some studies have recommended riparian buffers of 100 meters (328 feet) to protect the area of optimum foraging and cover habitat for mink and beaver (Melquist et al. 1981; Allen 1983; Knutson and Naef 1997). Although none of the alternatives would provide optimum habitat for the above bird and mammal species, No Action Alternative 1-Scenario 2 would do little to limit loss of habitat for the above species because of narrow buffer widths, and therefore, the relative impacts to species habitat would be expected to be high (subsection 2.3.1, Alternative 1(No Action)).

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would likely improve habitat over time for other wildlife species in Washington as compared to No Action Alternative 1-Scenario 2 in four main ways: 1) by increasing the acreage of riparian habitat protected by no-harvest buffers (Figures 4.7-5 and 4.7-6); 2) by increasing the amount of riparian habitat protected by selective harvest buffers and Equipment Limitation Zones; 3) by providing protection for riparian habitat along headwater (Type N) streams, which would generally receive no buffers under No Action Alternative 1-Scenario 2; and 4) by providing improved wetland protection due to better mapping techniques and protection of seeps and springs connected to Type N streams (subsection 4.7, Riparian and Wetland Processes). The wider riparian buffers under these alternatives would provide travel corridors for many upland wildlife species, including birds, terrestrial amphibians, and some mammals. However, the wider buffers alone would still not provide optimum habitat for most upland wildlife species. Additional information on the relative differences between the above alternatives can be found in subsection 2.3 (Alternatives Analyzed in Detail).

Alternative 4

Compared to existing conditions, Alternative 4 would have the most benefits for other riparian-associated species in Washington. Similar to No Action Alternative 1-Scenario 1, other wildlife would benefit in four main ways under Alternative 4 as compared to No Action Alternative 1-Scenario 2: 1) it would substantially increase the acreage of riparian habitat protected by no-harvest buffers (Figures 4.7-5 and 4.7-6); 2) it would provide protection for riparian habitat along streams with gradients greater than 30 percent, which would generally received no buffers under No Action Alternative 1-Scenario 2; and 3) it would provide improved wetland protection due to improved mapping techniques and protection of seeps and springs connected to Type N streams (subsection 4.7, Riparian and Wetland Processes). These proposed measures would have benefits for riparian-associated species, but the extent of the benefits is unknown. Nevertheless, Alternative 4 would provide the most protection and potential habitat improvement for other riparian-associated species of any of the alternatives.

Under Alternative 4, approximately twice as many acres of riparian habitat would be protected in both western Washington and eastern Washington forestlands than under No Action Alternatives 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). Larger buffers under Alternative 4 should increase snag densities and amounts of down woody debris for cavity-nesting birds, amphibians, and mammals, as well as increase habitat for various prey species. An increase in buffer widths may also provide for some additional demographic support for spotted owls on private lands, especially in association with a more contiguous, complex forest with older seral stages (subsection 4.10.2.2, Species-Specific Discussion, Northern Spotted Owl). Wide riparian buffers under this alternative would provide wide travel corridors for many upland wildlife species. However, it is unlikely that riparian buffer acres alone (Figures 4.2-1 and 4.2-2) would contribute substantially to the recovery of some species in Washington State.

4.10.2.2 Species-Specific Discussion

Marbled Murrelet

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would provide habitat protection for murrelets specified under WAC 222-10-042, and forest practices would be subject to SEPA where they may cause adverse impacts to marbled murrelets. These rules would not change under any of the alternatives.

Murrelets are known to use major river drainages to access nesting stands. Increased buffers may provide some additional murrelet habitat, particularly if it is adjacent to larger blocks of suitable nesting habitat (i.e., older seral stage forest). Nelson and Hamer (1995) found that successful marbled murrelet nests were located significantly farther from edges (greater than 180 feet) than unsuccessful nests. Small patches of habitat have a greater proportion of edge than do large patches of the same shape, and the linear nature of riparian corridors alone would not add significantly to the recovery of the marbled murrelet. Although none of the alternatives would provide substantial protection of suitable murrelet habitat, No Action Alternative 1-Scenario 2 would provide a higher potential for adverse impacts, followed in descending order by No Action Alternative 1-Scenario 1, Alternatives 2 and 3, and lastly, Alternative 4.

Northern Spotted Owl

Increased buffer widths would likely provide additional habitat for spotted owls especially near individual owl territories or clusters of territories. Riparian buffers would provide for the recruitment of snags and downed woody material for prey species, but perhaps not substantially, for another 50 to 80 years. However, none of the alternatives are likely to contribute substantially to the recovery of the spotted owl in Washington State.

No Action Alternative 1-Scenario 1 and Alternative 2 and Alternative 3 would require larger no-harvest buffers than No Action Alternative 1-Scenario 2. The majority of forested riparian areas in western Washington are in an early-seral stage with only 2 percent estimated in late-seral stage (subsection 3.7.1, Riparian Areas). Thus, none of these alternatives would likely provide suitable nesting habitat for northern spotted owl for many years. No Action Alternative 1-Scenario 2 would provide the smallest long-term benefit, followed in order of increasing habitat by No Action Alternative 1-Scenario 1, Alternative 3, Alternative 2, and lastly, Alternative 4.

Bald Eagle

The breeding population of bald eagles in Washington has increased dramatically in the past 20 years, although two-thirds of nests are on private lands. Land near shores is highly desirable for residential development, and the human population of Washington is expected to increase by 2 million to 7.7 million in the next 20 years, and double to 11 million by 2050 (Washington Department of Fish and Wildlife 2001b). Forests near shores are rapidly being cleared, and the needs of eagles and desires of humans are increasingly in conflict. The current Washington Forest Practices Rules (No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3) would provide more protection and future benefits to nesting eagles than No Action Alternative 1-Scenario 2. Although none of the alternatives would provide full protection of suitable bald eagle habitat, No Action Alternative 1-Scenario 2 would provide the least protection, followed in descending order by No Action Alternative 1-Scenario 1, Alternatives 3 and 2, and lastly, Alternative 4.

Oregon Silverspot Butterfly

In Washington, the Oregon silverspot butterfly has been documented only on the Long Beach peninsula in the Southwest analysis Region, but is likely extirpated from there. The last confirmed sighting there was during a 1990 survey. Subsequent surveys in 1992, 1996, 1997, and 1998 did not document any Oregon silverspot butterflies, and habitat monitoring for early blue violet shows a declining population along the Long Beach peninsula (U.S. Department of the Interior 2001). Due to the habitat requirements of this species, the Oregon Silverspot butterfly would not be expected to be impacted by any of the alternatives.

Canada Lynx

The lynx population in Washington probably numbers fewer than 100 individuals. Several factors combine to put the population at risk for extirpation. The population includes several small subpopulations (less than 20) that are somewhat isolated. Lynx habitat is limited in extent and fragmented by topography. Riparian areas can provide important habitat linkages in the landscape. Lynx are not limited to riparian corridors for movement to suitable habitat; however, given the naturally fragmented landscape of the more alpine areas of the State where lynx occur, they likely have potential value for lynx. Survival and recruitment of lynx in Washington is probably affected by fluctuations in prey populations. Snowshoe hare, the primary prey species of the lynx, prefer the dense cover of coniferous and mixed forests with abundant understory cover. Thus, protected riparian areas may provide some habitat for snowshoe hares (NatureServe 2003).

Under Alternative 4, approximately twice as many acres of riparian habitat would be protected on both westside and eastside forestlands than under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). The least number of acres would be protected by No Action Alternative 1-Scenario 2. Therefore, the greater the amount of protected riparian areas, the greater the benefit for lynx and their prey - the snowshoe hare.

Gray Wolf

Riparian buffers may benefit wolves, especially at low elevations (e.g., larger river drainages), and many serve as travel corridors in more fragmented landscapes. Riparian buffers may also concentrate prey species. Under Alternative 4, approximately twice as many acres of riparian habitat would be protected on both westside and eastside forestlands than under No Action Alternatives 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). No Action Alternative 1-Scenario 2 would provide the least habitat protection.

Columbian White-tailed Deer

The primary factors affecting the Lower Columbia population are land conversion, timber harvesting, vehicular traffic, poaching, and flooding (NatureServe 2003). Much of the documented use area is managed as a USFWS National Wildlife Refuge and managed for deer. Harvest within the riparian buffers of the use area is not likely to occur under any of the alternatives; however, if riparian buffers were managed, increased buffer widths may provide for some additional habitat protection, and may reduce potential flooding. Under Alternative 4, approximately twice as many acres of riparian habitat would be protected on both westside and eastside forestlands than under No Action Alternatives 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). No Action Alternative 1-Scenario 2 would provide the least habitat protection.

Woodland Caribou

Habitat fragmentation is cited as a concern under the Selkirk Mountain Woodland Caribou Recovery Plan (USFWS 1994). Timber harvest alters caribou habitat and creates additional human access, which increases potential for mortality from vehicle collisions, or poaching. Logging can potentially affect caribou habitat by eliminating escape (security) cover; migration corridors; and lichen production, a primary food source for this species (USFWS 1994). Riparian buffers may provide more secure travel corridors, as well as additional forage in the form of more complex forest structure. Under Alternative 4, approximately twice as many acres of riparian habitat would be protected on both westside and eastside forested lands than under No Action Alternatives 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). No Action Alternative 1-Scenario 2 would provide the least habitat protection.

Grizzly Bear

Riparian buffers provide some connectivity, down woody debris, and forage for grizzly bears, especially in areas of private lands between roadless areas. Under Alternative 4, approximately twice as many acres of riparian habitat would be protected on both westside and eastside forested lands than under No Action Alternatives 1-Scenario 1 and Alternatives 2 and 3 (Table 4.9-1). No Action Alternative 1-Scenario 2 would provide the least habitat protection.

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4.11 RECREATION

4.11.1 Introduction

The proposed alternatives could affect recreation use on State and private lands in Washington in three main ways. First, differences in the level of harvest within RMZs could affect recreation activities that occur in these areas. These different levels of harvest could also affect recreation activities in adjacent and nearby areas, including recreation activities occurring on adjacent rivers. Second, recreation activities could be affected by potential differences in conversion rates of private forestland under the different alternatives. Third, RMZ management actions could have long-term effects on fish populations that could affect fish-related recreation activities in the future. These potential effects are discussed in the following subsections.

In reading this analysis, it should be remembered from Chapter 2 that under the No Action alternative no ITPs or ESA Section 4(d) take authorization would be issued. This lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on recreation are likely to fall between these two scenarios.

4.11.1.1 Overview of Effects

From an historical perspective, less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation. The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past. No Action Alternative 1-Scenario 2 would likely result in future levels of harvest that are similar to current conditions. Reductions in potential future harvest would occur under No Action Alternative 1-Scenario 1, Alternatives 2 and 3, and Alternative 4 relative to current conditions. No Action Alternative 1-Scenario 2 would, however, likely maintain the quality of some recreation experiences, especially those that are enhanced by forested landscapes. These reductions could also maintain the quality of recreation experiences in some adjacent areas, including waterways used for boating, rafting, and other recreation activities.

More restrictive alternatives could result in more conversion from forestland to other uses and, therefore, less forested recreation area. While it is not possible to estimate the magnitude of this type of effect, it is likely to be much higher under Alternative 4 than under the other alternatives. The restrictions associated with Alternative 4 are more likely to negatively affect the economic viability of timber production for forest landowners, especially small forest landowners and, therefore, increase the potential for forestland conversion.

The RMZ management actions proposed under the different alternatives could have long-term effects on fish populations that could in turn affect fish-related recreation activities in the future.

While it is not possible to quantify the potential effects of the alternatives on salmonid populations, it is possible to assess the potential direction of the effects and to provide a general comparison between alternatives. The potential for adverse habitat impacts associated with No Action Alternative 1-Scenario 2 suggest that salmonid populations could decline over the long term under this alternative. Compared to No Action Alternative 1-Scenario 2, habitat impacts under No Action Alternative 1-Scenario 1 (and Alternatives 2 and 3) are much less likely to result in reductions in salmonid populations (i.e., would likely result in long-term improvements in salmonid populations). Alternative 4 could result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Effects on existing salmonid populations would likely have corresponding effects on the availability of salmonids for recreational harvest.

4.11.2 Recreation Use in Riparian Management Zones

Data on recreation use levels in the potentially affected RMZs are not available. It is, however, reasonable to assume that areas located adjacent to water bodies generally receive more use than similar areas located away from water. Types of recreation use in riparian corridors likely include walking/hiking, fishing, camping, hunting, and picnicking, with activities occurring in particular areas dependent on a number of factors including access and the degree of clearing. Potentially affected lands include lands owned by private forest landowners on both the east and westsides of the State, as well as State-managed lands on the eastside. State-managed lands on the westside are regulated separately under the State Trust Lands HCP (Washington DNR 1997d). State and private lands are estimated to account for 16 percent and 19 percent of total recreation use in Washington State, respectively (Interagency Committee for Outdoor Recreation 2002).

