Fish

This analysis examines how the alternatives would affect fish habitat by the delivery of large wood, nutrients, and fine sediments to streams and by alterations to peak stream flows and stream temperature.

A variety of anadromous and resident fish species occur throughout the planning area (see the *Fish* section of *Chapter 3*). The habitat requirements and the responses to habitat changes vary by species and among age groups within species. However, the fish species that would be affected by BLM management are similar enough in their habitat requirements to permit an analysis of how any changes to large wood, nutrient input, sediment, flow, or temperature would affect fish habitat in general.

Key Points

- The potential large wood contribution to streams would increase over time under all alternatives. The greatest increase would occur under the PRMP and the No Action Alternative, and the smallest increase would occur under Alternative 2.
- Fine sediment delivery to stream channels would not increase more than 1% above existing rates under any alternative and would not decrease fish survival.
- The PRMP would have the highest number of susceptible subwatersheds, but Alternative 2 would have the greatest acreage of susceptible BLM-administered lands. The susceptibility to peak flows under all alternatives would be more similar to the effects of the No Harvest reference analysis than to the effects of the Intensive Management on Most Commercial Timber Lands reference analysis.
- The risk of adverse effects to fish from an increase in peak flow would be very low under all alternatives, because of the small proportion of the planning area identified as susceptible to peak flow increases, the small proportion of the stream types in which streambed scour would occur, and the low likelihood that all factors required for adverse effects on fish would occur simultaneously.
- None of the alternatives would contribute to an increase in stream temperature that would affect fish.

Large Wood

This analysis uses a spatially explicit, GIS-based, wood recruitment model to estimate potential wood recruitment to stream channels in all fifth-field watersheds within the planning area from BLM and non-BLM-administered lands. See *Chapter 3* (*Fish* section) and *Appendix J – Fish* for details on the wood recruitment model. The potential wood contribution is not a prediction of actual instream conditions at a specific point in time, but represents a potential contribution to instream wood based on forest conditions over time. The analysis describes:

- large wood contribution to fish-bearing streams from BLM-administered[15] lands for the entire planning area, by physiographic province[16]
- large wood to non-fish-bearing streams from BLM-administered lands for the entire planning area, by physiographic province
- small functional wood contribution to fish-bearing and non-fish-bearing streams for the entire planning area, by physiographic province
- large wood contribution to fish-bearing stream channels across all ownerships for the entire planning area, by physiographic province

[15]For this analysis, the wood contribution from BLM-administered lands is the contribution from BLM-administered lands to streams on both BLM-administered lands and non-BLM-administered lands.
[16]See Appendix I - Water for a description of physiographic provinces.

For this analysis, trees greater than 20 inches diameter (i.e., dbh - diameter at breast height) are considered large wood. The analysis uses this size threshold to maintain consistency with the structural stage classification of forests, which uses the density of trees greater than 20 inches in diameter as a threshold for the definition of mature & structurally complex forests (see *Forest Structure and Spatial Pattern* in *Chapter 3*). Depending on stream size, trees less than 20 inches diameter can also function in smaller streams if they are "pool-forming" and are hereafter referred to as small functional wood (see the *Fish* section of *Chapter 3*). Because larger pieces have a greater influence on fish habitat and physical processes in stream channels than smaller pieces (Dolloff and Warren 2003), large wood and small functional wood are analyzed separately.

The results in this analysis describe potential wood recruitment in pieces/mile/year. Depending on the lifespan of the wood recruited and the rate of depletion, the differences in annual potential wood recruitment among alternatives could accumulate over time, so that relatively small differences in annual potential wood recruitment among alternatives would result in larger differences in in-stream accumulations over longer time periods.

This analysis makes frequent comparisons of the potential wood recruitment under the alternatives to potential wood contribution under the No Harvest reference analysis. As explained in the *Introduction* of *Chapter 4*, the reference analysis is not a reasonable alternative, because it would not meet the purpose and need for the action. There are no standards or thresholds for potential wood recruitment, but the No Harvest reference analysis provides a point of comparison for the effects of the alternatives. Specifically in this analysis, the No Harvest reference analysis helps provide context for evaluating the magnitude of differences among the alternatives in potential wood recruitment over time.

As explained in *Chapter 3,* in *Forest Structure and Spatial Pattern*, the classification of structural stage conditions for 2006 differ slightly among the alternatives because of differences in how the inventory information is assembled for modeling under each alternative. The differences in the assembly of inventory information have a lesser effect on 2016 modeling results, and a negligible effect on modeling results for later years. Consistent with the descriptions of current conditions in *the Forest Structure and Spatial Pattern* section of *Chapter 3*, this analysis uses the 2006 data from Alternative 3 for all alternatives. Therefore, the potential wood recruitment in 2016 cannot be precisely compared to the 2006 data for some alternatives, for the sake of providing a consistent description of current conditions. This does not prevent a reasonable comparison of the alternatives, because effects on potential wood recruitment are inherently long term, and effects in 10 years do not provide a reasonable basis for comparing the effects of the alternatives.

On BLM-administered lands:

- The large wood contribution to fish-bearing and non-fish-bearing streams would increase from current conditions under all alternatives. In 2106, the large wood contribution would be similar under the No Action Alternative and the PRMP, and under these two alternatives would be greater than under the other alternatives. See *Figure 4-155 (Potential large wood contribution from all sources to all streams for the entire planning area).* The differences in potential large wood recruitment among the alternatives in 2106 would be less than the difference between all of the alternatives and the current condition.
- The small functional wood contribution to fish-bearing and non-fish-bearing streams would very slightly increase from current conditions under the No Action Alternative and very slightly decrease under the PRMP and Alternatives 1, 2 and 3. In 2106, the small functional wood contribution would be greatest under the No Action Alternative, followed by the PRMP, Alternative 1, Alternative 2, and Alternative 3. See *Figure 4-156 (Potential small wood contribution from all sources to all streams for the entire planning area*).

The wood recruited from different source areas (riparian, debris flow, and channel migration) varies both temporally and spatially. Therefore, this analysis also determines the potential wood contribution from each source separately, rather than a combined annual average, in order to evaluate the effects of the alternatives on these processes separately. The analysis compares the wood contribution under each alternative over time to the current condition and to the wood contribution under the No Harvest reference analysis.

Figure 4-155. Potential Large Wood Contribution From All Sources For The Planning Area In 2106 By Alternative And The No Harvest Reference Analysis

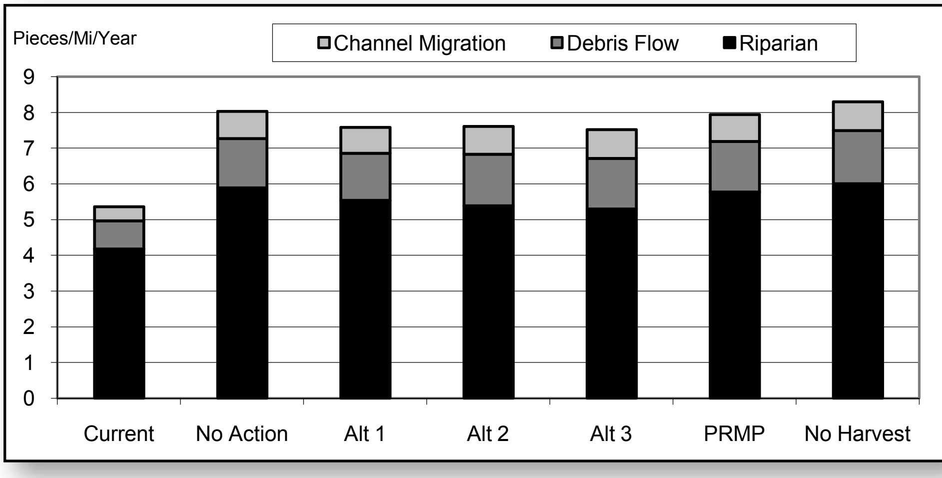
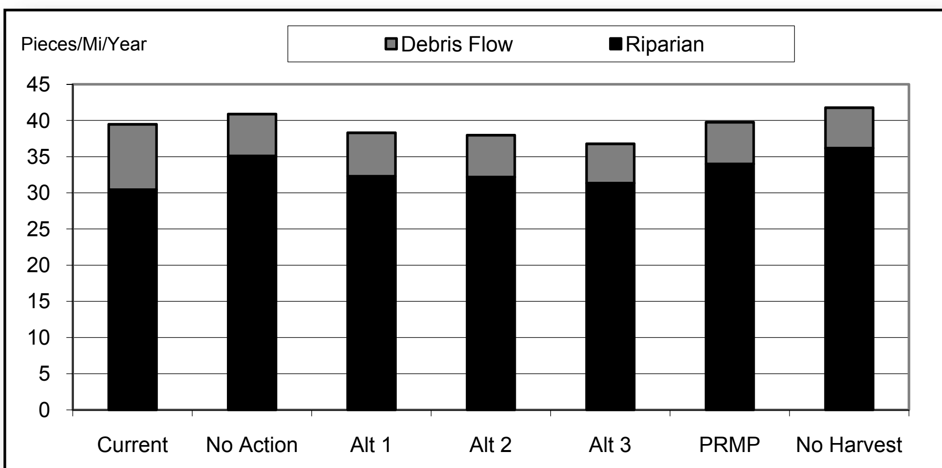


Figure 4-156. Potential Small Functional Wood Contribution From All Sources For The Planning Area In 2106 By Alternative And The No Harvest Reference Analysis



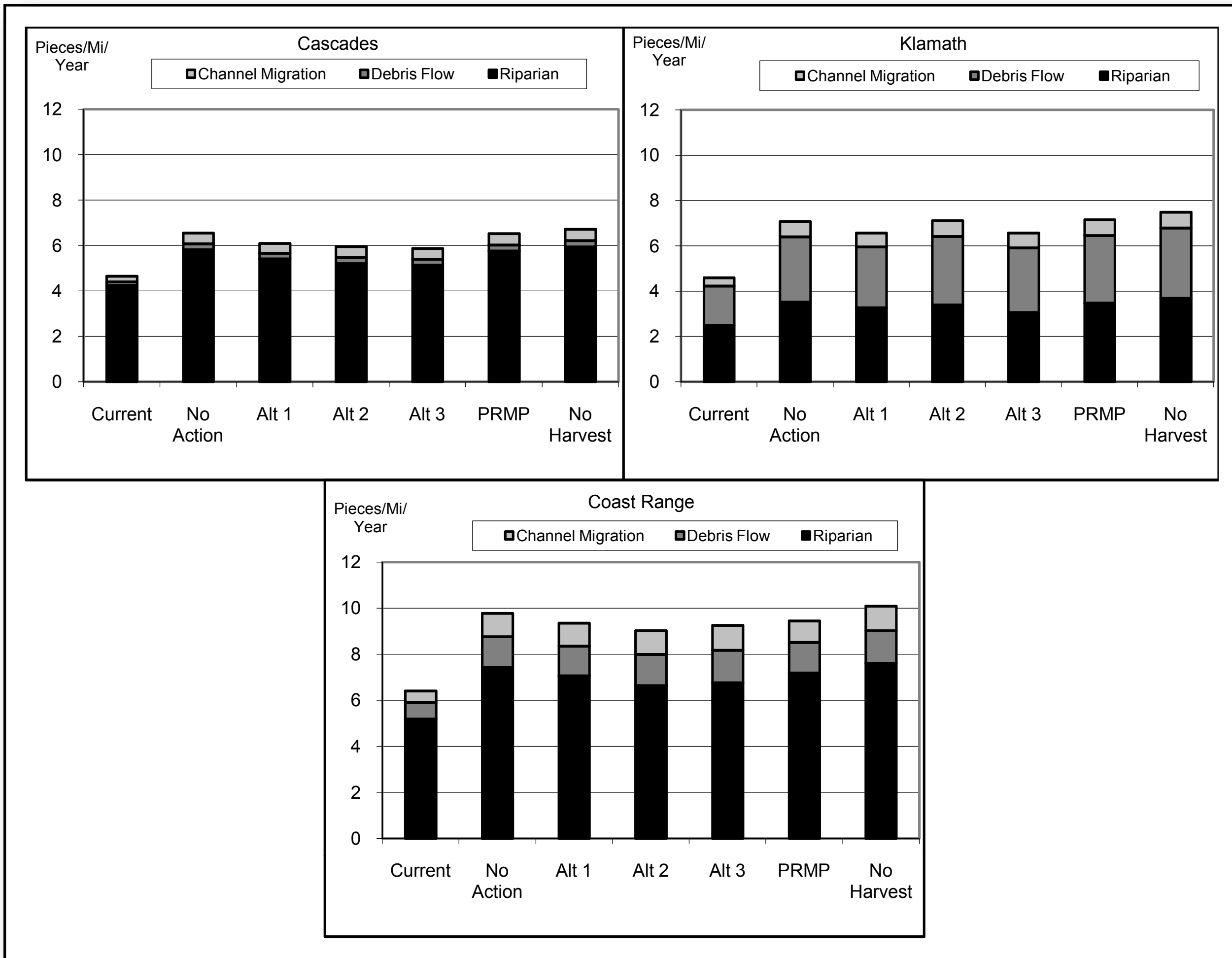
Large Wood Contribution to Fish-bearing and Non-Fish-bearing Streams

In all provinces, the potential large wood contribution to fish-bearing and non-fish-bearing stream channels would increase over time from BLM-administered lands under all alternatives, although the rate of increase would vary by alternative. See *Figure 4-157 (Potential large wood contribution from all sources for the planning area in 2106 by alternative and the No Harvest reference analysis for each province*).

Riparian Sources

Over long time periods, riparian sources would be the largest source of potential large wood contribution in all provinces under all alternatives. The potential large wood contribution to fish-bearing and non fish-bearing stream channels from riparian sources would increase over time from BLM-administered lands in all provinces under all alternatives, although the rate of increase would vary by alternative. The potential

Figure 4-157. Potential Large Wood Contribution From All Sources For The Planning Area In 2106 By Alternative And The No Harvest Reference Analysis For Each Province



NOTE: The "Cascades Province" in this analysis includes the West Cascades, Eastern Cascades, and Willamette Valley Provinces.

large wood contribution to fish-bearing streams would increase to a greater degree under the PRMP, No Action Alternative, and Alternative 1, than under Alternatives 2 and 3.

The potential large wood contribution from riparian sources would increase under all alternatives, because the riparian management areas (or riparian reserves) under every alternative would include all or most of the riparian wood source areas, particularly along fish-bearing and perennial stream channels (see the *Fish* section of *Chapter 3*). See *Figure 4-158 (Perennial and fish-bearing stream riparian management areas).*

Under all alternatives, the Riparian Management Areas (or Riparian Reserves) would become dominated by mature & structurally complex forest over time. See *Figure 4-159* (*Forest structural stage in the riparian management areas by alternative*). As the amount of mature & structurally complex forests increases within these source areas, the availability of trees that could potentially be delivered to stream channels would also increase.