The State lands most likely to be affected by the proposed alternatives are Washington DNR-managed forestlands on the eastside that are managed for support of trust beneficiaries with recreation allowed as a secondary use under the Washington State Multiple Use Act (Washington DNR 1992). The private lands currently used for recreation purposes that are most likely to be affected by the proposed alternatives are those owned and managed by large, industrial timberland owners who employ “good neighbor” policies and allow public access for general recreation. Recreation use on these types of private forestlands typically resembles use on forested State trust lands with recreation allowed as long as it does not compromise the owner’s ability to manage the land for business purposes (Interagency Committee for Outdoor Recreation 2002). Private lands that offer developed recreation opportunities, such as campgrounds and golf courses, would not be affected by the proposed alternatives unless they are affected by changes in management on State or private forestlands.

The alternatives evaluated in this environmental analysis are programmatic, meaning that they establish direction for broad land areas rather than scheduling activities on specific parcels of land. As a result, it is not possible to identify specific tracts of land that would be affected by the proposed alternatives. It is, however, possible to estimate the approximate number of acres that would be located in RMZs and unavailable for harvest by alternative. Estimates of the acres in RMZs by alternative are presented in Tables 4.11-1 and 4.11-2 for the eastside and westside, respectively, along with the net changes in acres relative to No Action Alternative 1-Scenario 2. Acres in RMZs as a percent of total private and State harvest on the eastside are shown in Figure 4.11-1. Acres in RMZs on the westside are shown as a percent of total private harvest in Figure 4.11-2. These figures provide a general indication of the relative level of protection by alternative, but it is important to note that not all of these acres are necessarily used for recreation purposes.

Table 4.11-1. Estimated Eastern Washington Acres in Riparian Management Zones by Alternative.

	No Action Alternative 1-Scenario 2		**No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3**		**Alternative 4**	
	Acres in RMZs	**Percent of Total (%)[1/]**	**Acres in RMZs**	**Percent of Total (%)[1/]**	**Acres in RMZs**	**Percent of Total (%)[1/]**
No-Harvest Acres	74,407	2.2	106,731	3.2	853.785	25.4
Light Selective Harvest Acres	43,236	1.3	204,979	6.1	0	0.0
Mod-Heavy Selective Harvest Acres	59,929	1.8	42,289	1.3	0	0.0
Stream Area	18,740	0.6	19,959	0.6	16,837	0.5
Total Acres in RMZs	**196,312**	**5.8**	**373,958**	**11.1**	**870,622**	**25.9**
NET CHANGE RELATIVE TO NO ACTION ALTERNATIVE 1-SCENARIO 2[2/]						
No-Harvest Acres	0	0	32,325	1.0	779,378	23.2
Light Selective Harvest Acres	0	0	161,743	4.8	(43,236)	-1.3
Mod-Heavy Selective Harvest Acres	0	0	(17,641)	-0.5	(59,929)	-1.8
Stream Area	0	0	1,219	0.0	(1,903)	-0.1
Total Acres in RMZs	**0**	**0**	**177,645**	**5.3**	**674,310**	**20.0**

1/ Total acres in RMZs are presented as a percentage of the total land area of private, city, and county forestlands on the eastside (2,619,736 acres), as well as the total land area of State-managed lands on the eastside (745,035 acres).

2/ Net change percentages are also presented in terms of the total land area of privately owned and State-managed eastside forestland (e.g., (119,335 acres/3,364,771 acres)*100=3.5 percent), not in terms of percent change relative to No Action Alternative 1-Scenario 2.

Source: DEIS Appendix B, Riparian Modeling.

Table 4.11-2. Estimated Western Washington Acres in Riparian Management Zones by Alternative.

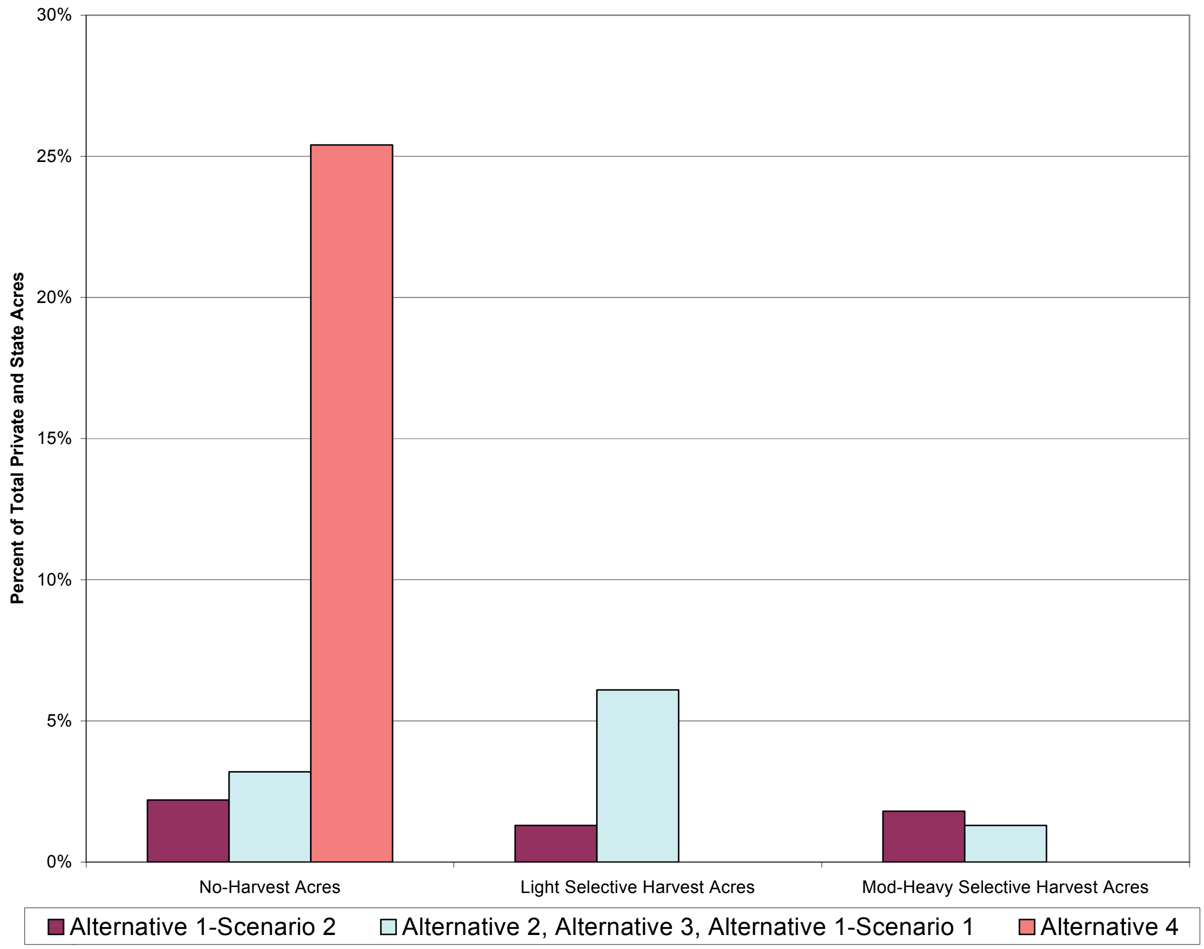
	No Action Alternative 1-Scenario 2		No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3		Alternative 4	
	Acres in RMZs	Percent of Total (%)[1/]	Acres in RMZs	Percent of Total (%)[1/]	Acres in RMZs	Percent of Total (%)[1/]
No-Harvest Acres	263,034	4.2	501,566	8.0	2,602,618	41.4
Light Selective Harvest Acres	195,879	3.1	499,144	7.9	0	0.0
Mod-Heavy Selective Harvest Acres	83,729	1.3	233,325	3.7	0	0.0
Stream Area	88,275	1.4	87,957	1.4	92,743	1.5
Total Acres in RMZs	**630,916**	**10.0**	**1,321,992**	**21.0**	**2,695,361**	**42.9**
NET CHANGE RELATIVE TO NO ACTION ALTERNATIVE 1-SCENARIO 2[2/]						
No-Harvest Acres	0	0	238,532	3.8	2,339,584	37.2
Light Selective Harvest Acres	0	0	303,265	4.8	(195,879)	-3.1
Mod-Heavy Selective Harvest Acres	0	0	149,596	2.4	(83,729)	-1.3
Stream Area	0	0	(318)	0.0	4,468	0.1
Total Acres in RMZs	**0**	**0**	**691,075**	**11.0**	**2,059,977**	**32.8**

1/ Total acres in RMZs are presented as a percentage of the total land area of private, city, and county forestlands on the westside (6,289,303 acres).

2/ Net change percentages are also presented in terms of the total land area of privately owned forestland (e.g., (614,403 acres/6,289,303 acres)*100=9.8 percent), not in terms of percent change relative to No Action Alternative 1-Scenario 2.

Source: DEIS Appendix B, Riparian Modeling.

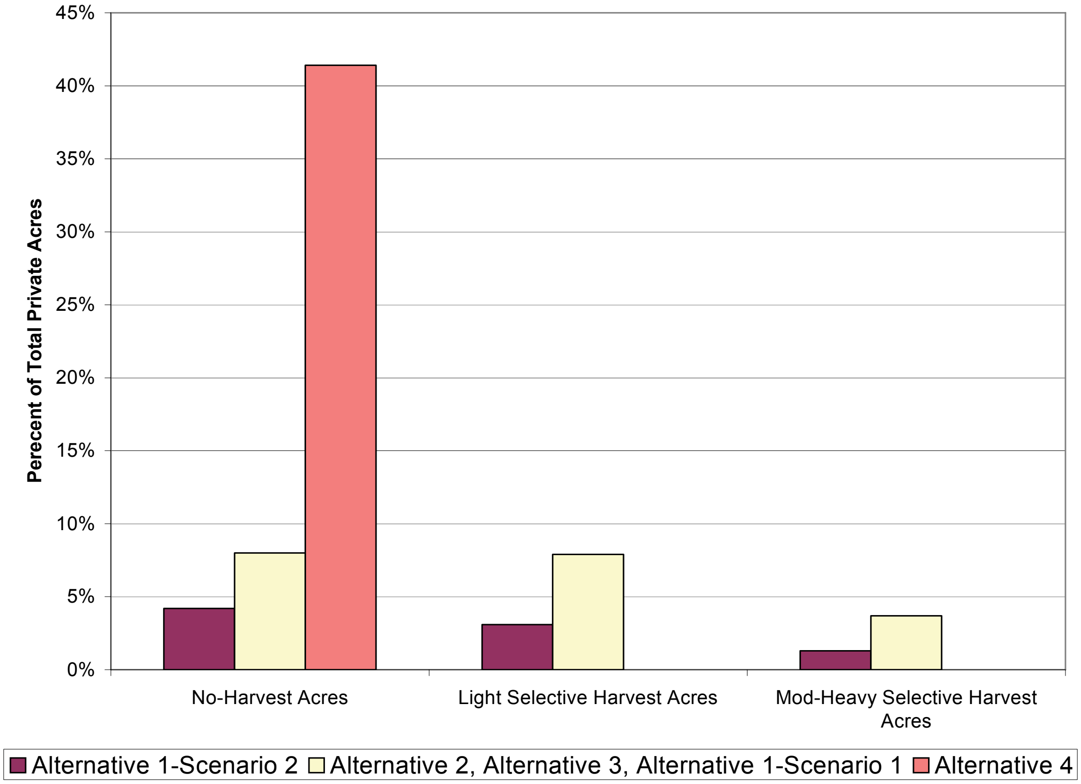
Figure 4.11-1. Estimated Percent of Eastern Washington Private and State Lands in Riparian Management Zones by Alternative.



Note: This figure illustrates the percent of total private and State acres in eastern Washington that would be in RMZs by alternative. It is important to note that not all of these acres are presently available for or used for recreation purposes.

Source: DEIS Appendix B, Riparian Modeling.

Figure 4.11-2. Estimated Western Washington Private Lands in Riparian Management Zones by Alternative.



Note: This figure illustrates the percent of total private acres in western Washington that would be in RMZs by alternative. It is important to note that not all of these acres are presently available for or used for recreation purposes.
Source: DEIS Appendix B, Riparian Modeling.

From an historical perspective, less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation (subsection 3.7.1.7, Current Condition of Riparian Areas). The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past. No Action Alternative 1-Scenario 2 would likely result in future levels of harvest that are similar to current conditions. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in an overall increase in the amount of acres in RMZs, relative to No Action Alternative 1-Scenario 2, with Alternative 4 resulting in a substantial increase in RMZ acres (Figures 4.11-1 and 4.11-2). Reductions in acres available for future harvest relative to current conditions would likely increase the acres that would continue to be available for recreation use in the long-term. Estimating the extent of these potential effects is not possible because the actual areas that would be affected are unknown.