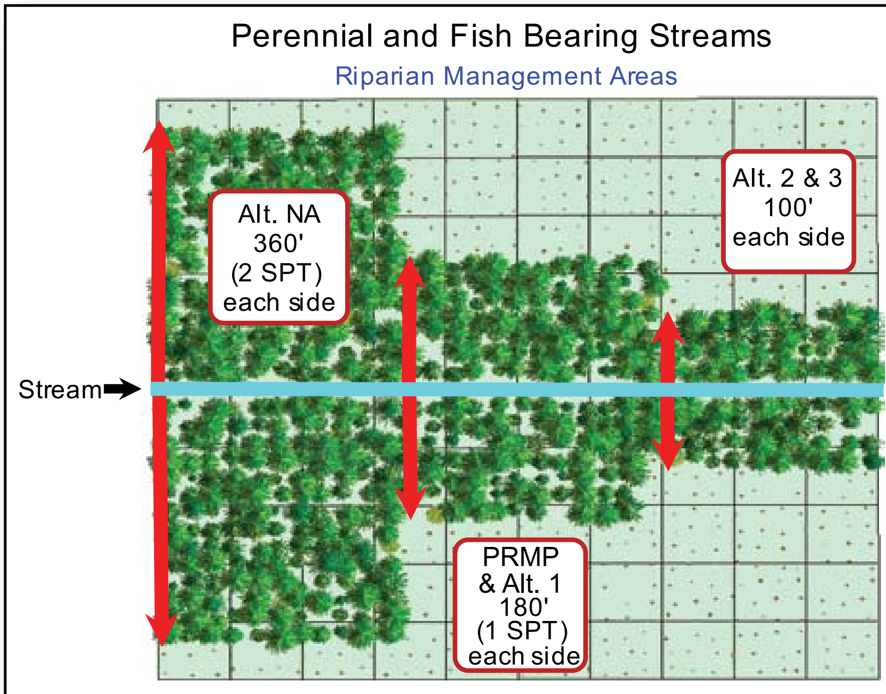
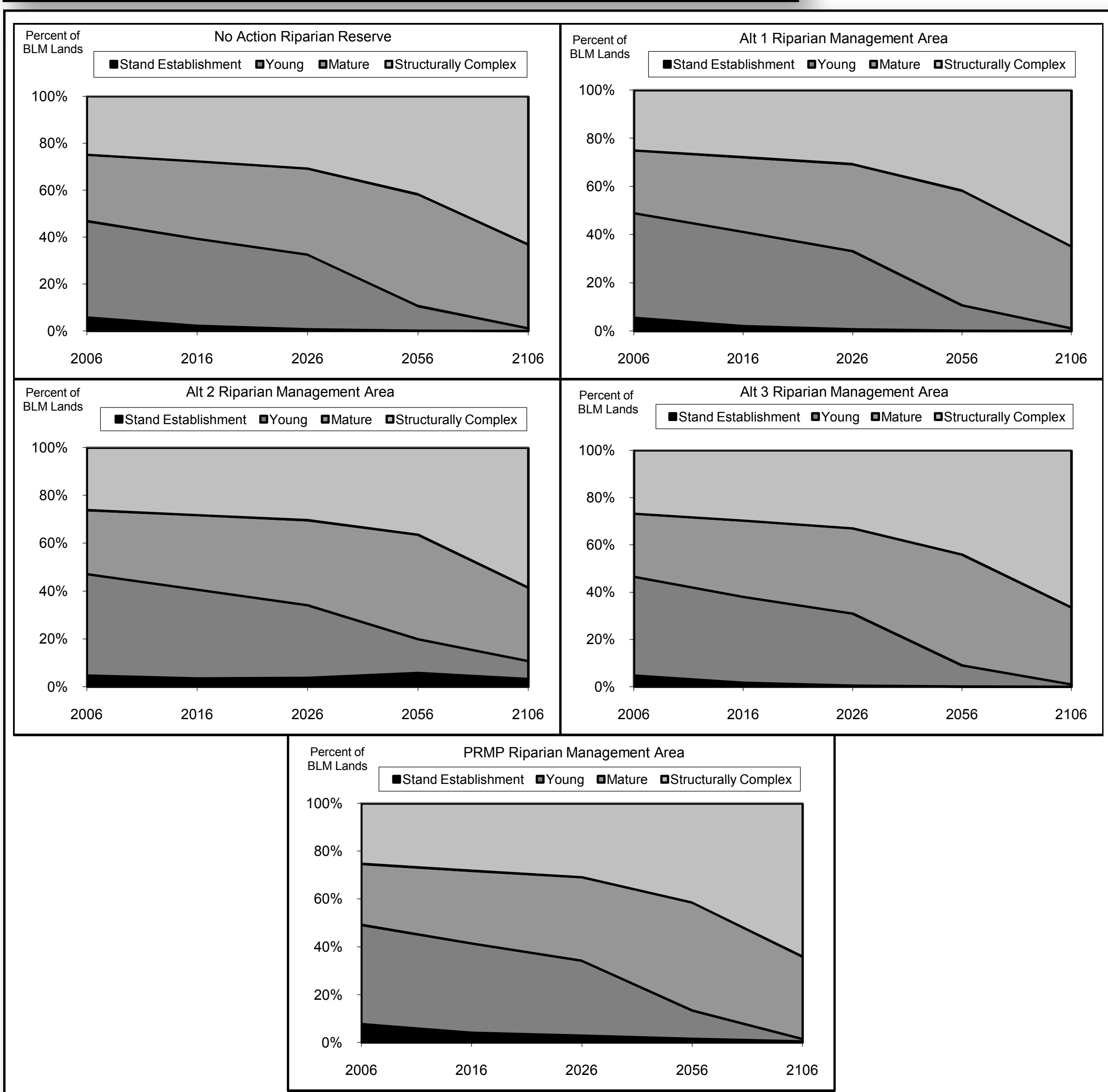


Figure 4-158. Perennial And Fish-Bearing Stream Riparian Management Areas

Figure 4-159. Forest Structural Stage In The Riparian Management Areas By Alternative



Although the large wood contribution would increase under all alternatives, it would increase the most under the No Action Alternative, Alternative 1, and the PRMP, because the riparian management areas (or riparian reserves) under these alternatives would include more of the riparian wood source area than under Alternatives 2 and 3. The majority of wood delivered to stream channels from riparian wood source areas is recruited from within a slope distance equal to one tree height from the stream (FEMAT 1993, Everest and Reeves 2007). The Riparian Management Areas (or riparian reserves) under the No Action Alternative, Alternative 1, and the PRMP would be at least one site-potential tree height in width along perennial and fish-bearing streams. For example, in the Coast Range Province, nearly all the potential large wood contribution to fish-bearing streams under the PRMP, No Action Alternative, and Alternative 1 would come from within the riparian management area (or riparian reserve) land use allocation. See *Figure 4-160* (*Percent of riparian large wood contribution to fish-bearing streams by Land Use Allocation at 2106 in the Coast Range*).

On intermittent, non-fish-bearing streams, the Riparian Management Areas under all action alternatives would be less than one site-potential tree height. See *Figure 4-161 (Boundaries of riparian management areas for each alternative on non-fish-bearing intermittent channels*).

Under Alternatives 2 and 3, a greater portion of the potential wood contribution to streams from riparian wood source areas would be recruited from within the harvest land base than under the No Action Alternative, Alternative 1, or the PRMP. For example, in the Coast Range Province in 2106, the percentage of the potential large wood contribution to non-fish-bearing streams from riparian sources to all streams that would come from the harvest land base would be 3%, 5%, 19%, 20%, and 5%, under the No Action Alternative, Alternatives 1, 2, and 3, and the PRMP, respectively. See *Figure 4-162* (*Percent of riparian large wood contribution to non-fish-bearing streams by Land Use Allocation at 2106 in the Coast Range Province).*

Timber harvest would reduce the number of trees available for potential delivery as large wood from riparian wood source areas within the harvest land base. The portions of the riparian wood source areas within the harvest land base under Alternatives 2 and 3 would still be capable of delivering large wood to the extent they would be in mature & structurally complex forest. Under Alternative 2, there would be 37% of the harvest land base in mature & structurally complex forest in 2106. Alternative 3 would have 59% of the harvest land base in mature & structurally complex forest in 2106. See *Figure 4-163 (Structural stage abundances in the harvest land base, by alternative).*

Figure 4-160. Percent Of Riparian Large Wood Contribution To Fish-Bearing Streams By Land Use Allocation At 2106 In The Coast Range

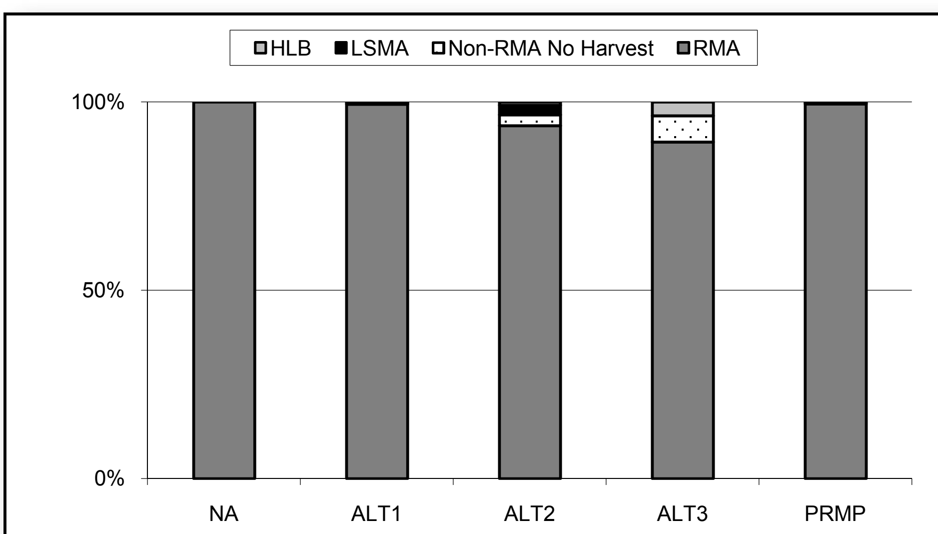


Figure 4-161. Boundaries Of Riparian Management Areas For Each Alternative On Non-Fish-Bearing Intermittent Channels

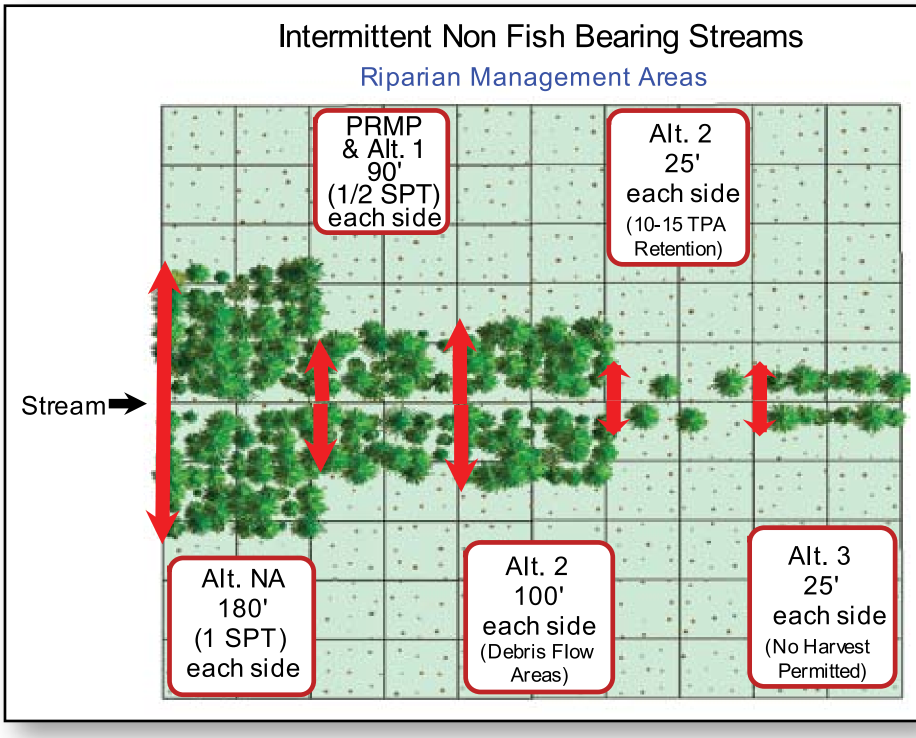


Figure 4-162. Percent Of Riparian Large Wood Contribution To Non-Fish-Bearing Streams By Land Use Allocation At 2106 In The Coast Range Province

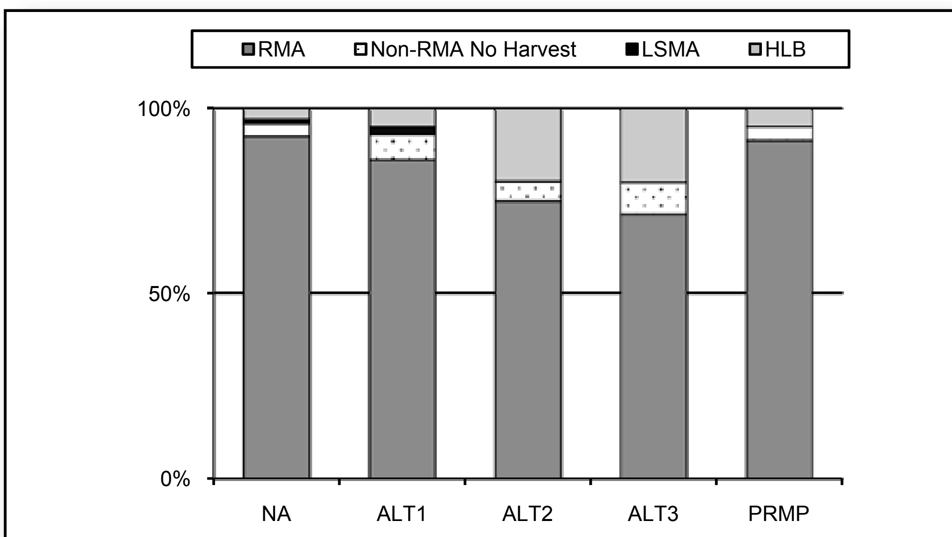
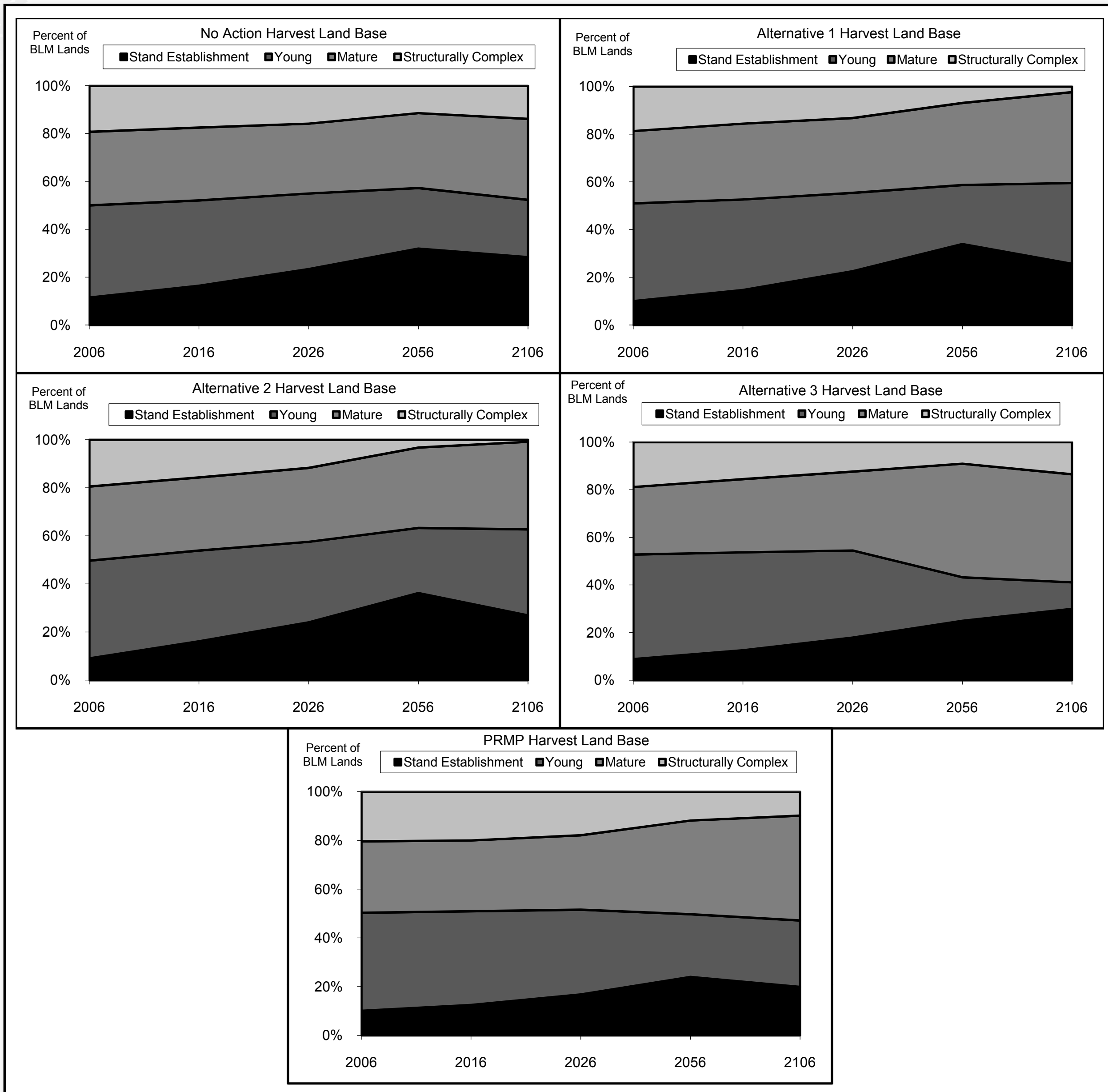


Figure 4-163. Structural Stage Abundances In The Harvest Land Base By Alternative



The No Action Alternative, Alternative 1, and the PRMP would differ slightly in the potential large wood contribution from riparian sources even though riparian sources areas are entirely within Riparian Management Areas (or Riparian Reserves) under each alternative because of the effects of thinning within those areas. The PRMP would preclude thinning within 60 feet of fish-bearing and perennial stream channels, and 35 feet of intermittent channels. These areas closest to streams have a larger effect on riparian recruitment rates than areas further from the streams. See *Appendix J-Fish, Figure J-29 (Riparian wood recruitment at year 2106 under the PRMP with and without No Harvest buffers in the Cascades Province)*. The exclusion of thinning near streams under the PRMP would result in higher potential wood contribution from riparian sources than Alternative 1 in some provinces, even though the riparian management areas are the same width.

Debris Flow Sources

Debris flow sources would be a smaller source of potential large wood contribution than riparian sources over long time periods (e.g., 100 years),[17] but larger than channel migration sources under all alternatives. Refer to *Figure 4-155 (Potential large wood contribution from all sources for the planning area in 2106 by alternative and the No Harvest reference analysis)*. The potential large wood contribution to stream channels from debris flow sources would increase in all provinces under every alternative, although the rate of increase would vary by alternative and province.

Similar to riparian sources, the potential large wood contribution stream channels from debris flow sources would increase under every alternative, because the abundance of mature & structurally complex forests would increase in large wood source areas under every alternative over time, and because the areas outside the riparian management area would contribute large wood to the extent they would be in mature & structurally complex forest. The amount of mature & structurally complex forests would increase similarly within Riparian Management Areas (or Riparian Reserves) under all alternatives. Refer to *Figure 4-159 (Forest structural stage in the riparian management areas by alternative).*

The rate of increase in potential large wood contribution to fish-bearing stream channels from debris flow sources would vary among alternatives, because the amount of debris-flow prone headwater stream channels allocated to riparian management areas (or riparian reserves) would vary among alternatives. Headwater stream channels also differ in their susceptibility to debris flows. Research from the Coastal Landscape Analysis and Modeling Study (CLAMS) indicates that a relatively small portion of headwater streams in a watershed deliver the majority of large wood to stream channels (Miller and Burnett 2007b). These steep, low-order streams have a higher probability of providing wood to debris flows than other parts of the landscape. Management actions along these streams would have a disproportionately greater influence on the potential delivery of wood from debris flows than management actions elsewhere in debris-flow source areas. The amount of thinning near these steep, low-order streams would vary among the alternatives, causing some variation in the potential large wood contribution among alternatives. Because the PRMP would exclude thinning adjacent to streams to a greater degree than other alternatives, there would therefore be less thinning near steep, low-order streams than other alternatives, which would contribute to greater potential large wood contribution from debris flow sources under the PRMP than the other alternatives.

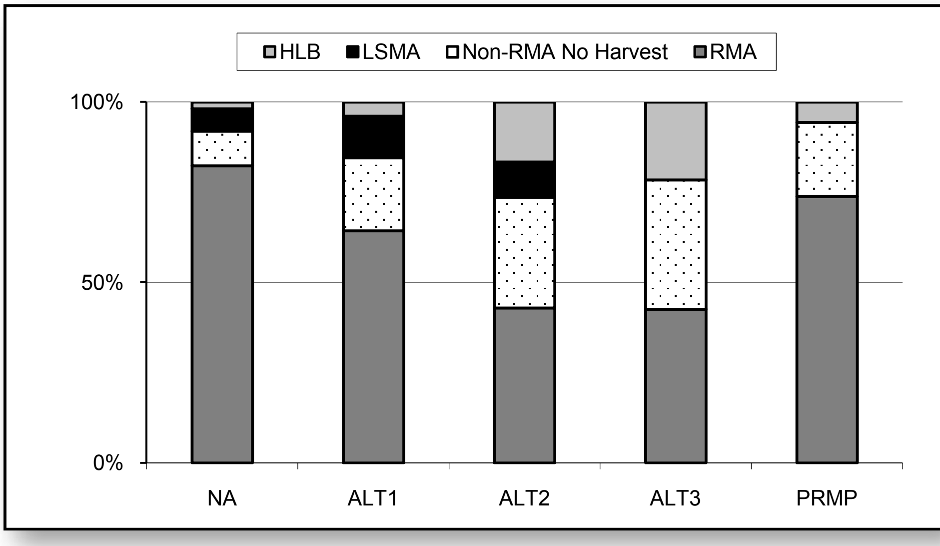
Although the PRMP and all other alternatives would incorporate some portion of debris-flow prone headwater stream channels into riparian management areas, a substantial portion of the large wood contribution from debris flow sources to fish-bearing and non-fish-bearing streams would come from outside the riparian management area, particularly under Alternatives 2 and 3. Under Alternatives 2 and 3, 17% and 22%, respectively, of the large wood contribution from debris flow sources would be delivered from the harvest land base. See *Figure 4-164* (*Percent of debris flow large wood contribution to streams by land use allocation at 2106 in the Cascades Province).*

Timber harvest would reduce the number of trees available for potential delivery as large wood in the portion of the debris flow wood source areas within the harvest land base, but these areas would still be capable of delivering large wood to the extent they would be in mature & structurally complex forest. As noted above, Alternative 2 would have 37% of the harvest land base would be in mature & structurally complex forest in 2106, and Alternative 3 would have 59%. Refer to *Figure 4-163 (Structural stage abundances in the harvest land base, by alternative).*

The analysis segregates the potential large wood contribution from debris flow sources by the diameter of the large wood and the size of the channel to which the wood would be potentially delivered. The amount of larger diameter trees (>30 inches) is important in debris flow source areas where larger trees can be

[17]Debris flows vary spatially and temporally. At the watershed or reach scale, some years may have no debris flow wood contribution because recurrence intervals span centuries. When averaged out to an annual rate, the contribution would be smaller than riparian inputs, but the volume of wood delivered in any debris flow may be greater than the riparian input for many years following the debris flow.

Figure 4-164. Percent Of Debris Flow Large Wood Contribution By Land Use Allocation At 2106 In The Cascades Province

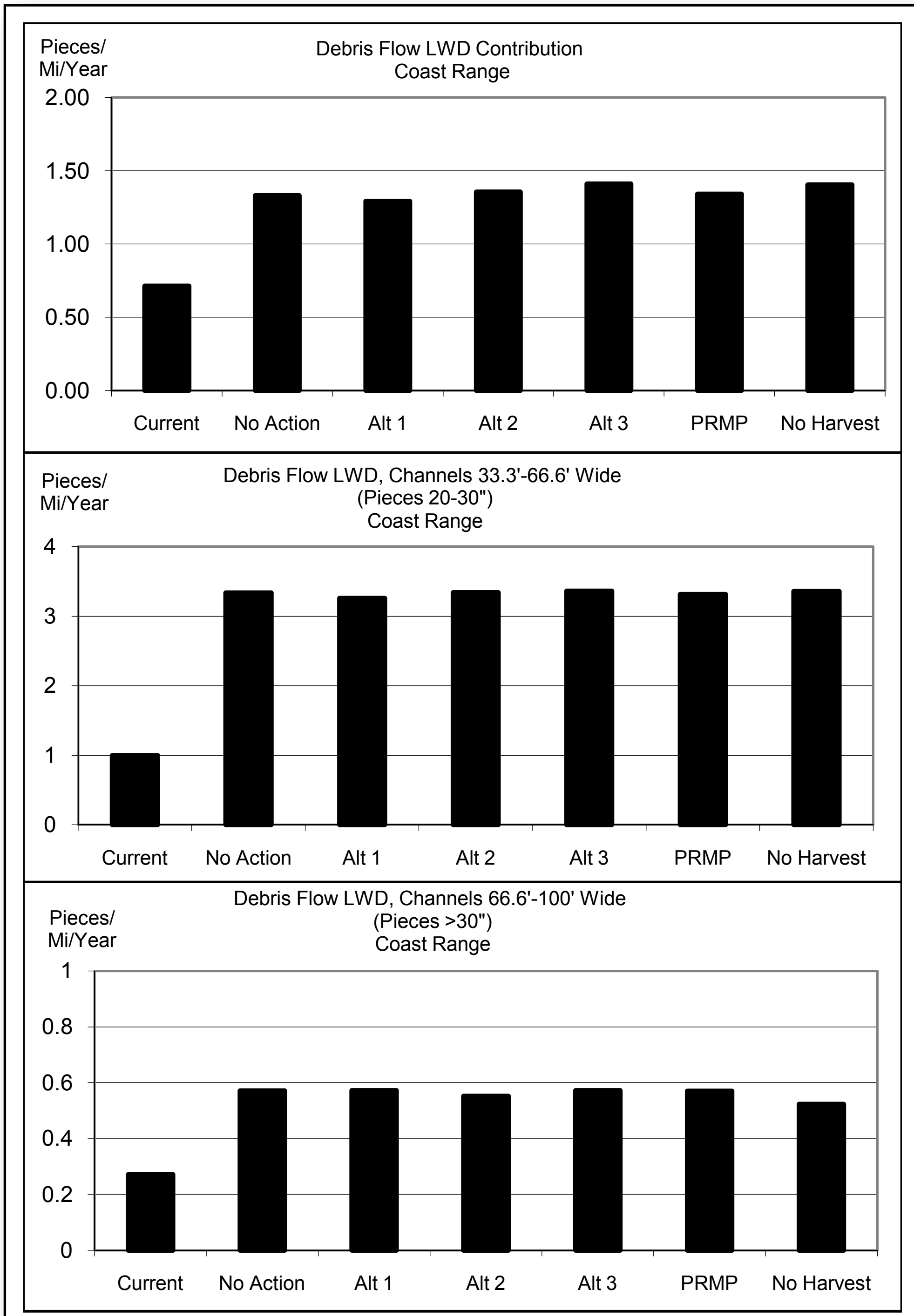


delivered to larger stream channels (greater than 66 feet wide), because larger diameter trees are necessary to be functional in larger stream channels (Beechie and Sibley 1997). The inherent potential for large wood to be delivered to larger streams from debris flow sources depends on topography and the amount of larger streams, which varies by province. Debris flows are one of the dominant geomorphic processes in steep mountainous terrain in the Coast Range Province, (May and Greswell 2004), and there are more large streams (greater than 66 feet wide) in the Coast Range Province than in the Klamath or Cascades Provinces. In the Cascades and Klamath Provinces, the majority of large wood is delivered to stream channels less than 66.6 feet wide from debris flow sources. Therefore, the potential delivery of large diameter wood to large streams from debris flow sources is of most relevance in the Coast Range Province.

In the Coast Range Province, the potential large wood contribution of trees greater than 30 inches in diameter to larger streams from debris flow sources under all alternatives would be greater than the contribution that the No Harvest reference analysis indicates would occur if no active management were to occur on BLM-administered lands. See *Figure 4-165* (*Potential and relative debris flow large wood contribution to streams from BLM-administered lands in the Coast Range Province*). Although this seems counter-intuitive, there is a reasonable explanation. Thinning within debris flow wood source areas that would occur in a managed forest would shift forest stands in debris-flow-prone areas to fewer but larger diameter trees, compared to unthinned areas that would take place in an unmanaged forest that would occur in the No Harvest reference analysis. The greatest shift in the diameter of trees available for potential delivery would occur under the PRMP. Although the PRMP would exclude thinning from along streams, as described above, it would have more thinning elsewhere on the landscape than the other alternatives and, therefore, shift more stands with debris flow source areas to fewer, but larger diameter trees. This would result in more potential for large wood contribution of trees greater than 30 inches in diameter to larger streams from debris flow sources than other alternatives.

In the Klamath Province, there would be a greater amount of larger diameter trees under the PRMP and No Action Alternative than under the other alternatives, in part because thinning would result in larger diameter trees in debris flow source areas. However, in the Klamath Province, trees greater than 30 inches in diameter would generally not be capable of being delivered to larger streams (greater than 66 feet wide) from debris flow sources, because BLM-administered lands are generally not located near larger streams in the province. In this province, there is a greater importance of trees delivered to streams less than 66 feet

Figure 4-165. Potential And Relative Debris Flow Large Wood Contribution To Streams From BLM-Administered Lands In The Coast Range Province



wide, where trees 20 to 30 inches in diameter are functional, and the greatest increase of total potential large wood contribution to streams from debris flow sources would occur under Alternative 2.

In the Cascades Province, the greatest increase of potential large wood contribution to streams from debris flow sources for both larger diameter trees and total large wood would occur under the PRMP. Similar to the Klamath Province, a small portion of trees greater than 30 inches in diameter are capable of being delivered to larger streams from debris flow sources. Also, there is a greater importance of trees delivered to streams less than 66 feet wide, where trees 20 to 30 inches are functional.

Channel Migration Sources

Over long time periods, channel migration sources would be a smaller source of potential large wood contribution than riparian sources or debris flow sources under all alternatives. Refer to *Figure 4-155 (Potential large wood contribution from all sources for the planning area in 2106 by alternative and the No Harvest reference analysis).* In all provinces, the potential large wood contribution to fish-bearing stream channels from channel migration sources would increase under every alternative. In all provinces, the potential large wood contribution from channel migration sources would vary little among the alternatives, and all alternatives would vary little from what the No Harvest reference analysis indicates would occur in the absence of active management.

Small Wood

Small Functional Wood Contribution to Fish-bearing and Non-Fish-bearing Streams

In all provinces, the potential small functional wood contribution from BLM-administered lands to fish-bearing and non-fish-bearing streams from riparian sources would increase over time under all alternatives. The potential small functional wood contribution from debris flow sources would decrease under all alternatives. See *Figure 4-166 (Potential small wood contribution to stream channels for the planning area in 2106 by alternative and the No Harvest reference analysis for each province).* Channel migration sources are not included in this analysis because small functional wood would only be considered functional in smaller constrained stream channels that would not typically migrate.

Riparian Sources

The potential small functional wood contribution to streams from riparian sources would increase over time under all alternatives. See *Figure 4-167 (Potential small functional riparian wood contribution from BLM-administered lands for each province).*The small functional wood contribution would vary more among alternatives than the large wood contribution, and the small functional wood contribution would decrease in some decades under some alternatives, in contrast to the large wood contribution. The differences among the alternatives would result from differences in the widths of riparian management areas along intermittent, non-fish-bearing streams and from differences in management direction within Riparian Management Areas. In 2106, the small functional wood contribution would be highest under the No Action Alternative in all provinces. Under the PRMP, the increase in small functional wood contribution would be similar to the No Action Alternative in all provinces until 2056, after which it would remain approximately stable or decrease slightly. The increase in small functional wood contribution under the PRMP would be greater than under Alternative 1 in all provinces, even though the Riparian Management Area would be the same width under each alternative, because the PRMP would exclude thinning adjacent to streams, from where the majority of smaller functional wood would recruited. In all provinces, the small functional wood contribution would be lowest in 2106 under Alternatives 2 and 3, because regeneration harvest would occur within the riparian source area near intermittent non-fish-bearing streams, which

Figure 4-166. Potential Small Functional Wood Contribution To Stream Channels For The Planning Area In 2106 By Alternative And The No Harvest Reference Analysis For Each Province

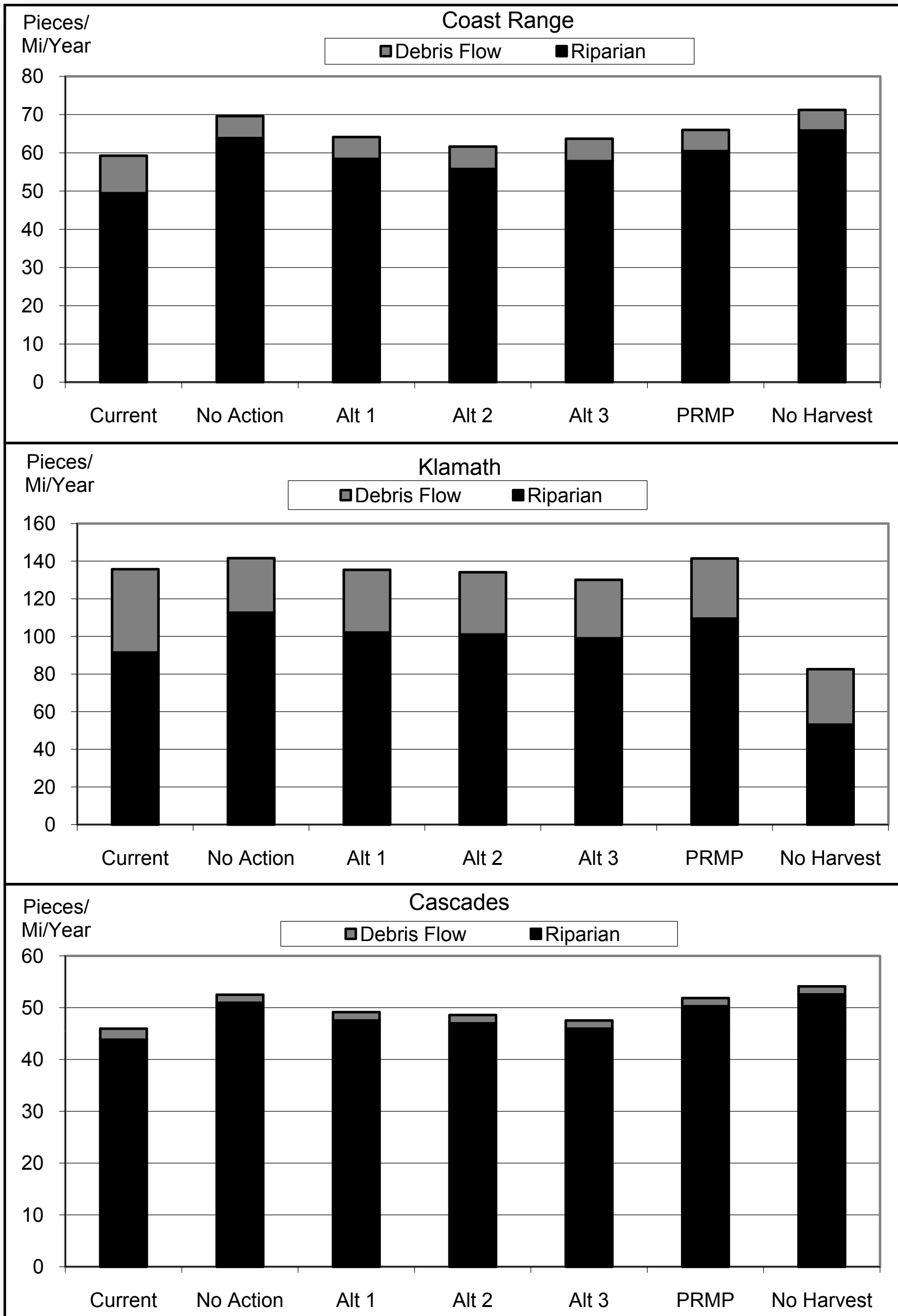
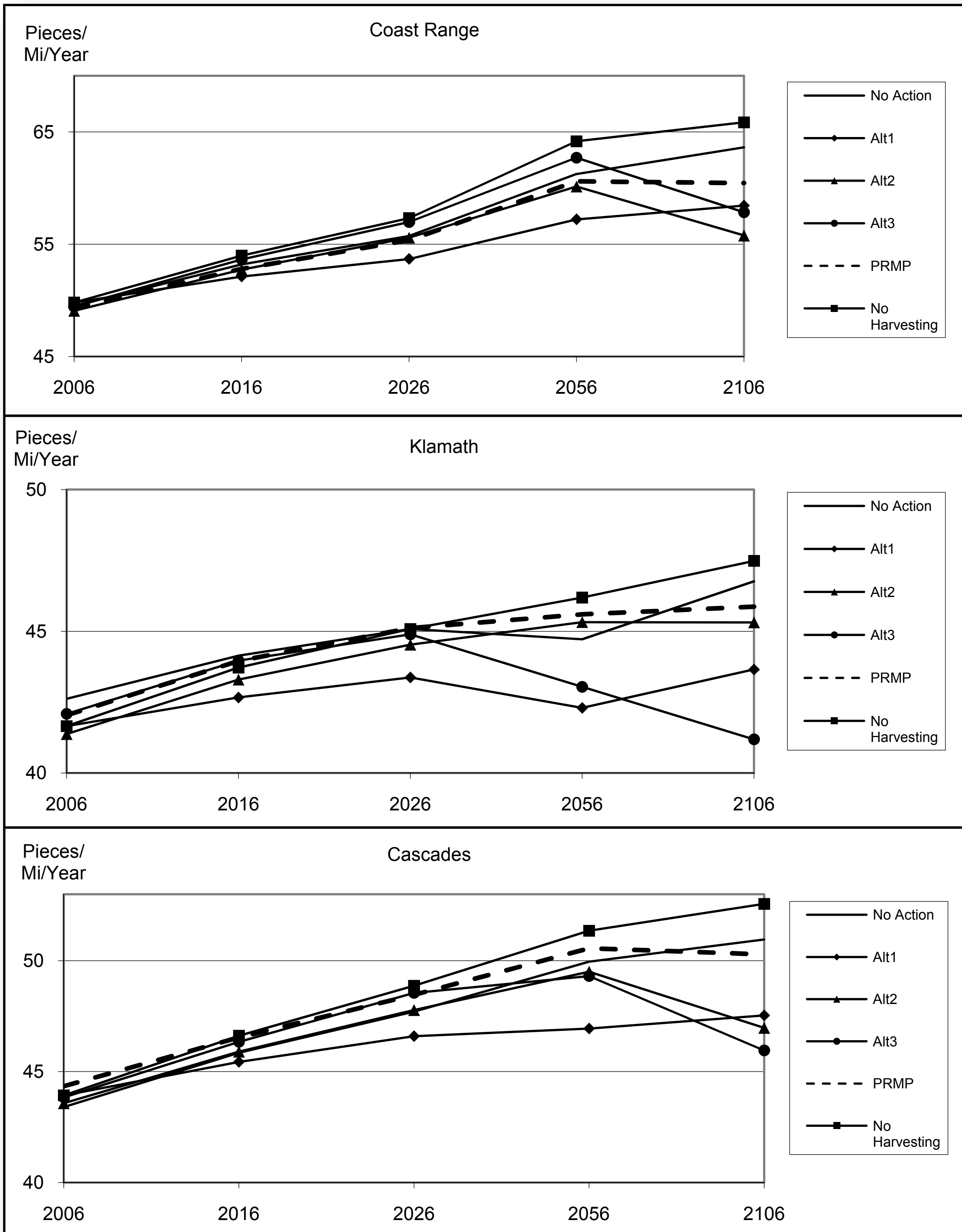