Figures 4.11-1 and 4.11-2 illustrate the percent of acres that would be within RMZs under each alternative. These figures provide a relative indication of acres that would be unavailable for harvest and potentially available for recreation use. Harvest may also affect the quality of recreation experiences on the affected lands and in adjacent areas. On the eastside, for example, approximately 20 percent more of total private and State acres (about 700,000 acres) would be available for harvest under No Action Alternative 1-Scenario 2 than would be available under Alternative 4 (Figure 4.11-1). That does not necessarily mean that harvest would occur on all of these acres, and harvest activities that would occur would likely be spread over an extended period of time into the future. In other words, harvest activities, where they occur, would not all occur at one time. As a result, the overall effects on the forested landscape would be less noticeable to many recreationists over time because there would be variations in the age of the regenerating vegetation in those areas that are harvested. Potential effects on recreation would also likely be reduced by the dispersed nature of much of the recreation use that occurs in these areas.

Under Alternatives 2 and 3, No Action Alternative 1-Scenario 1, and Alternative 4, reductions in potential future harvest, that would likely occur relative to current conditions and No Action Alternative 1-Scenario 2, could maintain the quality of recreation experiences in some adjacent areas, including waterways used for boating, rafting, and other recreation activities. However, many of the shorelines in Washington, including those along larger Type 1 streams, are currently largely protected from timber harvest and other management activities under Washington's Shoreline Management Act.

4.11.3 Effects of Forestland Conversion

The alternatives could result in conversion from forestland to other uses and, therefore, less forestland available for recreation activities. Forestland conversion trends are discussed in subsection 3.2.4 (Timber Harvest Rates for Western and Eastern Washington).

Past trends in conversion of forested lands to other land uses suggest that much of this conversion has occurred in areas located in proximity to major urban areas and transportation corridors. A recent study of land use conversion in King, Pierce, and Kittitas Counties conducted for The Wilderness Society concluded, for example, that between 1985 and 1999 approximately 96,000 acres of forest were converted to urban development (Thomson et al. 2003). Most of this conversion occurred through the removal of young westside forest on the fringe of the Seattle-Tacoma metropolitan area and eastward along Interstate 90 (Thomson et al. 2003). Conversion of forestland to other land uses could reduce the overall availability of private forestlands for recreation use. While it is not possible to estimate the magnitude of this type of effect, it is likely to be much higher under Alternative 4 than under both scenarios of No Action Alternative 1. The restrictions associated with Alternative 4 are more likely to negatively affect the economic viability of timber production for forest landowners, especially small forest landowners and, therefore, increase the potential for forestland conversion. This issue is discussed further in subsection 4.2 (Land Ownership and Use).

4.11.4 Effects on Anglers

The RMZ management actions proposed under the different alternatives could have long-term effects on fish populations that could in turn affect fish-related recreation activities in the future. Fish populations support a major recreational activity in the State. The 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation estimated that 808,000 State residents and 130,000 nonresidents 16 years or older fished in Washington in 2001, spending approximately $854 million on fishing-related expenses, including travel, lodging, and equipment (USFWS and Census Bureau 2003). The survey identified approximately 659,000 freshwater anglers, with 211,000 and 156,000 freshwater anglers indicating that they fished for salmon and for steelhead, respectively. The survey also identified 386,000 saltwater anglers, with 250,000 saltwater anglers indicating that they fished for salmon in 2001. These categories are not mutually exclusive. Some anglers fish in both fresh and salt water, and the majority fish for more than one species at any one time (U.S. Fish and Wildlife Service and Census Bureau 2003). These numbers do, however, provide a good indication of the importance of recreational fishing in Washington State, as well as the importance of salmon and steelhead to this activity.

While it is not possible to quantify the potential effects of the alternatives on salmonid populations, it is possible to assess the potential direction of the effects and provide a general comparison between alternatives. The potential for adverse habitat impacts associated with No Action Alternative 1-Scenario 2, suggest that salmonid populations could decline over the long term under this alternative. Habitat impacts under No Action Alternative 1-Scenario 1 are much less likely to result in reductions in salmonid populations. Alternative 3 would result in a slight improvement in salmonid populations over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements in salmonid populations. Alternative 4 would result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Effects on existing salmonid populations would likely have corresponding effects on the availability of salmonids for recreational harvest.

The preceding discussion provides a general indication of the likely impacts of the alternatives on recreational fishing. However, future changes in fish populations depend on many factors and programs, of which the proposed action is only one. The actions proposed under Alternatives 2, 3, No Action Alternative 1-Scenario 1, and Alternative 4 may not in and of themselves be sufficient to assure an increase in the fishery resource. As discussed above, habitat is just one of the so-called “four H’s” believed to affect fish and especially salmonid populations (Federal Caucus 1999, see also the archive for all Federal Caucus documents, http://www.salmonrecovery.gov/Archive_chronological.shtml) (subsection 4.8.4, Synthesis by Analysis Region). As a result, improvements in fish populations projected under the action alternatives have a high degree of uncertainty associated with them. Impacts to fish are discussed in detail in subsection 4.8 (Fish and Fish Habitat).

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4.12 VISUAL RESOURCES

4.12.1 Introduction

The proposed alternatives could affect visual resources in two ways. First, differences in the level of harvest within RMZs could affect visual resources in those areas. Harvest levels could also have visual effects when viewed from adjacent areas. Primary areas where forest-related visual concerns typically exist include major highway corridors, cities and towns, adjacent housing developments, and trails and other recreation areas. Second, visual resources could be affected by potential differences in conversion rates of private forestland under the different alternatives. The following subsections discuss these potential effects.

In reading this discussion, it should be remembered from Chapter 2 (Alternatives) that under the No Action alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on visual resources are likely to fall somewhere in-between these two scenarios.

4.12.1.1 Overview of Effects

From an historical perspective, less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation (subsection 3.7.1.7, Current Condition of Riparian Areas). The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past. No Action Alternative 1-Scenario 2 would likely result in future levels of harvest that are similar to current conditions improving visual resources slightly due to required RMZs. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in an overall increase in the amount of acres in RMZs, relative to No Action Alternative 1-Scenario 2, with Alternative 4 resulting in a substantial increase in RMZ acres and therefore an improvement in visual resources (Figures 4.11-1 and 4.11-2). Reductions in acres available for future harvest relative to current conditions would likely result in the retention of more natural forested landscapes, which would be seen from roads, trails, recreation areas, and viewpoints.

More restrictive alternatives could result in more conversion from forestland to other uses, which could have substantial impacts on visual resources with residential and other forms of development replacing natural forested landscapes. While it is not possible to estimate the magnitude of this type of effect, it is likely to be much higher under Alternative 4 than under the other alternatives. The restrictions associated with Alternative 4 are more likely to negatively affect the economic viability of timber production for forest landowners, especially small forest landowners and, therefore, increase the potential for forestland conversion and subsequent impacts to visual resources.

4.12.2 Effects of Harvest in Riparian Management Zones

The alternatives evaluated in this environmental analysis are programmatic, meaning that they establish direction for broad land areas rather than scheduling activities on specific parcels of land. As a result, identifying specific tracts of land that would be affected by the proposed alternatives is not possible. However, it is possible to estimate the approximate number of acres that would be located in RMZs by alternative, which can then be equated to acres potentially impacting aesthetic values due to harvest scenarios under each alternative. Estimates of the acres in RMZs by alternative are presented in Tables 4.11-1 and 4.11-2 for the eastside and westside, respectively, along with the net changes in acres relative to the No Action Alternative. Acres in RMZs as a percent of total private and State harvest on the eastside are shown in Figure 4.11-1. Acres in RMZs on the westside are shown as a percent of total private harvest in Figure 4.11-2. These figures provide a general indication of the relative level of protection by alternative, but not all of the acres shown in RMZs under the action alternatives would necessarily be harvested under the No-Action Alternative.

From an historical perspective, less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation (subsection 3.7.1.7, Current Condition of Riparian Areas). The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past. No Action Alternative 1-Scenario 2 would likely result in future levels of harvest that are similar to current conditions. No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in an overall increase in the amount of acres in RMZs, relative to No Action Alternative 1-Scenario 2, with Alternative 4 resulting in a substantial increase in RMZ acres relative to both No Action Alternative 1 scenarios (Figures 4.11-1 and 4.11-2). Reductions in acres available for future harvest relative to current conditions would likely result in the retention of more natural forested landscapes, which would be viewed from public roads, trails, and vistas. Estimating the extent of these potential effects is not possible because the actual areas that would be affected are unknown.

This broad assessment provides some indication of the relative potential of the alternatives to affect visual resources based on the level of timber harvest and associated ground disturbing activities, such as road construction, that could occur under each alternative. It is, however, important to recognize that affected State lands managed for timber production under all alternatives would be managed under the Washington DNR's visual management procedure, which seeks to minimize potential impacts to visual resources by managing harvest activities with respect to sensitive viewshed areas. In addition, potential impacts to visual resources on both State and private lands would be mitigated by various aspects of the current Washington Forest Practices Rules that would remain in effect under all alternatives (subsection 3.12.2, Visual Resources and the Current Washington Forest Practices Rules). These include the restriction on the size of clearcut harvest areas (240 acres or less) and the retention of four or five uncut trees per acre for wildlife. It may be noted that some private forest landowners voluntarily leave additional buffers specifically for visual resource protection (subsection 3.12.2, Visual Resources and the Current Washington Forest Practices Rules).

4.12.3 Effects of Forestland Conversion

Past trends in conversion of forested lands to other land uses suggests that much of this conversion has occurred in areas located in proximity to major urban areas and transportation corridors. Land conversion to uses other than forestland could have negative impacts on visual resources with residential and other forms of development replacing natural forested landscapes. While it is not possible to precisely estimate the magnitude of this type of effect, it is expected to be higher under Alternative 4 than under Alternatives 2, 3, No Action Alternative 1-Scenario 1, and especially No Action Alternative 1-Scenario 2. The restrictions associated with Alternative 4 are more likely to negatively affect the economic viability of timber production for forest landowners, especially small forest landowners and, therefore, increase the potential for forestland conversion. This issue is discussed further in subsection 4.2 (Land Ownership and Use).

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4.13 ~~ARCHEOLOGICAL~~ARCHAEOLOGICAL, HISTORICAL AND CULTURAL RESOURCES

4.13.1 Statutory and Regulatory Context

This subsection describes the statutory and regulatory context within which the alternatives are evaluated.

36 Code of Federal Regulations 800, Section 106-National Historic Preservation Act - Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470 et seq.) requires Federal agencies to take into account the effects of their undertakings on properties eligible for inclusion in the National Register of Historic Places. The NHPA also affords the Advisory Council on Historic Preservation a reasonable opportunity to comment. The historic preservation review process mandated by Section 106 is outlined in regulations issued by the Advisory Council on Historic Preservation (Protection of Historic Properties [36 CFR Part 800]). As defined in the regulations, "undertaking" means a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; or those requiring a Federal permit, license, or approval. With regard to making a determination as to whether any action is an undertaking, an agency should examine the nature of its Federal involvement taking into consideration factors such as the degree of Federal agency control or discretion, the type of Federal involvement or link to the action, and whether or not the action could move forward without the Federal action.

The issuance of a permit for a Habitat Conservation Plan is generally considered by the Services to be an undertaking subject to compliance with Section 106 of the NHPA, although each HCP is unique, and the degree of agency control or discretion may be low, or if determined to be an undertaking, the HCP may or may not have the potential to cause effects on historic properties. Consultation with the Tribes and the public is emphasized, while consultation with the State Historical Preservation Officer is required. Section 106 review requires that agencies: 1) determine if their action is an undertaking; 2) if so, gather information to determine if any cultural or historic properties within the area of potential effect are eligible for the National Register of Historic Places; 3) determine how historic properties might be affected; 4) explore alternatives to avoid or reduce harm to historic properties; and 5) reach agreement with the SHPO and Tribes affected by the action on measures to address any adverse effects.

RCW Chapter 27.44-Indian Graves and Records Act - This statute makes it a crime to knowingly disturb, remove, or damage American Indian graves and glyptic records, such as petroglyphs or pictographs.

RCW Chapter 27.53-Archaeological Sites and Resources Act - This statute prohibits any individual, corporation, or agency from knowingly removing, altering, or disturbing any archaeological site or object without a written permit from the Director of Community, Trade, and Economic Development, or the Director's designee (this includes forestland subject to the Forest Practices Act).

Washington Administrative Code 222-16-Forest Practices Rules - These regulations provide a venue for Washington Tribes to designate areas of interest, comment on individual forest practices applications and their impact on archaeological and cultural resources, and develop a plan with the forest landowner to protect the archaeological or cultural resource of concern.