Figure 4-167. Potential Small Functional Riparian Wood Contribution To Streams From BLM-Administered Lands For Each Province

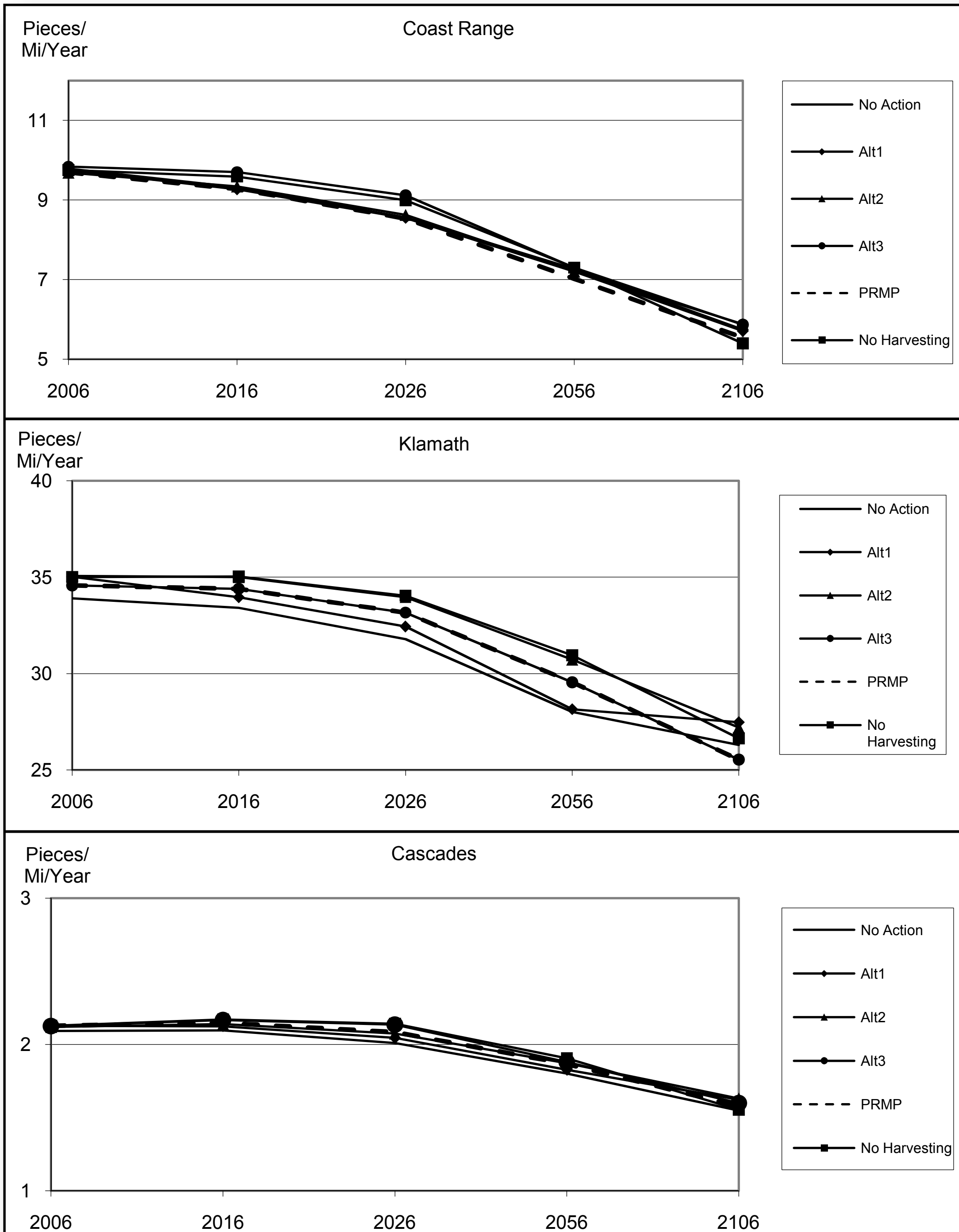


would have a 25-foot wide Riparian Management Area. Regeneration harvest within the riparian source area would temporarily reduce the supply of small functional wood following harvest.

Debris Flow Sources

The potential small functional wood contribution to stream channels from debris flow sources would decrease under all alternatives in all provinces. See *Figure 4-168 (Potential debris flow small wood*

Figure 4-168. Potential Debris Flow Small Wood Contribution From BLM-Administered Lands For Each Province



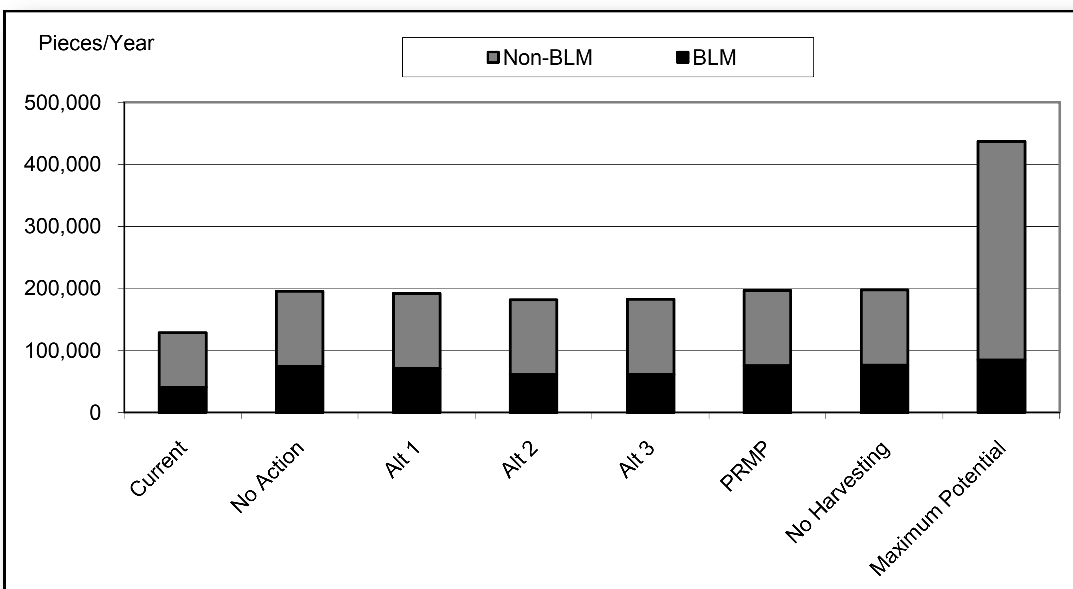
contribution from BLM-administered lands for each province). Young forests provide more small functional wood than mature & structurally complex forests, and the abundance of young forests would decrease, and mature & structurally complex forest would increase over time under all alternatives in all provinces (see the *Forest Structure and Spatial Pattern* section of *Chapter 4*). The No Harvest reference analysis indicates that the small functional wood contribution would decrease similarly to the alternatives, even in the absence of active management on BLM-administered lands.

Large Wood Contribution Across All Ownerships, By Province

The detailed forest stand data for BLM-administered lands that was used for the wood delivery model is not readily available for non-BLM-administered lands. Therefore, in order to show the relative potential large wood contribution from both BLM and non-BLM-administered lands, the wood delivery model used IVMP data, classified into five general structural stages for non-BLM-administered lands (as described in the *Forest Structure and Spatial Pattern* section of *Chapter 3)*. The IVMP data, however, only describes the current condition. It is not possible to conduct modeling of future conditions on lands other than the BLM-administered lands comparable to modeling of BLM-administered lands. Therefore, the analysis relies on broad and general assumptions about the future conditions on other lands: All forest-capable lands in the U.S. Forest Service Late-Successional Reserves, Administratively Withdrawn, and Congressionally Reserve lands would continue to develop, and all other lands would maintain their current abundances and spatial patterns (see *Forest Structure and Spatial Pattern* in *Chapter 4*). The analysis compares the relative large wood contribution against a maximum potential large wood contribution to show the general relative contribution between ownerships. The potential large wood contribution from BLM-administered lands differs from that shown in previous graphs due to differences in summarizing the data and using the data for this comparison.

There would be an increase in potential large wood from the combination of BLM and non BLM-administered lands under all alternatives. The greatest increase would occur under the No Action Alternative and the PRMP. See *Figure 4-169 (Potential large wood contribution comparison of all ownerships by 2106 with current and maximum potential large wood contribution)*. By 2106, the overall potential large

Figure 4-169. Potential Large Wood Contribution Comparison Of All Ownerships By 2106 With Current And Maximum Potential Large Wood Contribution



wood contribution from all sources, across all ownerships, would increase from the current condition. Although, the potential large wood contribution from BLM-administered lands would increase by 2106 similar to the contribution under the No Harvest reference analysis under every alternative, the overall large wood contribution would be substantially less than the maximum potential. This occurs because not all forests that are capable of delivery to streams would be within a mature & structurally complex forest on non-BLM-administered lands by year 2106, and because the BLM is rarely the predominant landowner within fifth-field watersheds in the planning area. The BLM-administered lands comprise only 16% of all forested lands within the planning area, which is too small an area to substantially increase the overall large wood contribution in a watershed to a level similar to the maximum potential. The No Harvest reference analysis indicates that, even if there were no active management on BLM-administered lands, the overall potential large wood contribution for all ownerships to streams at year 2106 would still be less than the contribution under the maximum potential.

There are differences in the overall increases in the potential large wood contribution that are masked by grouping all watersheds together. For example, there are three watersheds in the planning area where BLM-administered lands comprise more than two-thirds of the watershed. The potential large wood contribution is shown for the Rogue-Horseshoe Bend watershed as a general representation for watersheds where BLM-administered lands comprise more than two-thirds of the watershed. See *Figure 4-170 (Potential large wood contribution in the Rogue-Horseshoe Bend watershed).* In watersheds similar to the Rogue-Horseshoe Bend watershed, the potential large wood contribution would primarily occur from BLM-administered lands.

There are 30 watersheds in the planning area where BLM-administered lands comprise between one-third and two-thirds of the watershed. The potential large wood contribution is shown for the Evans Creek watershed as a general representation for watersheds where BLM-administered lands comprise between one-third and two-thirds of the watershed. See *Figure 4-171 (Potential large wood contribution in the Evans Creek watershed)*. In watersheds similar to the Evans Creek watershed, the potential large wood contribution from BLM-administered lands would have a greater potential to increase the overall contribution in the watershed compared to the contribution that would occur in the majority of watersheds where BLM-administered lands comprise less than one-third.

Figure 4-170. Potential Large Wood Contribution In The Rogue-Horseshoe Bend Watershed

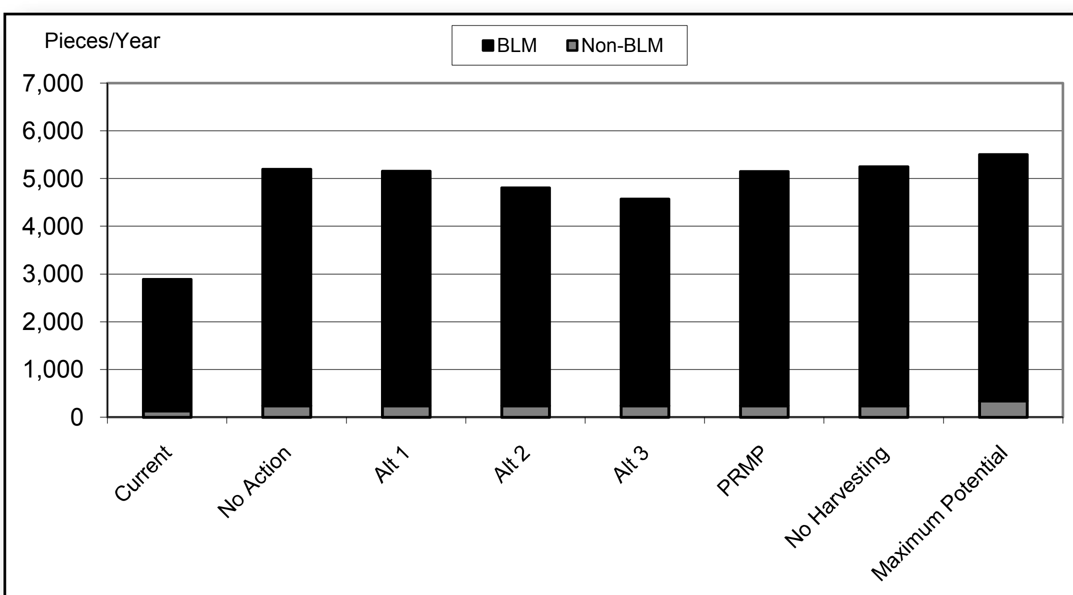
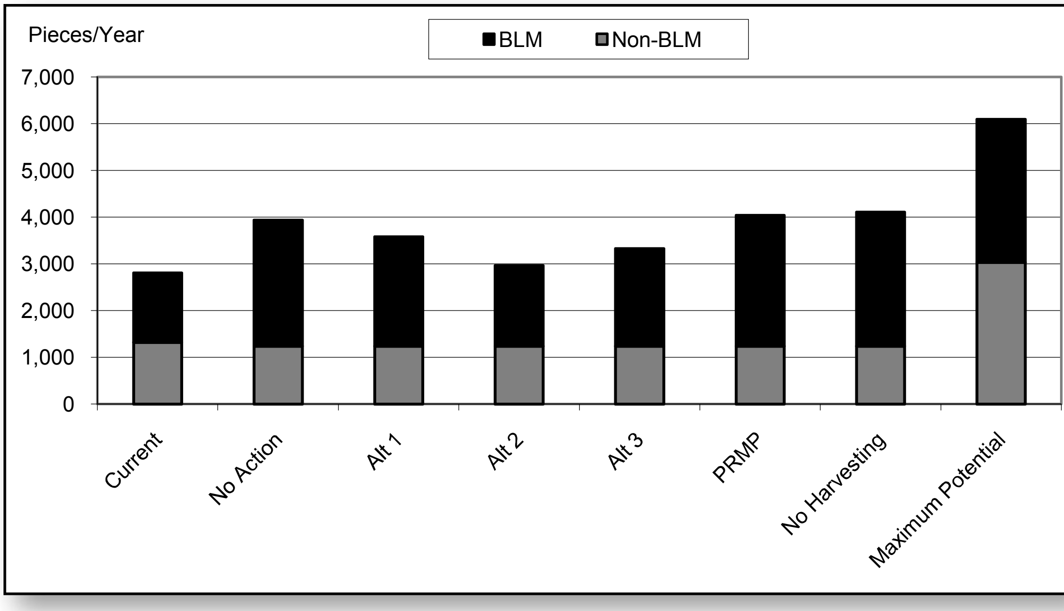
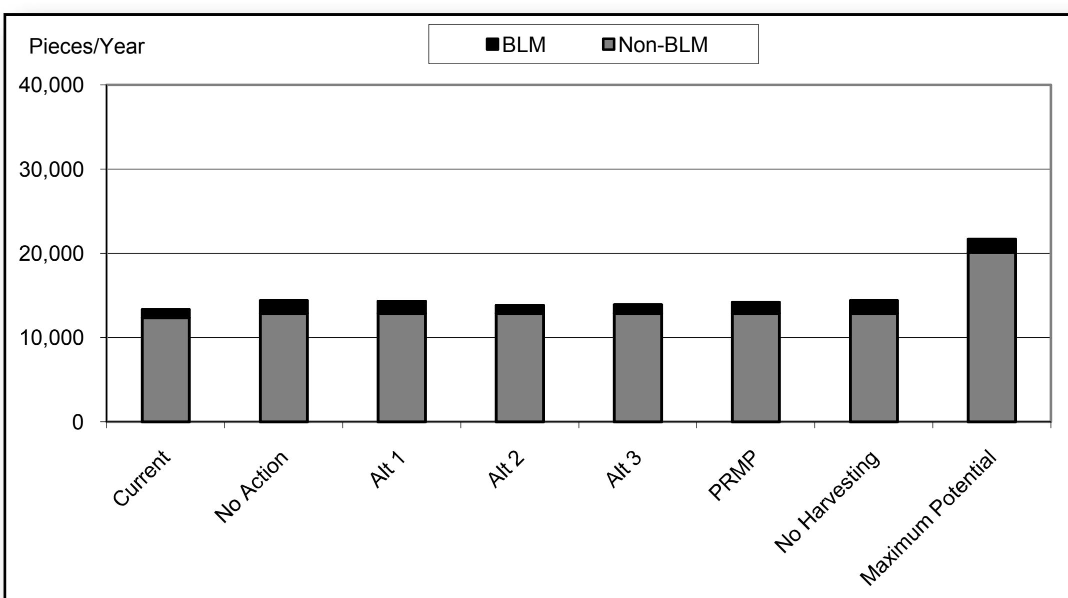


Figure 4-171. Potential Large Wood Contribution In The Evans Creek Watershed



In the majority of watersheds, the BLM-administered lands comprise less than one-third of watersheds in the planning area (138 watersheds). The large wood contribution is shown for the Eagle Creek watershed as a general representation for watersheds where BLM-administered lands would not be the predominant landowner. In the majority of watersheds, the potential large wood contribution would increase slightly above current conditions. This occurs because BLM-administered lands comprise too small of an area to substantially increase the overall large wood contribution in a watershed to a level similar to the maximum potential. See *Figure 4-172 (Potential large wood contribution in the Eagle Creek watershed*).

Figure 4-172. Potential Large Wood Contribution In The Eagle Creek Watershed



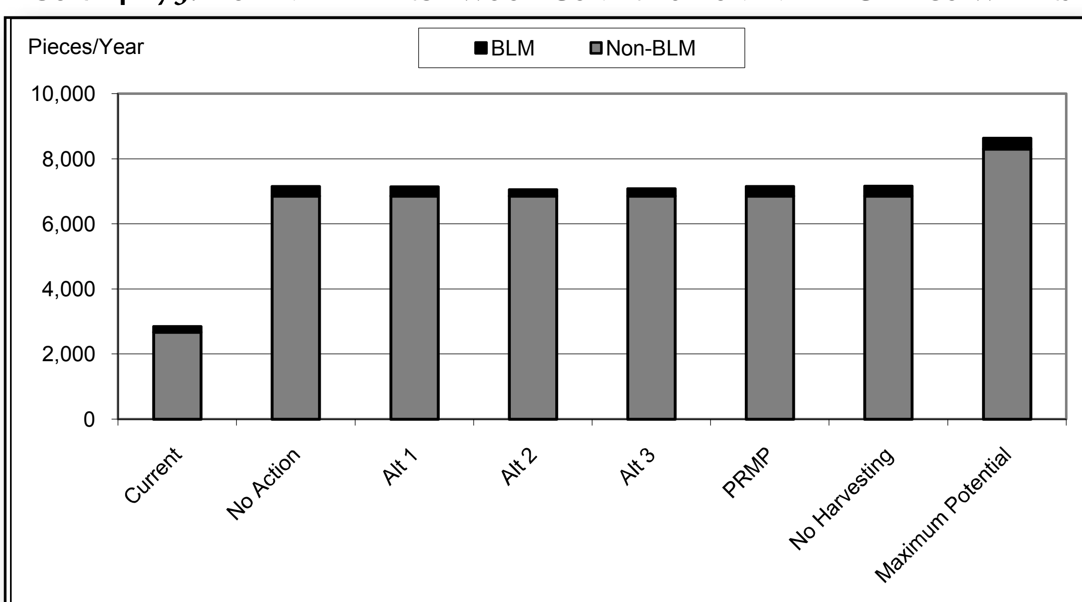
In some cases, federal ownerships other than BLM-administered lands would be the predominant landowner. The large wood contribution is shown for Chetco watershed as a general representation of the potential large wood contribution that would be typical in watersheds with a greater amount of other federal ownership. See *Figure 4-173 (Potential large wood contribution in the Chetco watershed)*. In these watersheds, the overall potential large wood contribution would increase to a greater degree from non-BLM-administered lands than BLM-administered lands, because the modeling relies on the assumption that all forest-capable lands in the Riparian, Administratively Withdrawn, Late-Successional, and Congressionally Reserved lands of the U.S. Forest Service would develop into mature & structurally complex forests over time (See *Chapter 4 –Forest Structure and Spatial Pattern*).

Nutrient Input

As described in the *Fish* section of *Chapter 3*, the type, successional stage, size, abundance, and overall stand composition of riparian vegetation within one-half site-potential tree height distance from the stream channel determines the amount of nutrient input to the stream channel from litterfall. The input of solar radiation to stream channels also contributes to stream energy and production and is also dependent on the forest structure near the stream channel. At the scale of this analysis, thresholds have not been established to determine the amount of organic input necessary to maintain food supplies for fish. Therefore, this analysis compares the abundance and spatial patterns of the riparian forest structure to the average historic conditions of forest structure in the planning area to determine effects of each alternative on the potential stream productivity from nutrient input, based on correlations of forest structure stage and stream productivity from O'Keefe and Naiman (2006). See the *Fish* section of *Chapter 3*. Average historic conditions do not represent a target or standard for management, but are used here to provide context for comparing relative effects of the alternatives in the absence of thresholds for nutrient input.

The Riparian Management Areas (or Riparian Reserves) under all of the alternatives have more stand establishment forests and less mature & structurally complex forests currently than it did historically. Over time, the structural stage abundance within Riparian Management Areas would shift from being dominated by stand establishment and young forests, to mature & structurally complex forests. The overall result of

Figure 4-173. Potential Large Wood Contribution In The Chetco Watershed



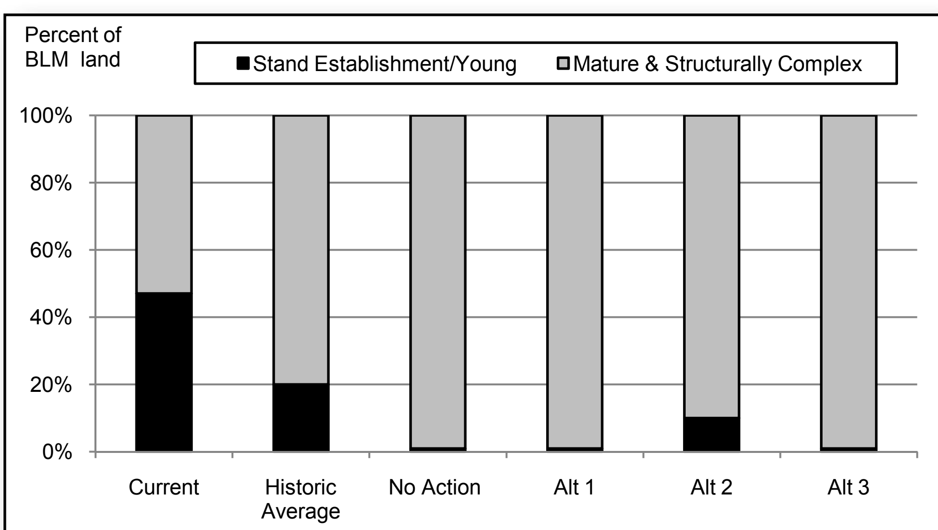
these changes would be a shift on BLM-administered lands from a condition where stream productivity from solar radiation in stand establishment and younger forests would dominate, to a condition where nutrient input from litterfall in mature & structurally complex forests would dominate. Under the PRMP, No Action Alternative, Alternative 1, and Alternative 3, the amount of nutrient input to stream channels would increase over time from litterfall sources to above average historic conditions and decrease over time from solar radiation to below average historic condition as Riparian Management Areas (or Riparian Reserves) would become almost completely dominated by mature & structurally complex forests. See *Figure 4-174 (Comparison of the structural stage abundance within riparian management areas on BLM-administered forested lands by 2106 with the current and average historical conditions).*

The abundance of structural stages within Riparian Management Areas under Alternative 2 would be most similar to the average historical conditions. Because of the more narrow riparian management widths areas along non-debris flow prone headwater channels, localized shifts in vegetation from timber harvest would occur in areas near the stream channel. Therefore, the amount of stand establishment within the Riparian Management Area would decrease to a lesser degree under Alternative 2 than under the other alternatives. Under Alternative 2, there would be a greater contribution to stream productivity from solar radiation and less nutrient input from litterfall sources than under the other alternatives.

However, BLM-administered lands comprise less than one-third of the majority of watersheds in the planning area and are typically intermingled with other ownerships where there would be a greater amount of stand establishment and young forests near stream channels. Therefore, increasing nutrient input from litterfall sources is likely more important than maintaining the historic condition on BLM-administered lands.

Thinning within Riparian Management Areas (or Riparian Reserves) would have little effect on nutrient input under all alternatives, because trees near the stream channel would be retained. Danehy et al. (2007) found little effect on instream flora, fauna, or macroinvertebrate assemblages due to thinning. Additionally, periphyton biomass was larger in thinned stands than in mature stands, and macroinvertebrate assemblages, biotic metrics, functional feeding group composition, and biomass measures were the same in both mature and thinned riparian stands (Danehy et al. 2007). This occurs because changes in abiotic and biotic features of these systems are less dramatic with the retention of trees near the channel than if all trees were removed

Figure 4-174. Comparison Of The Structural Stage Abundance Within Riparian Management Areas On BLM-Administered Forested Lands By 2106 With The Current And Average Historical Conditions



(Danehy et al. 2007). Under the PRMP, thinning within the Riparian Management Area would have little if any effect on nutrient inputs, because the PRMP would exclude thinning from within 60 feet of fish-bearing and perennial stream channels, and 35 feet of intermittent channels. Therefore, under the PRMP, nutrient inputs would be the most dominated by litterfall sources, with the least contribution from solar radiation of any alternative.

Fine Sediment Delivery

Under all alternatives, the increase in fine sediment delivery to streams would not increase more than 1% above the current conditions, and would therefore be below the threshold for measurable effects on fish survival at this scale of analysis.

As noted in the *Fish* section of *Chapter 3*, thresholds beyond general levels at which lethal and sub-lethal effects have not been well established in terms of the levels of sediment delivery that would cause impairment to fish at the scale of this analysis. Suttle et al. (2004) suggest there is no threshold below which fine sediment is harmless to fish, and the deposition of fine sediment in the stream channel (even at low concentrations) can decrease the growth of salmonids. Such sub-lethal effects on individual fish would occur under every alternative from timber harvest activities, broadcast burning, grazing, culvert replacements, and other management activities. *Chapter 3 (Fish* section*)* provides a qualitative description of potential sub-lethal effects to fish from sediment, but it is not possible to describe quantitative changes in sub-lethal effects under the alternatives over time at this scale of analysis. Therefore, this analysis focuses on the sediment levels that would affect fish survival. This analysis assumes that every 1% increase in fine sediment from management activities would result in a 3.4% decrease in fish survival (see *Chapter 3, Fish* section).

This analysis assumes that, like the watersheds used in the Cederholm study, existing fine sediment levels in watersheds in the planning area are not currently above background rates. The assumption is based on the current condition of fine sediment in streams within the planning area on BLM-administered lands (see *Chapter 3, Fish* section). For this analysis, sediment yields are calculated at a fifth-field scale and expressed as tons per square mile per year (see *Chapter 3, Water* section). Since this output (tons/square mile/year) cannot be directly equated to a percent embeddedness, using the assumption above (>1% increase above natural levels) provides the ability to utilize a comparison of the relative increase expected under each alternative in order to evaluate the relative effects of fine sediment delivery on fish species at the watershed scale for each alternative.

The *Water* section of *Chapter 4* provides a quantitative analysis of the potential fine sediment delivery to stream channels from new road construction, which typically accounts for the majority of sediment that is delivered to stream channels. The incremental increase in fine sediment delivery from new road construction over the next 10 years would range from 1,567 tons per year under the No Action Alternative, to 2,811 tons per year under the PRMP, compared to a current condition of 357,891 tons per year. Under all alternatives, this incremental increase would be less than 1% above current conditions. As explained in *Chapter 4 (Water* section*)*, these results over-estimate the future fine sediment delivery from roads under the alternatives, because they do not account for reductions in sediment delivery after road construction from vegetation establishment, or the effect of road decommissioning on reducing overall sediment delivery from roads.

The *Chapter 4 (Water* section*)* analyzes sediment delivery from landslides and concludes that relative landslide density across the planning area would decline from the current condition under all alternatives. Also, sediment inputs to streams from harvest-related landslides over time under all alternatives would be substantially similar to the amount that would occur naturally in the absence of active management on BLM-administered lands. Therefore, none of the alternatives would have an effect on fish survival as a result of an increase in fine sediment delivery to streams from landslides.

Chapter 4 (Water section*)* qualitatively analyzes other potential sources of fine sediment delivery to streams, and none of these other sources would result in delivery of fine sediment to streams that would be measurable at this scale of analysis.

Restoration activities, such as instream restoration and fish passage improvements that are beneficial to fish habitat, would also result in short-term increases in sediment delivery to stream channels. Under all alternatives, instream restoration would improve habitat complexity. Removal of fish-passage barriers would increase access for adults to reach spawning habitat, and also increase the ability for juveniles to move within the stream channel during winter high flows and access cooler stream reaches during summer months.

Placement of culverts and instream structures could result in an increase in turbidity and potential downstream sediment delivery, and often would occur during low flow periods when fish are most vulnerable to fine sediment. Under all alternatives, culvert replacements and other instream activities would cause short-term localized increases in turbidity (less than eight hours in duration, and less than 300 feet from the culvert placement or instream activity). The potential increase in turbidity would be the same under every alternative and would not affect entire fish populations because Best Management Practices–such as diverting water around a site, use of containment and filtering techniques (e.g., silt curtains), and limiting mechanized equipment along streambanks–would be applied to meet water quality standards. Site-specific and highly localized effects on sediment delivery from placement of culverts and instream structures would depend on site-specific stream conditions and the specific project design, which cannot be analyzed more precisely at this scale of analysis. Site-specific effects of placement of culverts and instream structures on sediment delivery and attendant effects on fish would be considered during the planning of implementation-level actions. Additionally, the overall benefit to fish species and fish habitat from these activities would outweigh the potential for short-term localized increases in turbidity.

Under all alternatives, grazing in riparian areas would reduce and eliminate streambank vegetation and contribute fine sediments to stream channels (see *Water* in *Chapter 4*). (USDI USFWS 2003d). Sedimentation is a limiting factor for endangered Lost River and Shortnose suckers. Under all of the action alternatives, up to 29 reservoirs and 48 miles of fence would be constructed within the Klamath Falls Resource Area of the Lakeview District. These range improvements would be used to improve livestock distribution by shifting the grazing pressure from riparian and wetland areas to upland areas, and by shifting the grazing distribution on the upland areas (including those areas that are not currently used). These range improvement actions would be consistent with conservation measures of the recovery plan for the Lost River and Shortnose suckers to fence portions of streams to reduce cattle-caused erosion and to replant streambanks with native vegetation (USDI USFWS 2003d).

Peak Flows

Chapter 4 (Water section*)* identifies subwatersheds that would be susceptible to peak flow increase under the alternatives. Peak flow increases can scour streambeds, which can potentially result in fish egg mortality (see *Fish* in *Chapter 3*). The *Chapter 4 (Water* section*)* concludes that, in the rain-dominated hydroregion, the PRMP would have the highest number of susceptible subwatersheds, but Alternative 2 would have the greatest acreage of susceptible BLM-administered lands. The No Action Alternative would have the fewest susceptible subwatersheds and the lowest acreage of susceptible BLM-administered lands. However, the susceptibility to peak flows under all alternatives would be more similar to the effects of the No Harvest reference analysis than to the effects of the Intensive Management on Most Commercial Timber Lands reference analysis. In the rain-on-snow hydroregion, there would be three subwatersheds with BLM-administered lands out of 248 (1%) susceptible to peak flow increase over all time periods under all alternatives except under Alternative 2, under which there would be one additional subwatershed susceptible for the 2056 time period. *Chapter 4 (Water* section*)* concludes that timber harvest on BLM-administered lands would not have any substantial effects on peak flow susceptibility in the rain-on-snow hydroregion that can be detected at this scale of analysis.