Forest Practices that may impact cultural, archaeological, or historic sites are Class III or Class IV-Special forest practices. A Class III application is triggered when

> *harvesting, road construction, site preparation, or aerial application of pesticides occurs on lands that contain cultural, historic, or archaeological resources which, at the time the application or notification is filed are: (i) on or are eligible for listing on the National Register of Historic Places (NRHP; or (ii) have been identified to the department as being of interest to an affected Indian Tribe" (tribal cultural resource).*

A Class IV-Special application is required for timber harvesting, road construction, landings, rock quarries, gravel pits, borrow pits, and spoil disposal areas on archaeological or historic sites registered with the Washington State Office of Archaeology and Historic Preservation, or on sites containing evidence of Native American cairns, graves, or glyptic records, as provided for in RCW Chapters 27.44 and 27.53 Under WAC 222-16, Washington DNR is required to consult with affected Indian Tribes in identifying Class IV Special sites of concern.

Washington DNR funds a position at the Office of Archaeology and Historic Preservation that maintains a data base with locations of known archaeological sites or resources, historic sites, or tribal cultural resources. Washington DNR accesses this database when a forest practices application/notification) is filed to correctly class the forest practices application/notification. If the forest practices application/notification causes a hit in the Office of Archaeology and Historic Preservation database, Washington DNR consults with the Office of Archaeology and Historic Preservation to determine the appropriate classification of the application/notification.

A Class IV-Special application must include a SEPA environmental checklist and public review in compliance with SEPA. Washington DNR may require additional information or a detailed environmental impact statement. Once the Class IV-Special forest practices application is complete (all necessary documents submitted), Washington DNR will do one of the following: approve, disapprove, or approve the application with conditions for mitigation measures to protect cultural resources.

Washington Administrative Code 222-20-120-Forest Practices Rules - This regulation designates that DNR will notify affected Indian Tribes of all of forest practices applications/notifications of concern to such Tribes and that landowners, where an forest practices application/notification involves cultural resources, shall meet with the affected Tribe(s) with the objective of agreeing on a plan for protecting the archaeological or cultural value.

When a Class III or Class IV-Special forest practices application involves a tribal cultural resource, the landowner must meet with affected Tribes with the objective of agreeing on a plan for protecting archaeological or cultural values. If the parties come to an agreement, then the landowner may voluntarily add the mitigation measures to the forest practices application. If this occurs, Washington DNR will enforce the mitigation measures as terms of the permit. The affected Tribe decides whether a copy of the agreement will be sent to the Office of Archaeology and Historic Preservation. Regardless of whether or not agreement between the landowner and Tribe is reached on a plan for protecting the resource, the provisions of RCW Chapters 27.44 and 27.53 (above) still apply to sites and resources under their scope. Enforcement of RCW Chapter 27.53 is assigned to the Director of the Office of Community, Trade, and Economic Development and RCW Chapter 27.44 is under the jurisdiction of the State superior court system.

Forest practices under both the TFW Agreement and FFR provide for procedures to increase cooperation between landowners and the Tribes over the protection of cultural resources. The most recent agreements are discussed below as the Cultural Resources Protection and Management Plan and Watershed Analysis Cultural Resources Module.

Cultural Resources Protection and Management Plan - In July 2003, the TFW Cultural Resources Committee presented the Washington Forest Practices Board with the Cultural Resources Protection and Management Plan (Plan). The Plan demonstrates Washington DNR's relationship with Washington Tribes. The Plan is a collaboratively developed multi-caucus proposal for cultural resource planning, protection, and management based on the commitments made in the 1987 Washington State TFW Agreement, an inter-tribal proposal, and the 1999 FFR.

The basic functions of the Plan involve largely voluntary actions designed to: foster improved communication and mutual respect between the State, Tribes, and land owners; provide cooperative processes to protect and manage cultural resources; and provide educational opportunities to foster trust, commitment, and understanding. Memoranda of Understanding, signed documents that describe the verbal agreements between landowners and Tribes are cited in the Plan as the preferred pathway to protect cultural resources.

The Plan's educational opportunities include programs and workshops designed for land owners, land managers, Tribes, and State agencies. The goal of this education is a common understanding of cultural resource issues in a forest management context. A small forest landowner educational program, for example, is currently under development.

For its part, the Washington DNR's Forest Practices commitments in the Plan include outreach to Tribes to identify and automatically give notice of permits in their geographic areas of interest, requiring cultural resources information on the forest practices application/notification form, updating Forest Practices program guidance on cultural resources rules, and assisting the Office of Archaeology and Historic Preservation in updating and maintaining its ~~archeological~~archaeological and historic inventories.

Watershed Analysis Cultural Resources Module -The Plan also includes a proposed Watershed Analysis Cultural Resources Module. The module is a required part of any new forest practices Watershed Analysis process, and is a stand-alone method for identifying and protecting resources in any landowner context outside the Watershed Analysis process. For example, the module could be used in consultations pursuant to a forest practices application on property that contains known cultural resources, and as a planning tool for producing a landowner's inventory of cultural resources. The methodology is a five-step process. Step 1, Startup, entails identifying and contacting stakeholders, choosing and training a research team, and developing a research plan. Step 2, Cultural Resources Assessment, produces an inventory of known cultural resources through literature and records review and interviews with tribal elders and other knowledgeable informants. Step 3, Synthesis, is an assessment of the condition, sensitivity, and vulnerability of identified cultural resources and the development of problem statements that identify threats to particular cultural resources. Step 4, Management Strategies Process, establishes a process for voluntarily minimizing or preventing adverse impacts. Step 5 is a summary of the process, including development of a plan for monitoring the effectiveness of the voluntary management strategies.

Forest Landowners Voluntary Involvement - In addition to statutory and regulatory efforts, many forest landowners in Washington voluntarily work with Tribes that may have concerns about the landowner's forest management and potential effects on cultural resources.

Summary

Under the laws, rules, and the agreements summarized above, cultural resources receive varying levels of protection. Archaeological sites and resources, including Indian graves, cairns, artifacts, and implements of culture or glyptic records are protected by State laws in RCW Chapters 27.44 and 27.53. These laws apply regardless of the forest practices rules. The Washington Forest Practices Rules, Chapter 222 WAC, require notice to the Tribes, SEPA review, landowner tribal meetings, and, once adopted into rule, a cultural resource assessment as part of any new Watershed Analysis process. Surveys to determine the location and identification of previously undocumented cultural resources are not required under Washington Forest Practices Rules unless committed to as a result of the SEPA process.

Existing Office of Archaeology and Historic Preservation information is supplemented by tribal and landowner knowledge of undocumented cultural resources. These resources are usually identified upon consultation with affected Tribes. Protections for cultural, historic, or archaeological resources are voluntary under Washington Forest Practices Rules, however, RCW Chapters 27.44 and 27.33 continue to provide protection for these resources.

Procedures exist under the Forest Practices application process, the Cultural Resources Protection and Management Plan, and the State Watershed Analysis Cultural Resources

Module whereby traditional sites and materials may be identified in consultation with affected Tribes who may choose not to document the resource outside of tribal knowledge because of the history of site disturbance and looting. Through voluntary processes in the TFW Agreement and the Cultural Resources Plan (including the stand-alone option for the Watershed Analysis Cultural Resources Module), understanding, respect, and protection of all cultures resources is enhanced.

4.13.2 Evaluation Criteria

Assessment of the effects of the four alternatives on cultural resources is necessarily qualitative. The actual numbers of archaeological sites and resources, historic sites, and cultural resources and the numbers of culturally important species (e.g., fish) are mostly unknown and in some cases remain un-assessed during the forest practices application process. Consequently, the evaluation of effects from the four alternatives is qualitative and based on acreage taken out of forest production with required RMZs, the anticipated degree of landowner cooperation with voluntary procedures, and the estimated effect on protected species of fish. Rationale for each measure is provided below. Archaeological sites and resources and Indian graves, cairns, and glyptic records, when known, would receive the same level of protection under all alternatives.

4.13.2.1 Acreage Taken Out of Forest Production

Alternatives differ in the width of the RMZ provided along watercourses and on unstable slopes. Whenever forested land, particularly land along streams, is unharvested, the archaeological sites and resources, historic sites, traditional sites, and traditional resources that may occur within that RMZ are protected from forest practices activities, whether or not they have been documented. The wider the RMZ, and the more stringent the constraints within the RMZ, the greater the number of cultural sites and population of resource species likely to be protected.

4.13.2.2 Voluntary Landowner Cooperation

Protection of historic sites, traditional sites, and traditional resources is largely voluntary under forest practices and dependent on the development of mutual good will between agencies, landowners, and Tribes. However, landowners are required to follow RCW Chapters 27.44 and 27.33, independent of any additional voluntary cooperation that takes place between landowners and respective tribal governments. It is assumed that forest landowners are more likely to voluntarily participate in protecting cultural resources when take authorization is granted and when regulations do not take much timberland out of production. Small landowners' ability to harvest timber profitably will be particularly affected by RMZ requirements, so willingness to voluntarily participate in cultural resource protection agreements may wane as RMZs expand. Still, the less regulatory certainty provided under a specific alternative, the less likely owners would agree to additional constraints on the use of their land. As voluntary participation declines, more historic sites, cultural sites, and traditional resources are likely to be adversely affected. The access by tribal members to traditional sites and traditional resources can also be expected to decline with regulatory uncertainty.

4.13.2.3 Effects on Salmonid Species

Salmon are important traditional resources to all Washington Tribes, and bull trout are particularly important in watersheds outside the historic range for salmon. Assessments of the relative impact of the four alternatives on these traditional resources will be incorporated in the assessment of cultural resources.

4.13.3 Evaluation of the Alternatives

4.13.3.1 No Action Alternative 1-Scenario 1

No take authorization or take limits under ESA Section 4(d) Rules would be granted by the Services under this alternative, yet the width of the no-harvest RMZ and the inner zones would be the same as those required under Alternatives 2 and 3 that do provide take authorization. Under this scenario, there is no requirement for Federal agencies to make a determination with respect to an undertaking because there is no proposed Federal action. With this scenario, it is unlikely that the Forests and Fish Agreement would continue to be supported by parties to the agreement. As a result, voluntary compliance with cultural resources policies established under the Cultural Resources Protection and Management Plan is thus, likely to be lower than expected if take authorization is granted (Alternatives 2 through 4).

No-harvest RMZs protect an estimated 700,000 acres in western Washington and 83,000 acres in eastern Washington, while inner zones of 135,000 acres in the east and 577,000 acres in the west provide partial protection. These zones protect undocumented archaeological sites and any traditional sites or resources that may occur within them. Salmonids are expected to be protected at a moderate level, as under Alternatives 2 and 3. In summary, undocumented archaeological sites are expected to receive moderate protection, while protection for historic sites, traditional resources, and traditional sites would be lower than that under all other alternatives except No Action Alternative 1-Scenario 2.

4.13.3.2 No Action Alternative 1-Scenario 2

This alternative assumes that no take authorization or take limits would be granted by the Services and thus, there is no requirement for Federal agencies to make a determination with respect to an undertaking because there is no proposed Federal action. Under No Action Alternative 1-Scenario 2, through legislative direction, the State would revert back to the Forest Practices Regulatory Program and Washington Forest Practices Rules as they existed before 1999. This would mean reduction or termination of funding for the Forests and Fish programs, elimination of the landowner incentive program, and a reduction in Washington DNR staff for rule implementation and enforcement.

Under this scenario, much of the voluntary process established in the Cultural Resources Protection and Management Plan may be abandoned, so voluntary protections for cultural resources, along with access to traditional sites and resources would likely be at their lowest level among all alternatives. Undocumented archaeological sites and traditional sites and resources located close to streams would receive less protection; only about 38,000 acres in eastern Washington and 147,000 acres in western Washington would be protected by no-harvest policies. An additional 317,000 acres in the west and 53,000 acres in the east would be partially protected by light selective harvest prescriptions. There would be less protection for undocumented archaeological sites. Salmonid species would receive the least protection under this alternative. In summary, under No Action Alternative 1-Scenario 2, adverse impacts to undocumented archaeological sites, traditional sites and resources, and to historic sites would be greatest among the four alternatives.

4.13.3.3 Alternative 2

This alternative presumes that the Services grant take authorizations to the State. Thus, under this alternative, Federal agencies have a responsibility under NHPA Section 106 to make a determination whether or not the proposed Federal action is an "undertaking," as previously defined. Regardless of the determination, protections of historic properties under this alternative would likely be increased and/or improved from those provided under No Action Alternative 1-Scenario 2 because there are already protection provisions incorporated into the current Washington Forest Practices Rules, and because of the collaboratively developed Cultural Resources Protection and Management Plan. Compared to No Action Alternative 1-Scenario 1, protection of historic properties under Alternative 2 may or may not change, depending on the determination and any subsequent consultation with the State Historic Preservation Office and the Tribes.