Whether susceptibility to peak flow increases identified in *Water* (*Chapter 4)* would result in fish egg mortality would depend on watershed and stream-specific characteristics and the timing of peak flow increases, making it impossible to make a reasonable prediction of precise effects on fish from peak flow increases under each alternative over time. For example, streambed scour that would result in egg mortality would generally occur in lower gradient stream channels with gravel and sand-bed substrates, and would not typically occur within cascade and step-pool stream types (Grant et al. 2008). On BLM-administered lands within the planning area, 80% of the streams are stream types where increases in peak flows would not cause streambed scour (see *Chapter 4, Water* section*)*. Increases in peak flow susceptibility would result in adverse effects on fish only if all of the following conditions would occur in concert: a storm that would increase flow would occur during the time period a subwatershed would be susceptible; the increase in flows would occur in pool/riffle stream types with gravel-bed and sand substrates; and the increase in flows would occur when fish would be spawning. Where and when storms would occur in relation to the susceptible subwatersheds and fish spawning cannot be predicted.

Therefore, it is not possible to make a reasonable prediction of the adverse effects to fish from increases in susceptibility to peak flows under the alternatives. However, the risk of adverse effects to fish from an increase to peak flow would be very low under all alternatives, because of the small proportion of the planning area identified as susceptible to increase in peak flows, the small proportion of the stream types in which streambed scour would occur, and the low likelihood that all factors required for adverse effects on fish would occur simultaneously. Furthermore, there would be no identifiable difference among the alternatives in the effects on fish from peak flow increases, because of the relatively small difference in peak flow susceptibility among the alternatives and the difficulty in directly ascribing adverse effects to fish from susceptibility to increases in peak flow.

Stream Temperature

Under all alternatives, management activities on BLM-administered lands would maintain stream shade and, therefore, would not contribute to an increase in stream temperatures (see *Water* in *Chapter 4)*. Because none of the alternatives would contribute to an increase in stream temperatures, this component of fish habitat would not be affected under any alternatives.

Fish Productivity

The ecosystem processes that affect habitat complexity for fish species in the planning area include large wood delivery, nutrient inputs, fine sediment delivery, stream temperature, and peak flows. This analysis determines the effect of the alternatives on each of these processes (wood, nutrients, sediment, stream temperature, peak flows) in terms of fish habitat independently. These processes do not act independently in terms of fish productivity. However, existing models cannot accommodate the synergistic interactions among these processes at the spatial scale of the planning area; therefore, the cumulative effects to fish productivity are described qualitatively.

All alternatives would provide for riparian and aquatic conditions that supply stream channels with shade, sediment filtering, leaf litter and large wood, and streambank stability, but to varying degrees. All alternatives would improve the riparian and aquatic conditions that affect fish productivity from current conditions. Although sub-lethal effects of fine sediment delivery to stream channels would occur under all alternatives, the increase in fine sediment delivery would be below the threshold for effects on fish survival under all alternatives. Of all riparian and aquatic conditions affecting fish productivity, increasing large wood and habitat complexity would have the greatest benefit (Nickelson 2001).

The PRMP, No Action Alternative, and Alternative 1 would provide more improvement to aquatic habitat and subsequent fish productivity than Alternatives 2 or 3. Under the PRMP, No Action Alternative, and Alternative 1, Riparian Management Area (or Riparian Reserve) widths would include the distances in which most ecological functions of riparian forests for streams are fulfilled (Reeves and Burnett 2007, FEMAT 2003). Overall, Alternatives 2 and 3 would have lower likelihood of providing habitat complexity and fish productivity than the other alternatives, because the large wood contribution to fish-bearing streams would be less over time than the contribution under the PRMP, No Action Alternative, and Alternative 1.

Aquatic Restoration

The analysis assumes that the levels of aquatic restoration described below would occur within the planning area. However, these levels are projections used for analytical assumptions, not targets. The amount of aquatic restoration that would occur would depend on future funding and site-specific conditions.

Fish Passage

For this analysis, it is assumed that activities to modify or replace fish passage barriers would decrease in the future, because the majority of fish passage barriers have already been corrected on BLM-administered lands for anadromous and/or listed fish. The priority may shift to barriers that occur on resident fish-bearing streams as opportunities to remove barriers for anadromous and listed fish would decrease. See *Table 4-88* (*Estimate of future fish passage barriers removed per decade by district in the planning area*).

Removing fish passage barriers increases access for adults to reach spawning habitat and increases the ability for juveniles to move within the stream channel during winter high flows and to access cooler stream reaches during summer months. Although many fish passage barriers on BLM-administered lands have been corrected, many barriers still exist on non BLM-administered lands. Refer to *Map 3-8* (*Fish passage barriers)* in *Chapter 3*. Therefore, working with watershed partnerships would be critical to improve fish passage in these watersheds.

Roads

The BLM controls approximately 14,000 miles of roads in the planning area. Approximately, 588 miles of BLM-controlled roads were decommissioned from 1995 to 2004. Although there are over 14,000 miles of roads on BLM-administered lands, most cannot be closed or decommissioned because of road right-of-way agreements (see the *Fish* section of *Chapter 3*).

As a result of these legal road right-of-way requirements and the amount of roads that have previously been decommissioned, opportunities on BLM-administered land to decommission roads have decreased over the last five years (2000-2005). Because improving roads can reduce sediment delivery to stream channels, road projects in the future would focus on improving existing roads to minimize their potential impact to

Table 4-88. Estimate Of Future Fish Passage Barriers Removed Per Decade By District In The Planning Area

Activity	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath Falls	Plan-wide Summary
Number of Fish Passage Barriers Removed Per Decade	23	58	20	20	20	3	144

the aquatic system. Actions such as the replacement of aging stream crossing culverts, adding ditch-line drainage culverts, road surface improvements, and outsloping of roads would be used in addition to road decommissioning. For this analysis, it is assumed that approximately 270 miles of road decommissioning; 38,115 miles of road maintenance; and 2,184 miles of road improvement would occur in the future. See *Table 4-89 (Estimate of future road restoration and decommissioning by district in the planning area)*.

Instream Restoration

For this analysis, it is assumed that instream restoration would continue at a similar rate per decade as the previous decade (1995-2004). See *Table 4-90 (Estimate of future instream restoration by district)*. Due to BLM's ownership pattern, it is assumed that the BLM would also continue to complete projects through partnerships on non BLM-administered lands to support the Oregon Plan for Salmon and Watersheds.

Under the No Action Alternative, key watersheds would continue to be high priority areas for instream restoration. Management activities in key watersheds under the No Action Alternative would focus on limiting road construction and would place priority for instream restoration activity in key watersheds in order to contribute to anadromous salmonid and bull trout conservation. However, a relatively small portion of the key watersheds under the No Action Alternative coincide with high intrinsic potential streams. See *Figure 4-175* (*Distribution of high intrinsic potential streams for chinook salmon, coho salmon, and steelhead trout within key watersheds of the planning area*).

Under all action alternatives, an emphasis for instream restoration would be placed on streams that have high intrinsic potential for fish, high priority fish populations (such as those defined in recovery plans), or high levels of chronic sediment inputs. Increasing habitat complexity in streams with high priority fish populations or occupied high intrinsic potential streams would be more effective in improving habitat complexity in those streams with a greater potential to support salmonids than others. Therefore, aquatic restoration under the PRMP and Alternatives 1, 2, and 3 would be more effective than the No Action Alternative in improving fish habitat on BLM-administered lands.

Table 4-89. Estimate Of Future Road Improvement And Decommissioning By District In The Planning Area

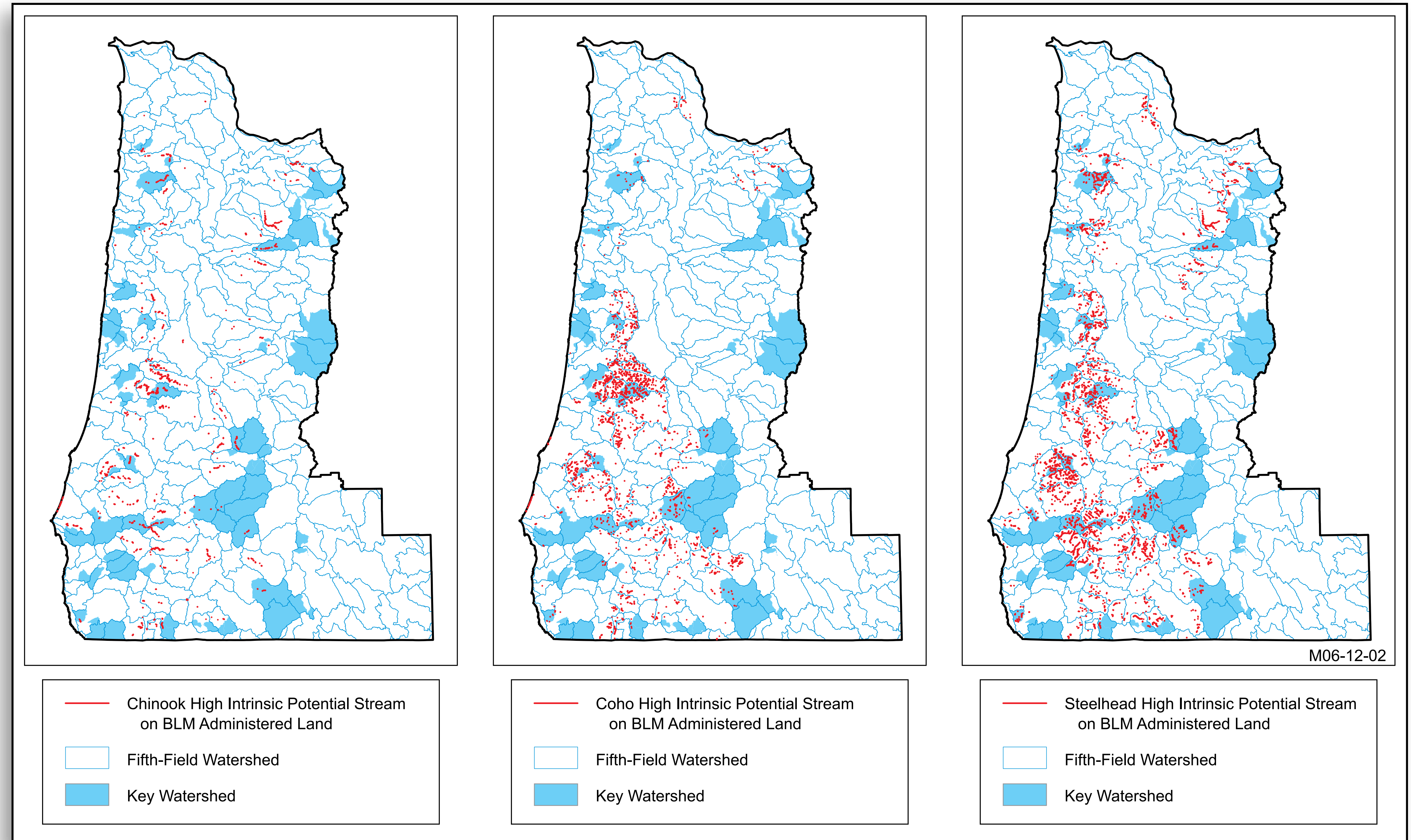
Activity	Unit	Districts						
		Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath Falls	Plan-wide Summary
Road Improvement[a] (Continuous Use)	Miles/ Decade	233	98	214	298	1,224	117	2,184
Road Maintenance	Miles/ Decade	6,500	7,660	7,580	6,940	8,860	575	38,115
Road Decommissioning (Non-continuous use)	Miles/ Decade	30	60	30	30	20	30	270

[a]Road improvement includes road renovation, stormproofing and improvement.

Table 4-90. Estimate Of Future Instream Restoration Projects Per Decade By District

	Districts						
	Salem	Eugene	Roseburg	Coos Bay	Medford	Klamath Falls	Plan-wide Summary
Number of Instream Restoration Projects Per Decade	19	42	30	25	8	2	126

Figure 4-175. Distribution Of High Intrinsic Potential Streams For Chinook Salmon, Coho Salmon, And Steelhead Trout Within Key Watersheds Of The Planning Area



Fire and Fuels

This analysis examines how the alternatives would affect fire severity and fire hazard on all BLM-administered lands, and also fire resiliency in the Medford District and Klamath Falls Resource Area.

Key Points

- In the Salem, Eugene, Coos Bay, and Roseburg Districts, compared to the current condition, all alternatives would reduce the fire hazard and would reduce the acres of high severity fire when wildfires occur.
- In the Medford District, compared to the current condition, all alternatives would reduce the fire hazard and would decrease the acres of high severity fire when wildfires occur. The No Action Alternative would result in the largest decrease and Alternative 2 would result in the smallest decrease.
- In the Klamath Falls Resource Area, compared to the current condition, the No Action Alternative and the PRMP would reduce the fire hazard and the acres of high severity fire when wildfires occur. Alternatives 1, 2, and 3 would increase the fire hazard and would increase the acres of high severity fire when wildfires occur.
- In the Medford District and Klamath Falls Resource Area, the No Action Alternative, Alternatives 1, and 2 would create stand establishment and young stands consisting of even-aged plantations, which would be highly susceptible to stand-replacing crown fires. Alternative 3 and the PRMP would reduce crown fire hazard and increase fire resiliency.
- Across the planning area, the No Action Alternative and the PRMP would be most effective in reducing fire hazards, decreasing the risk of large wildfires, and reducing the risk of resource damage due to high severity wildfire. Alternative 2 would be the least effective.

The analysis of fire and fuels divides the planning area into two geographic areas:

- Salem, Eugene, Coos Bay, and Roseburg Districts (the North), which generally have a low frequency/high severity fire regime (although the southern portion of the Roseburg District begins the transition to the southern area)
- Medford District and Klamath Falls Resource Area (the South), which generally have a high frequency/low severity fire regime

Fire severity, hazard, and resiliency can generally be equated to broad descriptions of vegetation conditions. This analysis uses the standard 13 fuel models (Andersen 1982), which are assigned to the forest structural stage classifications described in *Forest Structure and Spatial Pattern* in *Chapter 3*. However, fire severity, hazard, and resiliency are also influenced by site-specific or stand-specific factors, which are evaluated qualitatively in this analysis. Environmental conditions such as temperature, wind, and relative humidity can cause extreme variations in fire behavior within the fuel models. See the *Fire and Fuels* section of *Chapter 3* for specific discussion of weather, risk, hazard and ignition patterns, and how they contribute to fire severity and fire hazard.

The Wildland Urban Interface constitutes a large portion of BLM-administered acres in the planning area, and the trends described here would be reflected within the Wildland Urban Interface.

Fire severity is a function of both ground and surface fuel loading. As a young forest develops into a mature forest, the fire severity drops from high to low. As a mature forest develops into a structurally complex forest, ground fuels, surface fuels and ladder fuels increase, and fire severity changes to a mixed severity rating. Very heavy amounts of ground and surface fuels increase the probability of a crown fire, which would occur under extreme conditions (weather that exceeds the 90th percentile). Weather factors that influence fire behavior are temperature, relative humidity, and wind speed. Under moderate and extreme conditions, the primary source of high severity fire would be in stand establishment and young forests that consist of even aged plantations. Under extreme conditions, structurally complex forest could also burn with high severity.

In stand establishment and young forest in the North, slash levels created by timber harvest have a strong influence on fire behavior. In stand establishment and young forest in the South, live vegetation also provides a large influence on fire behavior.

Slash levels would be highly variable, depending on site-specific conditions such as:

- pre-harvest stand condition and composition
- harvesting methods
- timber merchantability standards
- market prices

Post-harvest slash treatment can greatly reduce slash levels. The effects of this treatment can be expected to last approximately 15 years. Because slash levels cannot be predicted at this scale of analysis, the effect of slash on fire severity and hazard is evaluated qualitatively.

For analysis purposes, this analysis assumes that the majority of the acreage within regeneration harvest units in the North would receive slash treatment, and thinning units would not receive slash treatment, based on experience with similar harvests over the past decade. In the South, however, based on this experience, it is projected that 90% of harvest units would receive some form of slash treatment. The remaining 10% would not have enough slash to require treatment.

The assignment of structural stages to fire severity and hazard levels reflects the severity and hazard of surface fires. At this scale of analysis, it is not possible to categorize the structural stages by crown fire hazard, or otherwise quantitatively evaluate crown fire hazard. This is because the hazard of crown fire depends in large part on site-specific stand conditions such as tree height-to-live crown and canopy density which cannot be modeled at this scale of analysis. There is no available information at this scale of analysis for evaluating these highly stand-specific characteristics which cannot accurately be inferred from the structural stage classification. Therefore, the analysis qualitatively evaluates crown fire hazard based on the amount and types of stand treatments and the expected stand conditions that would result from treatment based on past experiences with treatments. This qualitative evaluation provides a sufficient basis for evaluating the relative effects of the alternatives on crown fire hazard in order to make a reasoned choice among the alternatives, given the broad, programmatic nature of the management direction in the alternatives that would affect crown fire hazard. Site-specific effects on crown fire hazard would be considered during the planning of implementation-level stand management projects.