Under this alternative, salmonids would receive moderate protection. No-harvest zones and light selective cut acreages would be the same as under No Action Alternative 1-Scenario 1 and Alternative 3, providing moderate protection for undocumented archaeological sites and traditional resources found in riparian zones. Landowners would receive maximum assurances that they are considered to be in compliance with the ESA. They are, therefore, expected to be more likely to comply with the Cultural Resources Protection and Management Plan, entering into consultation with Tribes and Washington DNR and voluntarily protecting or allowing access to cultural resources that are not directly protected by statute. As a consequence, undocumented archaeological resources would be moderately protected, while historic sites, traditional sites, and traditional resources, except salmonids, would receive the most protection among the alternatives.

4.13.3.4 Alternative 3

This alternative provides take limits under the ESA Section 4(d) rule. It has not been determined whether or not a 4(d) rule limit qualifies as an undertaking under NHPA Section 106. Regardless of whether it is determined that take approval under ESA Section 4(d) is an "undertaking," protection of historic properties under Alternative 3 may or may not be changed compared to No Action Alternative 1-Scenario 1, but would likely be improved compared to No Action Alternative 1-Scenario 2 because of the protection provisions in the current Washington Forest Practices Rules. This alternative provides only take limits under the 4(d) rule and is thus, expected to receive a lower level of voluntary compliance with the Cultural Resources Protection and Management Plan than would Alternative 2. This level of compliance is, however, expected to be higher than that attained under Alternatives 4 and No Action Alternative 1 (both scenarios).

The width of no-harvest and inner zones is equal to that of Alternative 2, so the protected acreage, and thus, the protection of undocumented archaeological resources and other streamside cultural resources, is again moderate. Salmonids are expected to be protected at a moderate level, as under No Action Alternative 1-Scenario 1 and Alternative 2. Therefore, undocumented archaeological sites and salmonids would receive a moderate level of protection, while historic sites, traditional sites, and non-salmonid traditional resources would receive a lower level of protection than Alternative 2, but higher than No Action Alternative 1-Scenario 1 or Alternative 4.

4.13.3.5 Alternative 4

This alternative assumes that the Services would grant take authorizations under ESA Section 10(a)(1)(B). Depending on the Federal NHPA Section 106 determination, and any subsequent consultation to seek ways to address adverse effects on historic properties, the protection of historic properties under Alternative 4 may or may not be changed compared to No Action Alternative 1-Scenario 1, but would likely be improved compared to No Action Alternative 1-Scenario 2 because of more restrictions on timber harvest.

Alternative 4 designates a much higher proportion of forestland as no-harvest compared to all other alternatives; including 973,000 acres in eastern Washington and 2,963,000 acres in western Washington. This would remove approximately 29 percent of the forestland from production in the east and 47 percent from production in the west. This degree of restriction is expected to substantially lower the level of landowner cooperation with voluntary rules and would likely lead to much higher levels of conversion from forestland to residential development. As a result, under Alternative 4, undocumented archaeological sites and some traditional resources would receive much greater protection where wider RMZs are established and other limits to harvest are enforced. However, the lower level of voluntary compliance with the Cultural Resources Protection and Management Plan and the increased conversion rate could result in reduced protection of historic sites, traditional sites, and some traditional resources as well as reduced tribal access to traditional sites and resources on private land compared to all other alternatives.

Because of much broader no-harvest prescriptions along streams, salmonid resources would receive the greatest protection under this alternative. This alternative, therefore, would provide the greatest protection to undocumented archaeological sites and salmonid resources, moderate protection to non-salmonid traditional resources, and reduced protection to historic sites and traditional sites. Tribal access to traditional resources and levels of protection for traditional sites and historic sites might be similar to that expected under No Action Alternative 1- Scenario 1, but lower than for Alternatives 2 and 3.

4.14 SOCIAL AND ECONOMIC ENVIRONMENT

4.14.1 Introduction

Potential social and economic effects are addressed in the following subsections. The first subsection addresses the potential effects of the proposed alternatives on employment and the economy, primarily in terms of potential effects on employment and income. It also addresses potential effects to small and large forest businesses by summarizing the findings of the Small Business Economic Impact Statement that was prepared for the current Washington Forest Practices Rules (Perez-Garcia et al. 2001) and other existing studies (Zobrist 2003; ~~Oneill~~ O'Neil 2003). The second subsection discusses the potential effects of the alternatives in terms of non-use and ecosystem values. These values are difficult to quantify and are typically expressed in monetary terms or discussed qualitatively. The third and final subsection discusses potential environmental justice concerns associated with the project and the proposed alternatives.

In reading the following discussion, it should be remembered from Chapter 2 (Alternatives) that under the No Action Alternative no ITPs or ESA Section 4(d) take authorization would be issued. However, this lack of action would likely affect the Forest Practices Regulatory Program in a way that is difficult to predict. Therefore, two scenarios, which represent the endpoints of the reasonable range of possible outcomes for the Forest Practices Regulatory Program, have been defined (subsection 2.3.1, Alternative 1 (No Action)) to represent the No-Action Alternative. The effects of No Action are displayed for both of these endpoints in the following subsections, but the actual outcome and the actual effects of No Action on the social and economic environment are likely to fall between these two scenarios.

4.14.1.1 Overview

The potential effects of the alternatives on the social and economic environment are divided into three broad areas that address employment and the economy, non-use and ecosystem service values, and environmental justice.

The current Washington Forest Practices Rules provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas under the January 1, 1999 Washington Forest Practices Rules, as well as historic harvest levels. Reductions in future timber harvest would likely occur under No Action Alternative 1-Scenario 1, Alternatives 2 and 3, and particularly Alternative 4 relative to No Action Alternative 1-Scenario 2.

Employment and the Economy

Potential reductions in timber harvest would have negative effects on employment and income in the lumber and wood products sector and positive effects on recreational and commercial fishing, as well as natural amenities and quality of life issues. However, the potential for land conversion could change these outcomes (subsection 4.1.2.5, Alternative Groupings; Table S-1).

Lumber and Wood Products

Perez-Garcia et al. (2001) developed a ratio of jobs per million board feet harvested using statewide data for the different subsectors that comprise the wood products industry. Using this ratio, the potential reductions in average annual harvest would result in approximately 3,000 direct jobs foregone under No Action Alternative1-Scenario 1 and Alternatives 2 and 3 as compared to No Action Alternative 1-Scenario 2. The majority of these foregone jobs, about 94 percent, would be on the westside of the State. Using the same approach, approximately 15,000 jobs would be foregone under Alternative 4, with about 13,500 of these jobs foregone in western Washington counties.

Using 1997 average salary data from Perez-Garcia et al. (2001), these potential reductions in employment would result in annual losses of approximately $121 million and $476 million in income under No Action Alternative1-Scenario 1, Alternative 2, Alternative 3, and Alternative 4, respectively. Grays Harbor, Lewis, Cowlitz, Pacific, and Pierce Counties would experience the largest absolute reductions in harvest under No Action Alternative 1-Scenario 1, Alternative 2, Alternative 3, and Alternative 4, accounting for just over half of the projected statewide reduction under each alternative.

Recreational and Commercial Fishing

RMZ management actions proposed under the different alternatives could have long-term effects on fish populations that could in turn affect recreational and commercial fishing activities in the future. While it is not possible to quantify the potential effects of the alternatives on salmonid populations, it is possible to assess the potential direction of the effects and to provide a general comparison between alternatives.

In summary, the potential for adverse habitat impacts associated with No Action Alternative 1-Scenario 2, suggest that salmonid populations could decline over the long term under this alternative. Habitat impacts under No Action Alternative 1-Scenario 1 are much less likely to result in reductions in salmonid populations compared to No Action Alternative 1-Scenario 2. Alternative 3 would likely result in improvement over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements. Without land conversion, Alternative 4 would result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Effects on existing salmonid populations would likely affect the availability of salmonids for recreational and commercial harvest, which would, in turn, affect employment and income in these sectors.

Natural Amenities and Quality of Life

Natural amenities and local quality of life have increasingly been recognized as important factors determining the economic prospects of many rural communities. Natural amenities and quality of life do not directly generate income in the same sense as other factors such as a sawmill or tourist lodge, but they often act to attract and keep residents. The alternatives evaluated in this environmental analysis are programmatic, meaning that they establish direction for broad land areas rather than scheduling activities on specific parcels of land. As a result, it is very hard to identify the impact of the different alternatives on local amenities and, further, on the economic activity these amenities generate. However, based on the amount of acres that would be protected in RMZs, the relative contribution of the action alternatives considered here is likely to be greatest under Alternative 4, followed by Alternative 2, Alternative 3, and No Action Alternative1-Scenario 1, with the least relative contribution occurring under No Action Alternative 1-Scenario 2.

Non-Use and Ecosystem Service Values

Non-use values represent the value that individuals assign to a resource independent of their use of that resource. These types of values, which include existence, option, and bequest values, are usually measured via surveys that ask people to state how much they would be willing to pay to preserve a particular area (Arrow et al. 1993). These values represent the value that individuals obtain from knowing that a resource exists, knowing that it would be available to use in the future should they choose to do so, and knowing that it would be left for future generations to inherit. Endangered species preservation is well recognized as a potential source of non-use value. Studies have also identified non-use values associated with the preservation of forested landscapes. While these values are generally believed to exist, they are difficult to accurately measure. These values would, however, be expected to be higher under Alternative 2, Alternative 3, and No Action Alternative 1-Scenario 1 compared to No Action Alternative 1-Scenario 2, and higher still under Alternative 4 without land conversion.

Ecosystem services are those services and benefits provided by healthy ecosystems. Examples of ecosystem services that pertain to forests include water quantity and quality, soil stabilization and erosion control, improved air quality, climate regulation and carbon sequestration, and biological diversity (Krieger 2001). While the ecosystem service values associated with the proposed protection measures exist, they are very difficult to accurately quantify in monetary terms. As a result monetary values are not assigned to ecosystem services in this document, but it is possible to assess the potential direction of the effects and provide a general comparison between alternatives. In terms of the proposed alternatives, the value per household is likely to be highest for Alternative 4 without land conversion, followed by No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3.

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that Federal agencies ensure that minority and low-income populations are not disproportionately affected by their actions. The Order further stipulates that the agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination because of their race, color, or national origin.

The alternatives have the potential to affect Washington's Native American Tribes by affecting the availability of salmonid species and potentially altering access to traditional places and usual and accustomed use areas. No Action Alternative 1-Scenario 1 is much less likely to result in reductions in salmonid populations compared to No Action Alternative 1-Scenario 2. Alternative 3 would result in a slight improvement over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements. Without land conversion, Alternative 4 would result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Access to usual and accustomed places would be similarly affected by the alternatives with No Action Alternative 1-Scenario 2 having the largest potential impact and Alternative 4 the least.

Concerns have been expressed that potential reductions in lumber and wood products employment could have disproportionately high effects on small, timber-dependent communities. The proposed action is programmatic in nature and it is not possible to quantify the potential impacts of the alternatives on specific geographic locations or communities. It is possible that the overall effect of reductions in employment in the relatively well-paid lumber and wood products sector could have disproportionately negative effects on timber-dependent communities that may already have relatively high unemployment and poverty rates. For this element, it is likely that Alternative 4 would have the highest negative effect on timber-dependent communities due to greater reductions in timber harvest and the increased likelihood of land conversions.

4.14.2 Employment and the Economy

The following discussion is divided into three main parts that address potential economic impacts associated with lumber and wood products, recreational and commercial fishing, and natural amenities and quality of life issues.

From an historical perspective, less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation. The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past. No Action Alternative 1-Scenario 2 would likely result in future levels of harvest that are similar to current conditions. Reductions in potential future harvest would likely occur under No Action Alternative 1-Scenario 1, Alternatives 2 and 3, and Alternative 4, relative to current conditions and No Action Alternative 1-Scenario 2. These reductions would have negative effects on employment and income in the lumber and wood products sector and positive effects on recreation and commercial fishing, as well as natural amenities and quality of life issues.

4.14.2.1 Lumber and Wood Products

The following discussion is divided into two main parts that address employment and income and potential impacts upon forest businesses, respectively.

Employment and Income

All of the alternatives except No Action Alternative 1-Scenario 2 would result in an overall reduction in acres available for harvest in riparian zones on lands owned by private forest landowners on both the east and westsides of the State, as well as State-managed lands on the eastside. State-managed lands on the westside are regulated separately under the State Trust Lands HCP (Washington DNR 1997d).

The following subsections addresses potential employment and income effects at two geographic scales. The first subsection addresses potential impacts from a statewide perspective. The second subsection uses the available data to provide some insight into the distribution of potential impacts by county.