Fire resiliency depends in part on some of the same site-specific factors as crown fire hazard. However, surface fuels and the presence of large trees also affect fire resiliency, and these factors can be reflected in relationship of structural stages to fire resiliency levels as shown in *Table 4-91 (Structure stage relationship to fire resiliency)* and *Table 4-92* (*Fire severity, hazard, and resiliency by forest structural stage classifications*).

Table 4-91. Structure Stage Relationship To Fire Resiliency

Structural Stage	Principle	Effect	Advantage	Concern
Young and stand establishment with legacy.	Large legacy trees reduce probability of mortality to stand.	Low crown bulk density in overstory.	Separation of crown between legacy and young & stand establishment. Reduces crown fire potential in legacy.	Surface wind may increase, and surface fuels may be drier.
Mature	Low surface fuels.	Reduced flame length.	Easier to control.	Surface disturbance is less with fire than with other techniques.
	High height to live crown.	Requires longer flame length to initiate torching.	Less torching.	
Mature & structurally complex	Large trees	Thicker bark and taller crowns.	Increases probability of trees surviving.	May accumulate heavy ground and surface fuels.

Table 4-92. Fire Severity, Hazard, And Resiliency By Forest Structural Stage Classifications

Structural Stage	Severity	Hazard	Resiliency
Stand establishment *without* structural legacies; and young *without* structural legacies	High	High	Low
Stand establishment *with* structural legacies; and young *with* structural legacies	High	High	Moderate
Mature	Moderate	Moderate	Moderate
Structurally complex	Mixed	Moderate	Moderate

Fire Regime Condition Class

Chapter 3 analyzed current conditions using LANDFIRE data to describe fire regimes and Fire Regime Condition Class at a stand level scale for all ownerships within the planning area (see the *Fire and Fuels* section in *Chapter 3*). There is no LANDFIRE data on which to analyze future conditions under each alternative because data to build such projections is unavailable. The structural stage classification in the vegetation modeling in this analysis does not directly equate to information needed to derive LANDFIRE forest classifications. Therefore, it is not possible to analyze quantitatively the future Fire Regime Condition Class at a stand level under each alternative. Instead, this analysis broadly and qualitatively describes the future Fire Regime Condition Class under each alternative on BLM-administered lands based on general principles described in the LANDFIRE project (USDA Forest Service and USDI. URL: http://www.landfire.gov/index.php [accessed March 2008]), changes in forest structural stages; and changes in fire severity, fire hazard, and fire resiliency.

Throughout the planning area, all alternatives would reduce the departure from reference conditions in comparison to current conditions on BLM-administered lands, because all alternatives would decrease the high severity acres and would result in forest structural stages on BLM-administered lands that would more closely resemble historic conditions in 100 years than the current conditions (see the *Forest Structure and Spatial Pattern* section in *Chapter 4*).

In the northern districts (Salem, Eugene, Coos Bay, and Roseburg Districts), the No Action Alternative would have the most change in fire condition of all alternatives and would result in fire conditions similar to reference conditions in 100 years. The No Action Alternative would result in forest structural stages on BLM-administered lands that would approximate average historic conditions in 100 years and would have the largest decrease in high severity acres of all alternatives in most of the northern districts. Alternative 2 would result in the least change of all alternatives from current fire conditions in most of the northern districts. The PRMP would be intermediate in the amount of change from current fire conditions in most of the northern districts. In the Salem, Eugene, and Coos Bay Districts, the PRMP would have less of a decrease in high severity acres than the No Action Alternative, but more of a decrease than Alternative 2. In the Roseburg District, the PRMP would have the most decrease of all of the alternatives.

In the southern districts (Medford District and Klamath Falls Resource Area), the No Action Alternative and PRMP would have the most change in fire condition of all alternatives and would result in fire conditions more similar to reference conditions in 100 years than current conditions. The No Action Alternative would result in the largest decrease in high severity acres of all alternatives, followed by the PRMP. Both the PRMP and the No Action Alternative would result in more acres of mature and structurally complex forest on BLM-administered lands than average historic conditions in 100 years.

Under all alternatives, forests in the nonharvest land base would develop into closed canopy mature and structurally complex stands (see *Forest Structure and Spatial Pattern* in *Chapter 4*). Regeneration harvesting in the matrix and adaptive management areas under the No Action Alternative, and in the Timber Management Area under Alternatives 1 and 2, and the PRMP would create blocks of even-aged stand establishment and young forests. These stands would consist of dense canopies that would favor stand replacement fires and would not resemble typical historic stand conditions in southern districts. The No Action Alternative would create the least acreage of stand establishment and young forests in southern districts. The PRMP would create the second least acreage of stand establishment and young forests. Alternative 2 would create the most acreage of stand establishment and young forests of all alternatives. The No Action Alternative and the PRMP would result in less combined acreage of stand establishment and young forests in 100 years than average historic conditions in the southern districts. Alternatives 1, 2, and 3 would result in the more combined acres of stand establishment and young forests in 100 years than average historic conditions in the southern districts.

In the Uneven-Age Timber Management Area in the PRMP, forest conditions would better meet reference conditions over time than all other alternatives. The forest management in the Uneven-Age Timber Management Area in the PRMP would harvest trees across all age classes. This type of forest management would most closely mimic the historic disturbance patterns with which these forests developed. The forest management in the Uneven-Age Timber Management Area in the PRMP would result in mature & structurally complex stands with a mosaic of age classes and a relatively open stand structure in both the understory and the overstory, which would more closely resemble historic stand conditions than any other alternative. In the Timber Management Area in the PRMP, stand conditions over time would be similar to the Timber Management Area in Alternatives 1 and 2.

The overall ranking of the alternatives from most effective to least effective in reducing fire hazards, decreasing the risk of large wildfires, and reducing the risk of resource damage due to high severity fire would be the No Action Alternative, the PRMP, Alternative 1, Alternative 3, and Alternative 2.

Fire Severity and Hazard in the North

Over the next 100 years, all alternatives would reduce fire severity and hazard in the North, because all alternatives would reduce the combined abundance of stand establishment and young forest. See *Figure 4-176 (High fire severity and hazard trends for northern districts by alternative)*. The reductions in acres susceptible to high severity fire during wildfires and reduction of fire hazard would vary among districts. In general, the No Action Alternative would result in the largest decrease of high severity acres, and Alternative 2 would result in the smallest decrease of high severity acres. The PRMP would rank in the middle. There are no established thresholds for evaluating changes in fire severity and hazard. As detailed in *Chapter 3 (*in the *Fire and Fuels* section*)*, the majority of acres in the North currently have a moderate or lower fire hazard, and all alternatives would reduce the fire severity and hazard from current conditions.

Fire Severity, Hazard, and Resiliency in the South

Over the next 100 years, fire severity and hazard would decrease in the Medford District under all alternatives, but the amount of decrease would vary widely among the alternatives. The amount of decrease would be relative to the reduction in acreage of stand establishment and young forest compared to the current condition. The No Action Alternative would have the greatest decrease in high fire severity acres, followed by the PRMP. In the Timber Management Area under the PRMP, high fire severity acres would slightly decrease and fire resiliency would steadily decrease. In the Uneven-Age Timber Management Area under the PRMP, high fire severity acres would steadily decrease and fire-resilient acres would steadily increase. Alternative 2 would have the least decrease, maintaining the acres of high severity fire when wildfires occur and fire hazard at only slightly less than the current condition. See *Figure 4-177* (*High fire severity for southern districts by alternative*).

Figure 4-176. High Fire Severity and Hazard Trends For Northern Districts By Alternative

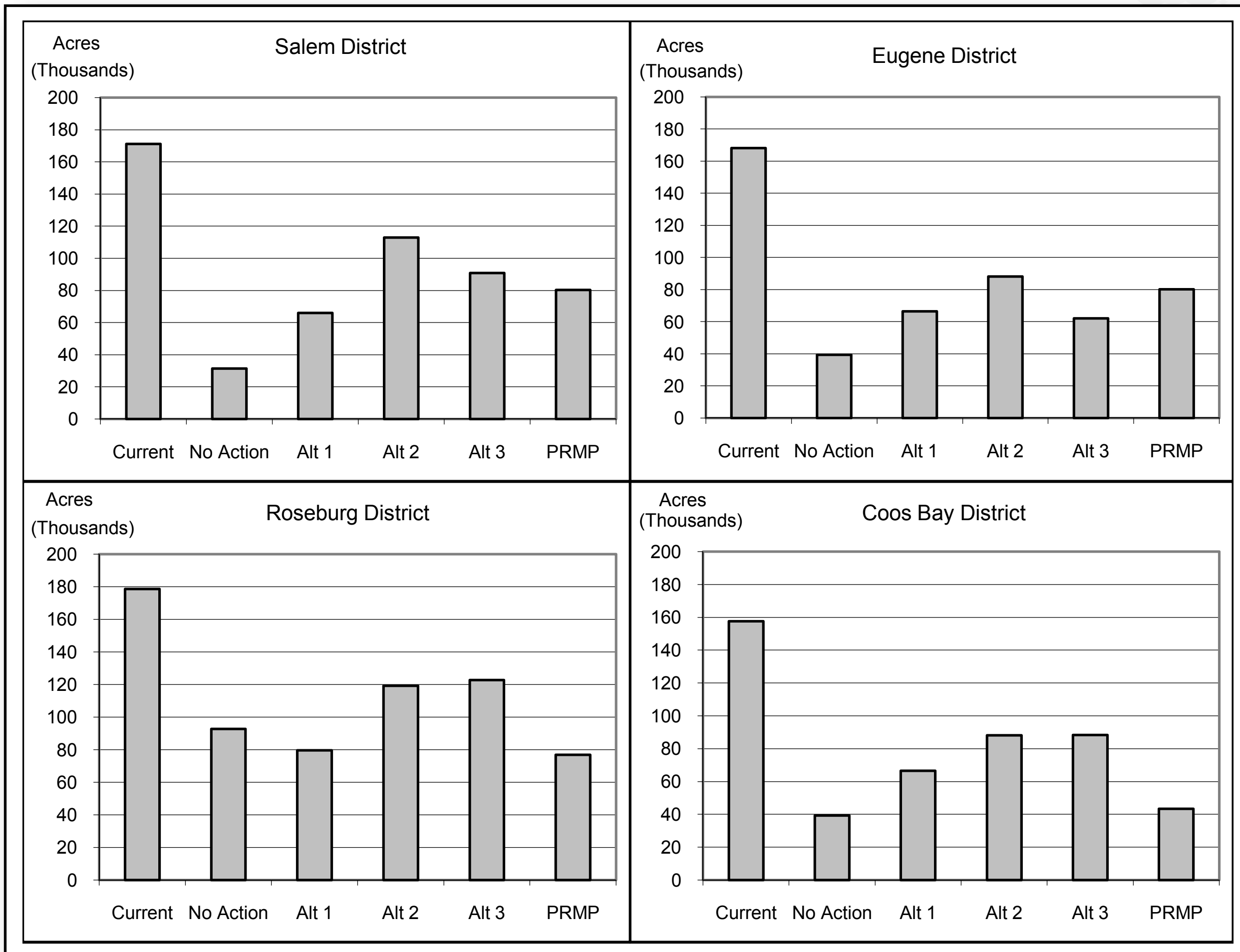
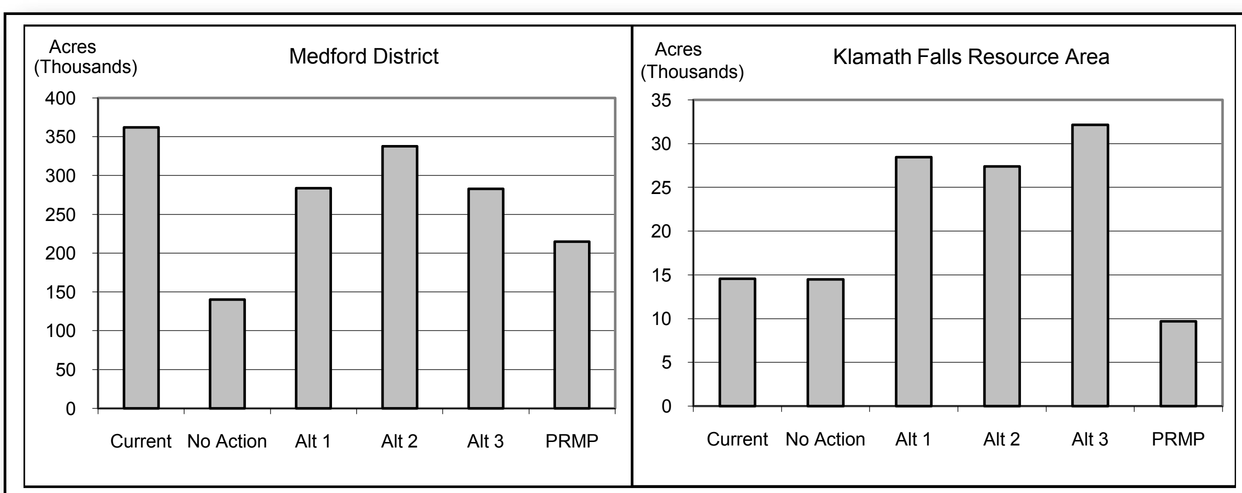


Figure 4-177. High Fire Severity And Hazard Trends For Southern Districts By Alternative



In the Klamath Falls Resource Area, the PRMP is the only alternative that would show a decrease in fire severity and hazard over time. The No Action Alternative would maintain fire severity and hazard approximately at current levels. Fire severity and hazard would increase from current conditions in the Klamath Fall Resource Area under Alternatives 1, 2, and 3. As discussed in *Chapter 3* in the *Forest Structure and Spatial Pattern* section, the forest structural stage classification in the Klamath Falls Resource Area under Alternative 3 is challenging and likely over-estimates the abundance of stand establishment forests over time. The stand establishment forests that would result from partial harvesting under Alternative 3 would differ in structure and fuel characteristics from the stand establishment forests that would be created under other alternatives, as described below. Therefore, the description of fire severity and hazard in the Klamath Falls Resource Area under Alternative 3 likely over-estimates the acreage of high fire severity and hazard over time. However, it is not possible at this scale of analysis to quantify more precisely the fire severity and hazard following partial harvesting under Alternative 3.

As in the Medford District, the change in fire severity and hazard in the Klamath Falls Resource Area would be consistent with the change in the acreage of the various structural stages. Under the PRMP, the application of uneven-age management would reduce the acres in stand establishment forest. The management action in the Uneven-Aged Timber Management Area would reduce understory vegetation with every entry, eliminating dense buildups of ladder fuels normally associated with even-aged plantations. This modification of fuel levels would reduce the likelihood of high severity fires under the PRMP.

The following assumptions were used in projecting fire resiliency and crown fire hazard in the Uneven-Age Timber Management Area of the PRMP in the Medford District and Klamath Falls Resource Area:

- Thinning or partial harvest would occur across all structure stage classifications.
- Small patches of group selection would occur that would not retain legacy trees.
- Legacy trees would be retained under a variable spacing and not clustered around the edges of regeneration units.
- Legacy trees would be a minimum of 16 inches in diameter.
- There would be a vertical separation between the canopies of the legacy trees and the understory of stand establishment and young forest.
- Understory thinning would occur.
- Surface fuels would be treated whenever a management action occurs that would increase existing surface fuel loads.

In general, leaving larger green trees would create a partially sheltered stand, which would materially alter the drying conditions of the stands. The more canopy that would remain, the less effect wind would have on drying fuels and surface fires. This reduction in mid-flame wind speed would reduce flame length, which can lead to a reduction in tree mortality(Fire Behavior Field Reference Guide: NFES 2224).

Frequent surface fires tend to favor the largest trees with the thickest bark (Hessburg et al. 2005). Large diameter trees (greater than 16 inches in diameter) have greater resistance to mortality from bole and crown scorch. The information in *Table 4-93* (*Probability of mortality by tree diameter in an extreme event*) was generated using the mortality module from the Behave Plus model under extreme burning conditions. This table shows expected mortality during a wildfire by diameter class and species. A lower probability of mortality equates to greater fire resiliency. *Table 4-93* displays the size and species of trees that promote fire resiliency.

A quantified comparison of crown fire hazard is not possible at this scale of analysis. Although the crown fire hazard cannot be analyzed quantitatively, there would be differences among the alternatives. The stand establishment and young forests created under the No Action Alternative, Alternative 1, and Alternative 2 would consist of even-aged plantations, which would be highly susceptible to stand-replacing crown fires, because even-aged plantations would have high canopy bulk density with continuous, single-storied

Table 4-93. Probability Of Mortality By Tree Diameter In An Extreme Fire Event

Medford, Douglas fir: Tree Diameter in inches	Probability of Mortality	Klamath Falls, Ponderosa: Tree Diameter in inches	Probability of Mortality
10	71	10	25
15	49	15	12
20	34	20	7
25	24	25	4
30	18	30	3
35	15	35	2
40	13	40	2

canopies without gaps. This would maintain or increase the crown fire hazard in the South. Alternative 3 would also create stand establishment and young forests, but there would be less crown fire hazard as a result of the use of partial harvest or uneven-aged management. Alternative 3 and the PRMP in the Uneven-Age Timber Management Area would increase the tree height-to-live crown ratio, create multiple-storied canopies with gaps, reduce canopy bulk density, and treat both surface and ladder fuels. All of these actions would increase fire resiliency. Any increase in wind or reduction of fuel moistures created by opening the canopy in the partial harvests would likely be offset by a reduction in fire severity and an increase in fire resiliency (Agee and Skinner 2005). As a combined result of the reduction in fire severity, increase in fire resiliency, and changes in stand canopy structure, Alternative 3 and the PRMP in the Uneven-Age Timber Management Area would be the only alternatives that would reduce crown fire hazard. Alternatives 1 and 2 would decrease fire resiliency from current conditions, and Alternatives 1 and 2 and the No Action Alternative would not alter stand canopy structure as described above, and therefore would not reduce crown fire hazard.