Statewide Employment and Income Effects

The following subsection addresses the potential effects of the alternatives on timber harvest and the timber industry and employment income in two ways. The first approach is based on data used elsewhere in this FEIS and considers the potential impacts in terms of acres that would no longer be available for harvest as a percentage of total acres and existing harvest levels. The second approach summarizes results of the analysis of Alternative 2 conducted as part of the Small Business Economic Impact Statement prepared for the current Washington Forest Practices Rules (Perez-Garcia et al. 2001).

Under RCW Chapter 19.85.030, an agency adopting a rule is required to prepare a Small Business Economic Impact Statement if the proposed rule will impose more than minor costs on the businesses within an industry. The current Washington Forest Practices Rules were expected to impose more than minor costs on forest products businesses and, therefore, a Small Business Economic Impact Statement (Perez-Garcia et al. 2001) was prepared to assess the effects of the new proposed rule compliance costs on small and large businesses.

Riparian Management Zone Acres

Less restrictive forest practices have resulted in riparian zones that are dominated by high levels of early-seral stage vegetation. The current Washington Forest Practices Rules, as well as those rules in effect on January 1, 1999, provide for reduced levels of harvest within riparian zones compared to harvest levels that occurred in these areas in the past.

Estimates of the number of riparian zone acres that would have harvest restrictions under each alternative are presented in Tables 4.11-1 and 4.11-2. Affected acres are estimated for three types of restriction, which correspond with the alternative descriptions presented in Chapter 2 (Alternatives). The following paragraphs summarize the potential reductions in harvest by alternative based on the number of acres that would be in RMZs. These estimates do not include potential reductions in harvest that could result from land conversions. The potential for increased land conversion from forestland to other uses would be highest under Alternative 4.

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in an overall net increase of 177,645 acres in eastside riparian zones compared to No Action Alternative 1-Scenario 2 (Table 4.11-1). This increase represents approximately 5.3 percent of all private, city, county, and State-managed forestlands on the eastside. Alternative 4 would result in an overall net increase of 674,310 eastside acres, approximately 20.0 percent of all private, city, county, and State-managed forestlands on the eastside (Table 4.11-1).

No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 would result in an overall net increase of 691,075 acres in westside riparian zones compared to No Action Alternative 1-Scenario 2, approximately 11.0 percent of all private, city, and county forestlands on the westside. Alternative 4 would result in an overall net increase of 2,051,068 acres, approximately 32.6 percent of all private, city, and county forestlands on the westside (Table 4.11-2).

Assuming that the reduction in available acres would lead to a corresponding annual reduction in harvest levels, Alternatives 2 and 3 and No Action Alternative 1-Scenario 1 would result in total harvest reductions of approximately 4 percent on the eastside and 6 percent on the westside compared to No Action Alternative 1-Scenario 2 (Table 4.14-1). Total harvest in this context refers to harvest from all land ownerships, not just State and private on the eastside or private on the westside. Alternative 4 would result in total harvest reductions of approximately 14 percent and 25 percent on the east and westsides, respectively. Statewide, No Action Alternative 1-Scenario 1, and Alternatives 2, and 3 would result in a total harvest reduction of approximately 5 percent. Alternative 4 would result in a total harvest reduction of approximately 23 percent (Table 4.14-1).

Table 4.14-1. Estimated Reductions in Average Annual Harvest by Alternative (thousand board feet [MBF]).

	Net Reduction in Acres (%)[1/]	Affected Harvest (MBF)[2/]	Net Annual Reduction (MBF)[3/]	Total Harvest (MBF)[4/]	Projected Net Reduction as a Percent of Total Harvest (%)
Alternative Alternative 1-Scenario 1					
Eastside	0	636,745	0	993,937	0
Westside	0	3,220,002	0	3,416,909	0
Total	**0**	**3,856,746**	**0**	**4,410,846**	**0**
Alternative 2, Alternative 3, No Action Alternative 1-Scenario 1					
Eastside	4	636,745	25,470	993,937	3
Westside	6	3,220,002	193,200	3,416,909	6
Total		**3,856,746**	**218,670**	**4,410,846**	**5**
Alternative 4					
Eastside	22	636,745	140,084	993,937	14
Westside	27	3,220,002	869,401	3,416,909	25
Total		**3,856,746**	**1,009,484**	**4,410,846**	**23**

1/ This represents the estimated net reduction in private/city/county and State forestland that would be unavailable for harvest under the action alternatives. This analysis assumes that there would be no harvest on no-harvest acres, and 30 percent and 70 percent of selective harvest and moderate-heavy selective harvest acres harvested, respectively.
2/ Affected harvest is annual average harvest from private and State lands for 1990 through 2002. Sources for harvest data include Washington DNR 2004b and Washington DNR 2004d.
3/ This represents the harvest that would be foregone assuming that the estimated net reduction in acres available for harvest would lead to a corresponding decrease in harvest.
4/ The total harvest figures are average annual harvest figures for all ownerships in Washington State for 1990 through 2002.

Perez-Garcia et al. (2001) developed a ratio of jobs per million board feet harvested using statewide data for the different subsectors that comprise the wood products industry. Using this ratio, the potential reductions in average annual harvest as compared to No Action Alternative 1-Scenario 2 would result in approximately 3,000 direct jobs foregone under No Action Alternative1-Scenario 1 and Alternatives 2 and 3. The majority of these lost jobs, about 94 percent, would be on the westside of the State.

Using the same approach, approximately 15,000 jobs would be lost under Alternative 4, with about 13,500 of these jobs foregone in western Washington counties as compared to No Action Alternative 1-Scenario 2. Using 1997 average salary data from the Small Business Economic Impact Statement, these potential reductions in employment would result in annual losses of approximately $121 million and $476 million in income under No Action Alternative 1-Scenario 1 and Alternatives 2, 3, and 4, respectively.

These general employment and wage estimates assume a linear relationship between potential harvest reductions and employment that is unlikely to occur in reality as adjustments to reduced harvests may take place over an extended period of time. In addition, a reduction in available acres due to RMZ restrictions may affect the profitability of harvesting in adjacent areas in cases where the amount of timber available to cover fixed harvest costs is reduced. This is particularly likely to be the case with small non-industrial private forest landowners (Zobrist 2003). Further, these estimates assume that harvest would occur in the inner zone under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. Although some large landowners, mostly industrial landowners, are harvesting in the inner zone, anecdotal field evidence suggests that many landowners are not harvesting within the inner zones. Many landowners are not harvesting in the inner zone because the value of the trees that “may” be available for harvest in this zone are not expected to justify the inventory/layout cost. This situation may change in the future if stumpage values increase.

Small Business Economic Impact Statement Analysis of Statewide Effects

The Small Business Economic Impact Statement assessed the potential employment and income effects of Alternative 2 in 2001 using a different approach (Perez-Garcia et al. 2001). This analysis found that potential reductions in the timber base under Alternative 2 would result in total harvest reductions of 10 percent and 20 percent in eastern and western Washington, respectively. Using annual harvest data for 1997, the Small Business Economic Impact Statement analysis identified potential harvest reductions of approximately 97 million board feet on the eastside and 650 million board feet on the westside. The analysis then applied job/million board feet ratios developed using the 1997 County Business Pattern (Perez-Garcia et al. 2001) and annual harvest data to estimate foregone employment and wages. This resulted in an estimated reduction in direct eastside employment of approximately 865 jobs, with an associated loss of approximately $27 million in wages. The Small Business Economic Impact Statement analysis estimated a loss of approximately 10,317 westside jobs and $351 million in wages.

The impacts projected for the current Washington Forest Practices Rules, Alternative 2 in the Small Business Economic Impact Statement (Perez-Garcia et al. 2001) analysis, are substantially higher than those identified for No Action Alternative 1-Scenario 1 and Alternatives 2 and 3 in the RMZ acres analysis presented above. This partially reflects the different methodologies employed and is also a result of the underlying database used to generate estimates of acres that would no longer be available for harvest.

Employment Effects by County

This subsection uses estimated net changes in RMZ acres at the county level to assess potential effects on county employment and income. As with the statewide RMZ-based analysis summarized above, this analysis assumes that a reduction in available acres would lead to a corresponding annual reduction in harvest levels. Potential reductions in harvest levels are, in turn, assumed to result in corresponding reductions in annual employment and income. The county-level analysis is complicated because harvest activities in a particular county do not necessarily employ residents of that county. Timber harvested could be processed elsewhere in the State, and the mill employment potentially forgone due to a reduction in acres available for harvest that could be located in other counties. Alternatively, timber harvested could be exported as unprocessed logs, with port workers and longshoremen affected by potential harvest reductions rather than local mill workers. In addition, loggers and logging contractors employed to harvest timber that would otherwise be harvested may not reside in the county where the harvest would have occurred. The logging activities themselves and at least some of the associated expenditures would, however, have occurred in the county where the timber is located. With these points in mind, the following analysis is intended to give a general overview of the potential distribution of employment and income impacts by county.

Viewed at a county level the projected net change (as compared to No Action Alternative 1-Scenario 2) in RMZ acres on State and private lands associated with Alternatives 2 and 3 and No Action Alternative 1-Scenario 1, would range from 4 percent to 7 percent. Assuming that a reduction in available acres would result in similar decreases in harvest levels, counties that would experience relatively large reductions in harvest from State and private lands include San Juan, Island, Kitsap, Pierce, Grays Harbor, Lewis, and Cowlitz Counties (Table 4.14-2).

Projected net changes in RMZ acres under Alternative 4 would range from 18 percent in Jefferson County to approximately 32 percent in San Juan and Island Counties. Assuming that a reduction in available acres would result in similar decreases in harvest levels, counties that could experience relatively large reductions in harvest from State and private lands include San Juan, Island, Kitsap, Pierce, Grays Harbor, Lewis, and Cowlitz Counties (Table 4.14-2).

Counties with the largest absolute reductions in harvest under Alternatives 2 and 3, No Action Alternative 1-Scenario 1, and Alternative 4 would be Grays Harbor, Lewis, Cowlitz, Pacific, and Pierce Counties. Using the statewide jobs to million board feet-ratios developed by Perez-Garcia et al. (2001), Alternatives 2 and 3 and No Action Alternative 1-Scenario 1 would result in statewide annual reductions of approximately

Table 4.14-2. Estimated Percent of Harvest from State and Private Lands Affected in Each County by Alternative (Compared to No Action Alternative 1-Scenario 2).

State and Private Annual Harvest Reduction (%)	Counties
No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3	
4	Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Jefferson, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Stevens, Spokane, Walla Walla, Whitman, and Yakima
5 to 6	Clallam, Clark, Mason, Skagit, Snohomish, Skamania, Thurston, Wahkiakum, and Whatcom
7	Cowlitz, Grays Harbor, Island, King, Kitsap, Lewis, Pacific, Pierce, and San Juan
Alternative 4	
15 to 21	Jefferson and Skamania
22 to 27	Adams, Asotin, Benton, Chelan, Clallam, Clark, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Skagit, Snohomish, Spokane, Stevens, Thurston, Wahkiakum, Walla Walla, Whatcom, Whitman, and Yakima
28 to 32	Cowlitz, Grays Harbor, Island, King, Kitsap, Lewis, Mason, Pacific, Pierce, and San Juan

3,000 direct jobs and $121 million in foregone income. The five counties with the largest absolute reductions, noted above, would account for just over one-half of this potential loss. This would also be the case under Alternative 4 where statewide annual reductions would be approximately 15,000 direct jobs and $476 million in income.

Effects on Forest Businesses

The Small Business Economic Impact Statement prepared for the current Washington Forest Practices Rules, included in this FEIS as Alternative 2, assessed the effects of proposed rule compliance costs on small and large forest businesses (Perez-Garcia et al. 2001). Forest businesses were defined as businesses that own or control cutting rights on forestlands and included, but were not limited to, landowners, loggers, and mill owners. Small businesses were identified as those with 50 or fewer employees.

Riparian habitat management and lost sales associated with RMZs and road maintenance and stream crossings were the major compliance cost elements assessed in the Small Business Economic Impact Statement. The Small Business Economic Impact Statement found that the cost of implementing the proposed rules fell more heavily on small businesses. In eastern Washington the cost of compliance was 31 percent of total business value for small businesses and 22.1 percent for large businesses.

In western Washington compliance costs comprised 25.6 percent and 18.5 percent of total business value for small and large businesses, respectively. Total business value was defined in terms of timber asset value. Road maintenance and stream crossing requirements accounted for the majority of compliance costs in eastern Washington.

Foregone sales associated with RMZs comprised the major cost in western Washington (Perez-Garcia et al. 2001).

Two subsequent studies attempted to assess the effects that site-specific differences would likely have on potential effects to small, non-industrial private forest landowners (Zobrist 2003; O’~~n~~Neil 2003). These studies were based on 10 case studies in western Washington (six in Lewis County; four in Grays Harbor County) and nine case studies in eastern Washington (three in Pend Oreille County, four in Stevens County, one in Okanogan County, and two in Whitman County).