In the Medford District and Klamath Falls Resource Area, the No Action Alternative and Alternative 3 would increase the acreage of fire-resilient forest from current conditions, because they would create forests with structural legacies. Although the No Action Alternative would increase the acres of fire-resilient forest similar to Alternative 3, other aspects of fire resiliency would differ from Alternative 3. Similar to Alternatives 1 and 2, the No Action Alternative would create stand establishment and young forests, consisting of even-aged plantations that would be highly susceptible to stand-replacing crown fires as described above. The increased crown fire hazard under the No Action Alternative would partially offset the increase in fire resiliency from the retention of structural legacies.

Alternatives 1 and 2 would decrease the acres of fire-resilient forest from current conditions, because they would create forests without structural legacies, which would have lower fire resiliency compared to forests with such structural legacies. Increased crown fire hazard under Alternatives 1 and 2 would exacerbate the reduction in fire resiliency (resulting from stand establishment and young forests that lack structural legacies). Alternative 2 would have the greatest reduction in fire resiliency by creating the largest acreage of forest without structural legacies, combined with high crown fire hazard.

The PRMP would decrease the acres of fire-resilient forest in the Medford District overall and increase the acres of fire-resilient forest in the Klamath Falls Resource Area. In the Medford District under the PRMP, fire resiliency would increase over time in the Uneven-Age Timber Management Area, and decrease over time in the Timber Management Area. See *Figure 4-178 (Fire-resilient acres in the Medford District by land use allocation under the PRMP).* Fire resiliency would decrease in the Timber Management Area under the PRMP similarly to the Timber Management Area in Alternatives 1 and 2. As in Alternatives 1 and 2, the increased crown fire hazard in the Timber Management Area under the PRMP would exacerbate the reduction in fire resiliency. In the Uneven-Age Timber Management Area, the PRMP would reduce crown fire hazard by maintaining large trees while reducing crown bulk density, which would interact with the increase in fire-resilient acres to further improve overall fire resiliency. See *Figure 4-179* (*Comparison of fire-resilient acres by district and alternative*).

Figure 4-178. Fire-Resilient Acres In The Medford District By Land Use Allocation Under The PRMP

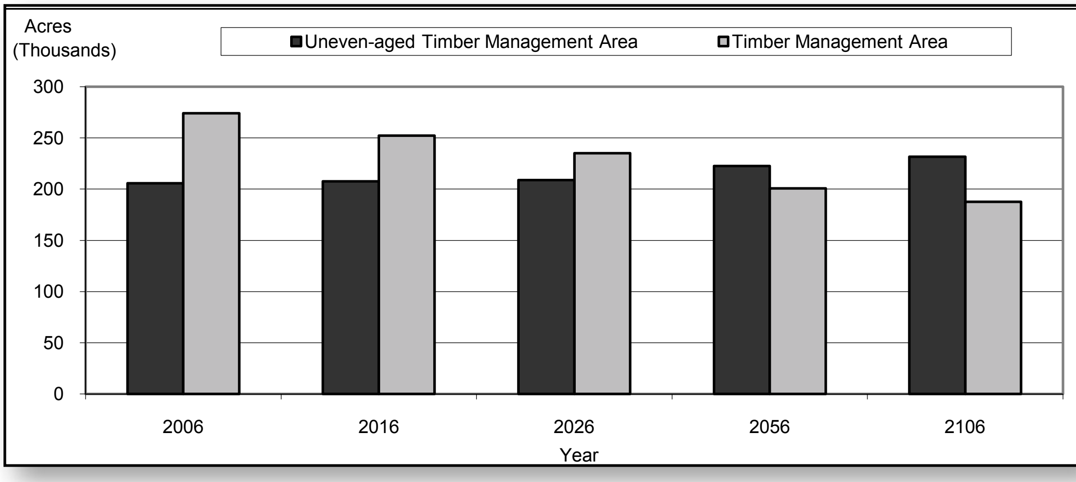
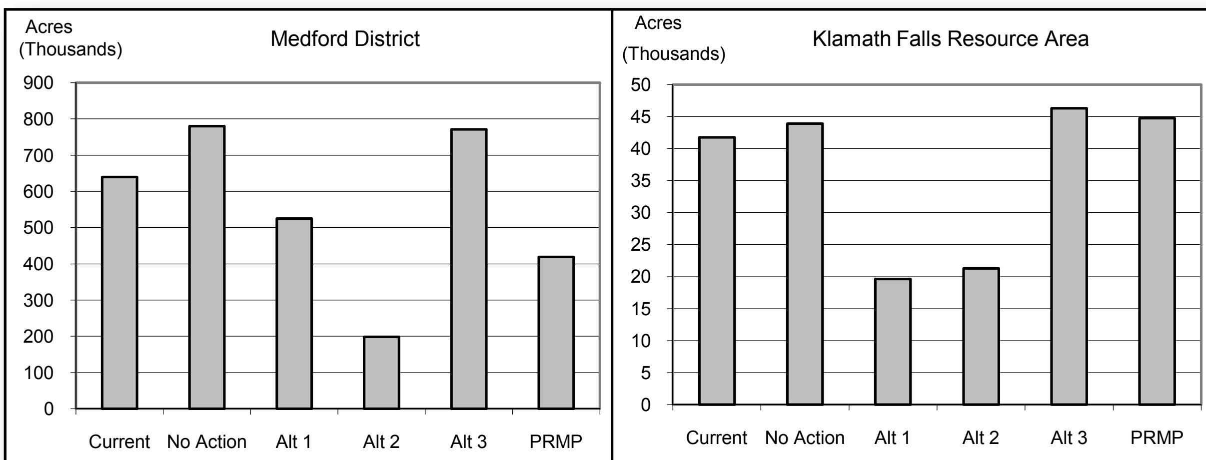


Figure 4-179. Comparison Of Fire-Resilient Acres By District And Alternative



Air

This analysis examines the effects of prescribed burning and wildfire on air quality that would result from the alternatives.

> ***Key Points***
>
> - Emissions from prescribed burning from all activities in the northern districts would be highest under Alternative 2, and lowest under the No Action Alternative. Emissions from prescribed burning from all activities in the southern districts would be highest under the PRMP, and lowest under the No Action Alternative.
> - Under all alternatives, compliance with the Oregon Smoke Management Plan would prevent particulate matter from prescribed burning from reaching levels considered a health hazard and would protect Class 1 visibility areas.

Prescribed burning for the purpose of hazardous fuels treatments and site preparation would be the only management action under the alternatives that would have a notable effect on air quality. This effect would be largely at the local level, because prescribed burning would be implemented in accordance with the Oregon Smoke Management Plan. Adhering to the guidance in the Oregon Smoke Management Plan minimizes smoke impacts from prescribed fires on local communities and directs smoke away from Smoke Sensitive Receptor Areas (see the *Air* section of *Chapter 3*).

The analysis of future emissions is based on the acreage treated and the amount of slash per acre expected to be burned in such treatments. The emissions shown in this analysis assume that all acres projected to receive treatment would be treated. This may overestimate actual emissions, because weather conditions and compliance with the Oregon Smoke Management Plan may prevent some treatments. Thus, the emissions from prescribed burning, which are based on an annual average of the first 10 years of activities projected under each alternative in this analysis, present an upper limit to what could reasonably be expected. The annual emissions would fluctuate in future decades, making it impossible to predict emissions into the future. However, the relative differences in emissions from prescribed burning forecast for the first decade among the alternatives would continue in future decades.

The acreage of BLM-administered lands that would be burned by prescription for the purpose of hazardous fuels treatment would remain at current levels in the northern districts (Salem, Eugene, Roseburg, and Coos Bay Districts) under all alternatives. Therefore, emissions from hazardous fuels treatments would not vary in the northern districts among the alternatives. The hazardous fuels treatment acreage would remain at current levels in the southern districts (Medford District and Klamath Falls Resource Area) under all alternatives except the PRMP, under which the hazardous fuels treatment acreage would increase from current levels.

Emissions from the treatment of timber harvest units would vary by alternative, because both the acreage treated and the slash per acre would vary by alternative. Therefore, the total emissions from all activities would vary by alternative. See *Table 4-94* (*Annual emissions from prescribed burning from all activities on BLM-administered lands*). At this scale of analysis, it is not possible to relate the average annual emissions from prescribed burning under the alternatives to standards of the Environmental Protection Agency (EPA) for particulate matter (PM) 2.5 or PM 10, which are defined at the scale of cubic meters. How emissions from a specific prescribed burn would relate to EPA standards would depend on highly localized conditions, weather conditions, and project-specific features that cannot be predicted at this scale of analysis. Whether such emissions would actually cause any health or visibility concerns cannot be assumed from the projections of annual emissions at the plan level. Compliance with the Oregon Smoke Management Plan would prevent particulate matter caused by prescribed burning from reaching levels considered a health hazard and would protect Class 1 visibility areas.

Under the No Action Alternative, annual PM10 emissions from prescribed burning in the northern districts would be a substantial increase from current emissions. Annual emissions in southern districts would also increase from current emissions. These increased emissions would result from the difference between the actual implementation of the 1995 resource management plans over the past 10 years, and the management actions and analytical assumptions in those plans regarding timber harvest methods. Implementation of the 1995 district resource management plans has resulted in not only less overall timber harvest than anticipated, as described in *Chapter 1*, but also disproportionately less regeneration harvest than anticipated in the 1995 RMPs. The analysis in this EIS of the future effects of the No Action Alternative assumes that the management actions and analytical assumptions described in the 1995 resource management plans regarding timber harvest methods would be implemented in the future (see the *Timber* section of *Chapter 4*). Therefore, the analysis in this EIS assumes that more regeneration harvest would occur under the No Action Alternative than has been implemented over the past 10 years, and concludes that emissions from treatment of timber harvest units would increase under the No Action Alternative from current levels.

Alternative 1 would have more emissions than the No Action Alternative, because Alternative 1 would have more acres of regeneration harvest, which would create heavier slash loadings than thinning and would be treated with prescribed burning.

Alternative 2 would have more emissions than any other alternative, because Alternative 2 would have the most acres of regeneration harvest.

Alternative 3 would have more emissions than the No Action Alternative, but less than Alternative 1, Alternative 2, and the PRMP. This difference would result from the interaction of the large acreage of partial harvest under Alternative 3 and the lower amounts of slash that would result from partial harvest compared to regeneration harvest. Alternative 3 would have little regeneration harvest in the first 10 years. However, the partial harvest acreage under Alternative 3 would be greater than the regeneration harvest acreage in the Roseburg and Medford Districts under all alternatives, and similar or greater than the regeneration harvest acreage in all districts under the No Action Alternative (see the *Timber* section of *Chapter 4*). Partial harvest would produce less slash per acre than regeneration harvest and therefore lower emissions per acre.

Table 4-94. Annual Emissions From Prescribed Burning From All Activities On BLM-Administered Lands

Annual Particulate Emissions (tons/year)						
PM 10 Emissions						
BLM Districts	**Current[a]**	**No Action[b]**	**Alt. 1**	**Alt.2**	**Alt.3**	**PRMP**
Northern Districts	368	3,443	4,090	7,414	3,979	4,989
Southern Districts	1,486	2,004	3,094	3,137	3,138	3,975
PM 2.5 Emissions						
Northern Districts	225	2,410	2,863	5,189	2,785	4,203
Southern Districts	930	1,402	2,004	2,195	1,949	2,782

[a]Average emissions over the past 10 years of implementing the current RMPs, which has included less regeneration harvest than assumed in the RMPs and less total harvest volume than the declared ASQ.

[b]Average emissions modeled into the future for implementing the current RMPs as they are written, including assumptions about the mix of harvest types. In addition, these emissions are based on the adjustment of the ASQ under the No Action Alternative described in the *Timber* section of *Chapter 4*.

The PRMP would have more emissions in the northern districts than the No Action Alternative and Alternatives 1 and 3, because the PRMP would have more acres of regeneration harvest. The PRMP would have more emissions in the southern districts than the No Action Alternative and Alternatives 1 and 3, because the PRMP would have more emissions from both hazardous fuels treatments and timber harvest units. The PRMP would have more acres of regeneration harvest than the No Action Alternative and would also treat areas of uneven-aged management with prescribed fire treatments. In addition, the acres of hazardous fuels treatment would be higher under the PRMP than all other alternatives, as described above.

The analysis in this EIS assumes that emissions from prescribed burning on all other lands would maintain their current levels. There is no information on which to model future changes in emissions from other ownerships, because it would be speculative to assume changes in acres harvested or treated on other ownerships, and there is no specific data available on slash per acre on other ownerships. Nevertheless, the broad assumptions are sufficient to provide context for evaluating the relative effect of the different BLM management actions on the total emissions across all ownerships. If emissions from other landowners remain at current levels, based on the average annual emissions over the past 10 years, total emissions from non-BLM-administered lands from prescribed burning would be 15,119 tons of PM 10, of which 9,076 tons would be PM 2.5. When combined with current emissions from BLM-administered lands, based on the average annual emissions over the past 10 years, total emissions from all ownerships from prescribed burning would be 17,009 tons of PM 10, of which 10,254 tons would be PM 2.5. When combined with the future emissions from BLM-administered lands under each alternative, the cumulative total emissions for the entire planning area would range from 20,566 tons of PM 10 and 12,888 tons of PM 2.5 under the No Action Alternative, to 25,670 tons of PM 10 and 16,460 tons of PM 2.5 under Alternative 2. The PRMP would contribute total emissions that would be less than under Alternative 2, but more than under all other alternatives. See *Table 4-95 (Annual emissions from prescribed burning from all activities on all ownerships).*

Wildfire emissions are greater than those from prescribed burning (Huff 1995). For example, the Timbered Rock wildfire produced an estimated 12,000 tons of PM 10 emissions and 11,000 tons of PM 2.5 over a two-month period. These emissions over two months from one wildfire were more than the annual emissions that would occur from prescribed fire for all BLM-administered lands in the planning area under any of the alternatives. The prediction of the amount of emissions from future wildfires would be speculative, because the location, timing, severity, and extent of future wildfires cannot be reasonably foreseen (see the *Introduction* of *Chapter 4*). There is no basis for belief that future emissions from wildfire would vary among the alternatives. Therefore, future wildfire emissions do not provide a reasonable basis for choice among the alternatives. Wildfires and prescribed burns do not usually occur at the same time, and smoke produced from wildfires would dissipate before smoke would be produced from prescribed burns. Therefore, there would be no cumulative effect of the emissions from these two sources.

Smoke from prescribed burning and wildfire has potential indirect effects on human health. Whether smoke from prescribed burning or wildfire would result in health effects would depend on site-specific conditions and weather, which cannot be predicted at this level of analysis. In the planning of implementation-level prescribed burning projects, site-specific effects would be considered, and mitigation measures to reduce or avoid health effects from smoke could be designed.

Table 4-95. Annual Emissions From Prescribed Burning From All Activities On All Ownerships

	Annual Emissions (tons/year)					
Particulate Emissions Level	Current	No Action	Alt. 1	Alt. 2	Alt. 3	PRMP
PM 10	17,009	20,566	22,303	25,670	22,236	24,083
PM 2.5	10,254	12,888	13,943	16,460	13,810	16,061

There are many pollutants associated with smoke, but the primary pollutant of concern from both wildfire and prescribed fire is particulate matter. The health effects of smoke vary from the irritation of the eyes and respiratory tract to more serious disorders, including asthma, bronchitis, reduced lung function, and premature death. Studies have found that fine particulate matter (PM 2.5) is linked (alone or with other pollutants) to a number of significant respiratory-related and cardiovascular-related effects, including increased mortality and the aggravation of existing respiratory and cardiovascular diseases (Therriault 2001). Airborne particles are respiratory irritants, and laboratory studies show that high concentrations of particulate matter cause persistent coughing, phlegm, wheezing, and physical discomfort in breathing (Therriault 2001).

Particulate matter can also alter the body's immune system and affect the removal of foreign materials, such as pollen and bacteria, from the lungs (Therriault 2001). Smoke from prescribed burning and wildfire also contains carbon monoxide. The health threat from lower levels of carbon monoxide is most serious for those who suffer from cardiovascular disease. At higher levels, carbon monoxide exposure can cause headaches, dizziness, visual impairment, reduced work capacity, and reduced manual dexterity. For the general population, levels of carbon monoxide would not rise to the level to be considered a health hazard (Therriault 2001). People exposed to toxic air pollutants at sufficient concentrations and durations may have an increased chance of cancer or other serious health problems.

Smoke from prescribed burning under all alternatives would have the potential to reach nuisance levels for a short duration in a highly localized area. However, compliance with the Oregon Smoke Management Plan under all alternatives would prevent particulate matter from reaching levels that would be considered a health hazard and would protect Class 1 visibility areas.