The results of the westside case studies indicated that some small landowners could potentially incur substantial economic losses under the current Washington Forest Practices Rules, Alternative 2 in this analysis, with the severity of potential impacts varying by landowner (Zobrist 2003). Potential impacts were most severe under a modeling scenario that assumed there would be no harvest in the riparian zone at all, with some of the case studies losing most or all of their land value. These losses were reduced when the modeling scenario was adjusted to assume that landowners would harvest in the outer zone, with only small incremental or no benefits associated with harvesting in the inner zone.

RMZs are divided into three zones under No Action Alternative 1-Scenario 1 and Alternatives 2 and 3. The core zone is nearest to the water and adjacent to the bankfull width. The inner zone is adjacent to the core zone. The outer zone is adjacent to the inner zone and furthest from the water (Figure 2-2). Harvest requirements vary by zone and alternative. Although potential losses were reduced when harvesting occurs in the outer zone, the overall losses were still substantial in some cases. The analysis found that maximizing selective inner zone riparian harvest did not do more to minimize impacts because calculating the allowable riparian harvest would involve additional cruising and layout costs that offset any value recovery (Zobrist 2003).

Under Alternatives 2 and 3 and No Action Alternative 1-Scenario 1, the land value for timber management would be completely lost in no-harvest areas, such as the core zone and parts of the inner zone, as these acres could no longer be used for commercial management (Zobrist 2003). Further, if buffer restrictions result in a large portion of a given property being taken out of timber production, it could make the entire property unprofitable because the production base available to cover fixed production costs would be much smaller. Also, buffer restrictions may fragment properties, separating unrestricted areas from one another and making management unfeasible in these areas, as well as those areas within the RMZ. Substantial decreases in land value imply that it would not be economically viable for some landowners to continue to use their property for forest management beyond the current rotation, which could motivate land use conversion, particularly to residential development (Zobrist 2003). This is discussed further in subsection 4.2 (Land Ownership and Use).

The results of the nine eastern Washington case studies also found that the severity of potential impacts under the current Washington Forest Practices Rules (Alternative 2) varied substantially by landowner (Oneil 2003). The analysis evaluated potential impacts to small businesses in terms of reductions in annual cash flows projected into the future. Impacts to small eastside businesses ranged from a 0 to 49 percent reduction in discounted cash flows when compared to the prior baseline (No Action Alternative 1-Scenario 2). Losses varied with the amount of riparian holdings and the nature of the currently standing inventory (Oneil 2003).

The preceding analyses of potential effects on businesses specifically addressed the potential effects of the current Washington Forest Practices Rules (i.e., No Action Alternative 1-Scenario 1, Alternative 2, and Alternative 3 in this analysis). They did not address the potential effects of Alternative 4. It is, however, reasonable to assume that RMZ restrictions associated with Alternative 4 would have greater impacts on small businesses located on both sides of the State. The restrictions associated with Alternative 4 are more likely to negatively affect the economic viability of timber production for forest landowners, especially small forest landowners and, therefore, increase the potential for forestland conversion. This issue is discussed further in subsection 4.2 (Land Ownership and Use).

4.14.2.2 Recreational and Commercial Fishing

This subsection addresses the potential effects of the alternatives on employment in the recreation and commercial fishing sectors, both of which could be affected positively by the action alternatives in the long-run.

Recreational Fishing

RMZ management actions proposed under the different alternatives could have long-term effects on fish populations that could in turn affect fish-related recreation activities in the future. While it is not possible to quantify the potential effects of the alternatives on salmonid populations and recreation-related employment and income, it is possible to assess the potential direction of the effects and provide a general comparison between alternatives.

In summary, the potential for adverse habitat impacts associated with No Action Alternative 1-Scenario 2 suggests that salmonid populations could decline over the long term under this alternative. Habitat impacts under No Action Alternative 1-Scenario 1 are much less likely to result in reductions in salmonid populations compared to No Action Alternative 1-Scenario 2. Alternative 3 would likely result in improvement over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements. Without land conversion, Alternative 4 would likely result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Effects on existing salmonid populations would likely affect the availability of salmonids for recreational harvest, which would, in turn, affect recreation-related employment and income.

The preceding discussion provides a general indication of the likely impacts of the alternatives on recreational fishing. It should, however, be noted that future changes in fish populations depend on multiple factors and programs, of which the proposed action is only one. The actions proposed under Alternatives 2 and 3, No Action Alternative 1-

Scenario 1, and Alternative 4 may not in and of themselves be sufficient to assure an increase in the fishery resource. Many factors have contributed to the decline of the listed fish species in the Pacific Northwest. As discussed above, habitat is one of the four factors believed to affect these fish. The other three factors are hydropower, harvest, and hatcheries (Federal Caucus 1999) (subsection 4.8.4, Synthesis by Analysis Area). The actions being considered in this document would affect habitat, but the overall future effects on covered species will also depend on the effects of other activities on habitat, as well as the effects of the other Hs. As a result, improvements in fish populations projected under the action alternatives have a substantial degree of uncertainty associated with them. Impacts to fish are discussed in detail in subsection 4.8 (Fish and Fish Habitat).

Other recreation activities could also potentially benefit from the proposed action alternatives, with the maintenance of RMZs improving the overall quality of some recreation experiences, such as hiking and camping, as well as river-based activities, such as kayaking and rafting. The quality of inland recreational fishing may also improve. These potential benefits depend largely on the perceptions of recreationists and an assumed preference for forested landscapes. It is, however, possible that maintaining RMZs may in some cases reduce river access and result in a potential reduction in the quality of the recreation experience or the potential for lost recreation opportunities. These potential effects are discussed further in subsection 4.11 (Recreation). It is reasonable to assume that these types of effects would occur under the action alternatives, with the magnitude of the effects likely to be greatest under Alternative 4. Given the programmatic nature of this assessment and the potential for land conversion, it is not, however, possible to quantify their magnitude or assess these effects in terms of potential employment and income gains or losses.

Commercial Fishing

The commercial fishing industry accounted for 9,418 jobs in Washington in 2000, with the majority of these jobs associated with saltwater harvest, and salmon accounting for about one-third of the catch by value (U.S. Bureau of Economic Analysis 2004a; Washington DNR 2004c). As discussed above with respect to recreation-related employment and income, it is not possible to quantify the potential effects of the alternatives on salmonid populations. It is, however, possible to assess the potential direction of the effects and provide a general comparison between alternatives. In summary, the potential for adverse habitat impacts associated with No Action Alternative 1-Scenario 2 suggests that salmonid populations would likely decline over the long term under this alternative. Habitat impacts under No Action Alternative 1-Scenario 1 are much less likely to result in reductions in salmonid populations compared to No Action Alternative 1-Scenario 2. Alternative 3 would result in a slight improvement over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements. Without land conversion, Alternative 4 would result in the highest likelihood of long-term improvements in habitat and salmonid numbers.

Effects on existing salmonid populations would likely affect the availability of salmonids for commercial harvest, which would, in turn, affect commercial fishing-related employment and income. Again, as noted with respect to recreational fishing, the proposed action is only one of a number of factors that could potentially affect future fish populations. As discussed above, habitat is one of the four factors believed to affect these fish. The other three factors are hydropower, harvest, and hatcheries (Federal Caucus 1999) (subsection 4.8.4, Synthesis by Analysis Area). The actions being considered in this document would affect habitat, but the overall future effects on covered species will also depend on the effects of other activities on habitat, as well as the effects of the other Hs. As a result, improvements in fish populations projected under the action alternatives have a substantial degree of uncertainty associated with them. Impacts to fish are discussed in detail in subsection 4.8 (Fish and Fish Habitat).

4.14.2.3 Natural Amenities and Quality of Life

Natural amenities and local quality of life have increasingly been recognized as important factors determining the economic prospects of many rural communities in the American West and elsewhere (Power 1996; ~~Rasker 1993;~~ Rudzitus and Johnson 2000). While local amenities and quality of life do not directly generate income in the same sense as other factors such as a sawmill or tourist lodge, they do act to attract and keep residents. This, in turn, supports communities and their economies in several ways. Many of these residents may earn a substantial proportion of their income from non-job related sources that are independent of local economic activity. Non-job related sources of income include dividends, interest, and rent, as well as transfer payments from the government, which include retirement and unemployment benefits. Much of this income will then be spent locally, resulting in additional employment and income in the community. Similarly, residents attracted to a region for its local amenities and quality of life may have occupations that are not dependent on local economic activity or constrained to one particular location. These residents may also bring with them important skills and energy that constitute valuable assets for the community. These types of residents may also serve to attract and retain businesses that are dependent on a skilled labor force, but are otherwise relatively footloose from a location standpoint.

Although it is difficult to directly measure the importance of natural amenities in attracting and keeping residents, proximity to natural environments and the recreational activities they support are undeniably a benefit enjoyed by Washington residents. It should be noted, however, that the atmosphere of a community also constitutes an important amenity, and this may often be linked to more traditional forms of economic activity, such as fishing or timber. The size of a community may also significantly affect the local amenities available. If a community is too small, it cannot provide many of the basic social and economic amenities many residents require, local natural amenities notwithstanding.

The alternatives evaluated in this environmental analysis are programmatic, meaning that they establish direction for broad land areas rather than scheduling activities on specific parcels of land. As a result, it is very hard to identify the impact of the different alternatives on local amenities and, further, on the economic activity these amenities generate. While the amount of protected acres would increase under the action alternatives, and under Alternative 4 in particular, relative to the No Action Alternative (Tables 4.11-1 and 4.11-2), it is difficult to predict whether these effects would be significant enough in themselves to result in measurable changes in economic activity. Although it is not possible to measure the incremental benefits associated with the action alternatives, the cumulative impact of the action alternatives combined with other planning initiatives over the coming decades, may have profound effects on local amenities, both natural and social (Chapter 5, Cumulative Effects). Based on the amount of acres that would be protected in RMZs, the relative contribution of the action alternatives considered here is likely to be greatest under Alternative 4 (excluding land conversion), followed by Alternative 2, Alternative 3, and No Action Alternative 1-Scenario 1, with the least relative contribution occurring under No Action Alternative 1-Scenario 2.

4.14.3 Non-Use and Ecosystem Service Values

The preceding subsections address the potential effects of the alternatives on the economy and employment and primarily focus on activities that involve direct consumptive or non-consumptive use of forests or fish. Consumptive uses are activities, such as timber management and fishing that involve resource harvest. Non-consumptive uses are those that do not reduce the available stock of resources and include activities such as river rafting, bird watching, or amenity values. The unique characteristics of some resources have, however, caused some economists to question whether this type of analysis incorporates all of a resource's value. The following subsections address two broad categories of value that are not dependent on direct use by humans: non-use or passive use values and ecosystem services.

4.14.3.1 Non-Use Values

Non-use values represent the value that individuals assign to a resource independent of their use of that resource. These types of values, which include existence, option, and bequest values, are usually measured via surveys that ask people to state how much they would be willing to pay to preserve a particular area (Arrow et al. 1993). These values represent the value that individuals obtain from knowing that a resource exists, knowing that it would be available to use in the future should they choose to do so, and knowing that it would be left for future generations to inherit.

Endangered species preservation is well recognized as a potential source of non-use value. Studies have also identified non-use values associated with the preservation of forested landscapes. While these values are generally believed to exist, they are difficult to accurately measure. One indication of the potential value of the fishery resource is provided by the cost benefit analysis prepared for the current Washington Forest Practices Rules (Perez-Garcia et al. 2001). In this analysis, Perez-Garcia et al. (2001) applied the results of an earlier stated preference survey of Washington residents that was designed to estimate the non-use value of changes in fish populations for a full range of fish under a variety of conditions (Layton et al. 1999).

The Layton et al. (1999) survey was designed to value incremental changes in the various types of fish populations over time relative to baseline conditions. This survey addressed both use and non-use values. Uncertainty over future baseline conditions led the authors to use two different baselines in their survey. The low baseline condition showed populations declining over the next 20 years at the same rate as the previous 20 years. In the stable baseline condition, populations stabilized at current levels over the next 20 years. In the absence of projected fish returns, Perez-Garcia et al. (2001) assumed, in line with the Layton et al. (1999) study, that the forests and fish rule would result in a 5 percent increase of fish populations over a 20-year study period. Using a discount rate of 5.8 percent and data from the Layton et al. (1999) study, Perez-Garcia et al. (2001) estimated that the net present value of this increase to Washington households would range from $7 billion to $10.3 billion. It is reasonable to assume that this estimate would increase under Alternative 4. Layton et al. (1999) estimated that a further 5 percent increase in fish populations (i.e., from 6 to 10 percent above the baseline) would be valued at $3 billion, with the value of each successive 5 percent increment decreasing.

Forested landscapes have also been the subject of numerous non-use studies usually conducted for specific natural areas. Often viewed in a wilderness context, willingness-to-pay estimates for forest protection have identified a wide range of values (See Krieger 2001 for a summary of studies). At a general level, for example, Loomis and Richardson (2000) estimated annual willingness-to-pay values of $6.72 per acre for roadless area protection in the western United States based on two earlier studies of wilderness preservation. In Washington State, a study measuring willingness-to-pay for different types of forest management found that urban residents were willing to pay $450 per household per year to restore biodiversity to a specified level. Rural residents were willing to pay $225 to achieve the same level of biodiversity (Center for International Trade in Forest Products 1999).

Examining the results of two case studies that addressed wilderness designation, Loomis (2000) noted two important trends. First, willingness-to-pay per household increases with an increase in the number of acres proposed for wilderness protection, but at a decreasing rate. Second, existence, option, and bequest values in both cases represented about half the total value of wilderness. It seems likely that willingness-to-pay would be higher for forested wilderness areas than it would be for riparian buffers. Areas are designated wilderness based on rigorous evaluation criteria and tend to be areas that represent unique and valuable resource areas. Nevertheless, the values from other studies do provide some indication of the potential non-use value of forested landscapes. These values would likely increase with the number of acres, but at a decreasing rate. In terms of the proposed alternatives, and without land conversion, the value per household is likely to be highest for Alternative 4 followed by Alternative 2, Alternative 3, and No Action Alternative 1-Scenario 1, with the least value per household occurring under No Action Alternative 1-Scenario 2.

4.14.3.2 Ecosystem Services

Ecosystem services are those services and benefits provided by healthy ecosystems. Definitions of ecosystem services can be broad, including both use and non-use values

(Costanza et al. 1997; Krieger 2001; Morton 1999). Some definitions include consumptive uses, such as logging, fishing, and hunting that can be considered market goods. Other types of ecosystem services provide what might be considered long-term life support benefits to society as a whole. Examples of so-called "life-support benefits" that pertain to forests include water quantity and quality, soil stabilization and erosion control, improved air quality, climate regulation and carbon sequestration, and biological diversity (Krieger 2001).

Economists have expressed concerns that ecosystem service values are not adequately considered in decision-making processes because they are not valued on a par with goods and services that are traded in commercial markets. A number of methods have been used to assign monetary values to these types of services and include travel cost, hedonic pricing, and defensive expenditure approaches that use observed behavior to estimate values, as well as contingent valuation approaches that ask people what they would be willing to pay for an ecosystem service.

Costanza et al. (1997) estimated that the total value of the services currently provided by the world's ecosystems ranges from $16 trillion to $54 trillion per year, with an average value of $33 trillion. Costanza et al.'s (1997) estimate involved the review and synthesis of a wide variety of existing studies and included estimates of recreation and cultural values, as well as more life-support-related services. Many of the studies used in their synthesis were based directly or indirectly on estimates of willingness-to-pay.

While the ecosystem service values associated with the proposed protection measures exist, they are very difficult to accurately quantify in monetary terms. The values identified by Costanza et al. (1997), for example, which are based on a wide variety of data sources and aggregated on a global scale, allow useful rough estimates of magnitude at large scales, but they are not suitable for a detailed comparison of alternatives. It is also difficult to quantify the effects of the alternatives on physical and biological resources in terms of unit values. The fact that no monetary value is assigned to ecosystem services in this FEIS does not lessen their importance in the decision making process. In terms of the proposed alternatives, and without land conversion, the value per household is likely to be highest for Alternative 4 followed by Alternative 2, Alternative 3, and No Action Alternative 1-Scenario 1, with the least value per household likely occurring under No Action Alternative 1-Scenario 2.

4.14.4 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that Federal agencies identify and address disproportionately high and adverse environmental effects of its programs, policies, and activities on minority and low income populations. The Order further stipulates that the agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination because of their race, color, or national origin.

Assessing these potential issues initially involves identifying those minority and low income populations that have the potential to be disproportionately affected by the proposed action and alternatives. This typically involves identifying low income and minority populations in the vicinity of the proposed action based on the percentage of the population below the poverty level or the percentage of the total population made up of minority groups.

The alternatives evaluated in this environmental analysis are programmatic meaning that they establish direction for broad land areas rather than scheduling activities on specific parcels of land. As a result, this assessment focuses on those groups that could be disproportionately affected at a programmatic level, primarily groups that would be affected by potential changes in salmonid populations, as well as loggers, mill workers, and others involved in timber harvest.

4.14.4.1 Salmon

Information compiled as part of the Puget Sound Chinook Harvest Resource Management Plan indicated that the majority of resident sport anglers in Washington State are White (NMFS 2004) Data collected for 2001 found that 94 percent of Washington resident sport anglers were White (U.S. Fish and Wildlife and Census Bureau 2003). NMFS (2004) also found, based on contacts with Federal and State agencies responsible for non-tribal commercial fisheries management, that there are no substantial aggregations of minority commercial fishermen in Washington, with the exception of American Indians. Data from the 2000 census suggests that American Indians in Washington State are twice as likely to be employed in the agriculture, forestry, fishing, and hunting sector than the State population as a whole, with 4.8 percent of employed American Indians working in this sector compared to 2.4 percent of the statewide population (U.S. Census Bureau 2004). This percentage varies by reservation with employment in the agriculture, forestry, fishing, and hunting sector accounting for more than 10 percent of employment on the Makah, Kalispel, Quileute, Quinault, and Skokomish Reservations, as well as the Squaxin Island, Yakama, and Nooksack Reservations and off-reservation trust lands (Table 4.14-3).

In addition to being important for commercial harvest, salmon are also important traditional resources to all Washington Tribes. Bull trout are also important, particularly in watersheds outside the salmon's historic range. Salmon and bull trout are also important tribal subsistence resources (subsection 3.13, ~~Archeological~~Archaeological, Historical, Cultural and Indian Trust Resources). The Tribes that entered into treaties with the United States during the nineteenth century, which includes 27 of the 31 federally-recognized Tribes with cultural interests in Washington forests (Table 3-27), all retained the right to certain resources on ceded territories. All treaties include the right to fish in usual and accustomed grounds and places in common with other citizens and to hunt and gather roots and berries on open and unclaimed land.

The alternatives have the potential to affect Washington's Tribes by affecting the availability of salmonid species. While there are no provisions in Washington Forest Practices Rules and the proposed alternatives that affect future tribal harvest any

Table 4.14-3. Tribal Employment by Industry, 2000.[1/]

State/Reservation	Total Employment	Agriculture, Forestry, Fishing, and Hunting: Number of Jobs	Agriculture, Forestry, Fishing, and Hunting: Percent of Total (%)	Wood Products: Number of Jobs	Wood Products: Percent of Total (%)
Washington	2,793,722	66,471	2.4	21,760	0.8
	Tribal Employment				
Tribal Total	**26,800**	**1,273**	**4.8**	**472**	**1.8**
Chehalis Reservation	116	2	1.7	0	0.0
Colville Reservation and O-R TL	1,297	110	8.5	67	5.2
Kalispel Reservation	43	7	16.3	0	0.0
Lower Elwha Reservation and O-R TL	63	6	9.5	1	1.6
Lummi Reservation	553	34	6.1	3	0.5
Makah Reservation	323	74	22.9	0	0.0
Muckleshoot Reservation and O-R TL	287	10	3.5	0	0.0
Nisqually Reservation	125	7	5.6	0	0.0
Nooksack Reservation and O-R TL	119	12	10.1	8	6.7
Port Gamble Reservation	166	12	7.2	0	0.0
Port Madison Reservation	174	11	6.3	3	1.7
Puyallup Reservation and O-R TL	397	11	2.8	0	0.0
Quileute Reservation	93	13	14.0	2	2.2
Quinault Reservation	326	37	11.3	3	0.9
Skokomish Reservation	123	15	12.2	2	1.6
Spokane Reservation	413	33	8.0	2	0.5
Squaxin Island Reservation and O-R TL	80	9	11.3	0	0.0
Swinomish Reservation	159	6	3.8	2	1.3
Tulalip Reservation	553	45	8.1	2	0.4
Upper Skagit Reservation	37	5	13.5	4	10.8
Yakama Reservation and O-R TL	1,735	195	11.2	81	4.7

O-R TL = Off-Reservation Trust Land

[1/] These data were compiled from the Census 2000 American Indian and Alaska Native Summary File (AIANSF) - Sample Data. They were collected as part of the 2000 census and are not directly comparable with the other types of employment data summarized in Chapter 3 (Affected Environment).

Source: U.S. Census Bureau 2000.

differently than they affect other types of harvest, the potential exists for American Indians to be disproportionately impacted. This potential is due to the relatively important role that commercial fishing plays in tribal economies, as well as the significance of salmon and bull trout for ceremonial and subsistence purposes.

In summary, without land conversion, habitat impacts under No Action Alternative 1-Scenario 1 are much less likely to result in reductions in salmonid populations compared to No Action Alternative 1-Scenario 2. Alternative 3 would result in a slight improvement over No Action Alternative 1-Scenario 1, and Alternative 2 would likely result in long-term improvements. Without land conversion, Alternative 4 would result in the highest likelihood of long-term improvements in habitat and salmonid numbers. Impacts to fish are discussed in detail in subsection 4.8 (Fish and Fish Habitat).

Effects on existing salmonid populations would likely affect the availability of salmonids for tribal harvest, including traditional, subsistence, and commercial uses. The proposed action is only one of a number of factors that could potentially affect future fish populations. Habitat is one of the four factors believed to affect fish and especially salmonid populations. The other three factors are hydropower, harvest, and hatcheries (Federal Caucus 1999). The actions being considered in this document would affect habitat, but the overall future effects on covered species will also depend on the effects of other activities on habitat, as well as the effects of the other three factors. As a result, improvements in fish populations projected under the action alternatives have a substantial degree of uncertainty associated with them. Access to traditional places and usual and accustomed use areas would be similarly affected by the alternatives with No Action Alternative 1-Scenario 2 having the largest potential impact and Alternative 4 the least.

4.14.4.2 Wood Products

Logging employment data are included in the agriculture, forestry, fishing, and hunting sector discussed above. These data suggest, as noted above, that American Indians are twice as likely to be employed in this sector as the State population as a whole. Data from the 2000 census also indicate that American Indians are slightly more than twice as likely to be employed in the wood products sector than the State population as a whole (1.8 percent versus 0.8 percent) (U.S. Census Bureau 2000). This percentage also varied by reservation, ranging from 0 percent of total employment on eight American Indian Reservations in Washington to around 5 percent and above on the Yakama (4.7 percent), Nooksack (6.7 percent), and Colville (5.2 percent) Reservations and off-reservation trust lands, and 10.8 percent on the Upper Skagit Reservation (Table 4.14-3).

While these data suggest that American Indians could be disproportionately affected by reductions in State and private timber harvest, it should be noted that much of this employment is likely related to tribal timber harvest activities that would not be affected by the proposed alternatives. Harvest on tribal lands comprised approximately 9 percent of total harvest in Washington State in 2002 (Table 3-3).

The potential effects of the proposed action on economic and social structures in rural areas were identified as a potential environmental justice issue during public scoping for this project. The rationale expressed for this concern was that many low income and minority populations reside in and around forested lands and depend on these lands for their livelihood. As noted above, the proposed action is programmatic in nature and it is not possible to quantify the potential impacts of the alternatives on specific geographic locations or communities.

Viewed in terms of economic impacts, potential reductions in harvest associated with increased buffers or, alternatively, a failure to obtain take authorization would tend to disproportionately affect those individuals directly employed in the wood products industry. Potential reductions would also have indirect and induced employment and income impacts. Indirect impacts would occur in industries that support the wood products sector. Induced impacts would occur in those industries that benefit from local expenditures of wood products-related income. Direct and indirect impacts would tend to affect workers who are relatively well paid, but the overall effect of reduced employment and income could have negative effects on communities that are considered timber-dependent and may already have relatively high unemployment and poverty rates. Subsection 4.14.2.1 (Lumber and Wood Products) provides a general overview of potential employment effects by county.

4.14.4.3 Participation

The Services published a Notice of Intent to prepare a Draft EIS in the Federal Register on March 17, 2003 (U.S. Federal Register, Vol. 68, No. 51, March 17, 2003, pages 12676-12678). Public scoping meetings were held in Tacoma, Port Angeles, Spokane, and Ellensburg. The scoping meetings were intended to gain input from the affected public and to identify local concerns with the proposed action, as well as to provide members of the public with information about the project. In accordance with the requirements of Executive Order 12898 and the required operating practices of the Services, the scoping process was open to all public members who wished to participate regardless of their race, color, and national origin.