Fish

Key Points

- There are eight anadromous fish populations and four resident fish population segments that occur on BLM-administered lands within the planning area that are listed as threatened or endangered under the Endangered Species Act. Habitat degradation is a factor of decline for most of these populations, and is a major risk factor that continues to threaten all of the population segments.
- Large wood, stream temperature, sediment, and water flow have the greatest influence on aquatic habitat and the ability of aquatic habitat to support fish populations.
- The abundance and survival of salmonids is often closely linked to the abundance of large woody debris in stream channels. The current amount of large woody debris in streams is low and hinders recovery of salmonid populations.
- Eighty-one percent of sampled stream channels on BLM-administered lands in the planning area had low levels (<22%) of fine sediment, and 19% of stream channels had higher levels (>22%).
- The past land use practices that most severely degraded fish habitat (stream cleaning and building of splash dams) no longer occur. Additionally, improvements in road construction and grazing practices have reduced or eliminated adverse effects to fish habitat on BLM-administered lands.

This section focuses on the current condition of fish habitat in the planning area and the ecosystem processes that can affect fish habitat.

Aquatic ecosystems within the planning area include (USDA USFS and USDI BLM 1994b):

- large river systems (e.g., the Rogue, Umpqua, Klamath and Columbia rivers)
- small headwater streams
- coastal rain-influenced streams
- lakes and ponds
- wetlands

Threatened/Endangered Fish

Within the planning area, there are eight anadromous fish population segments that are listed as threatened or endangered under the Endangered Species Act:

- *Lower Columbia River Chinook*
- *Lower Columbia River Coho*
- *Lower Columbia River Steelhead*
- *Columbia River Chum*
- *Upper Willamette River Chinook*
- *Upper Willamette River Steelhead*
- *Southern Oregon/Northern California Coho*
- *Oregon Coast Coho*

There are four resident fish populations that are listed as threatened or endangered under the Endangered Species Act within the planning area:

- *Columbia River and Klamath River bull trout*
- *Lost River sucker*
- *Shortnose sucker*
- *Oregon chub*

The Columbia River chum salmon and the Oregon chub do not occur on any BLM-administered lands in the planning area. The Columbia River and Klamath River bull trout occur on less than eight miles of BLM-administered lands.

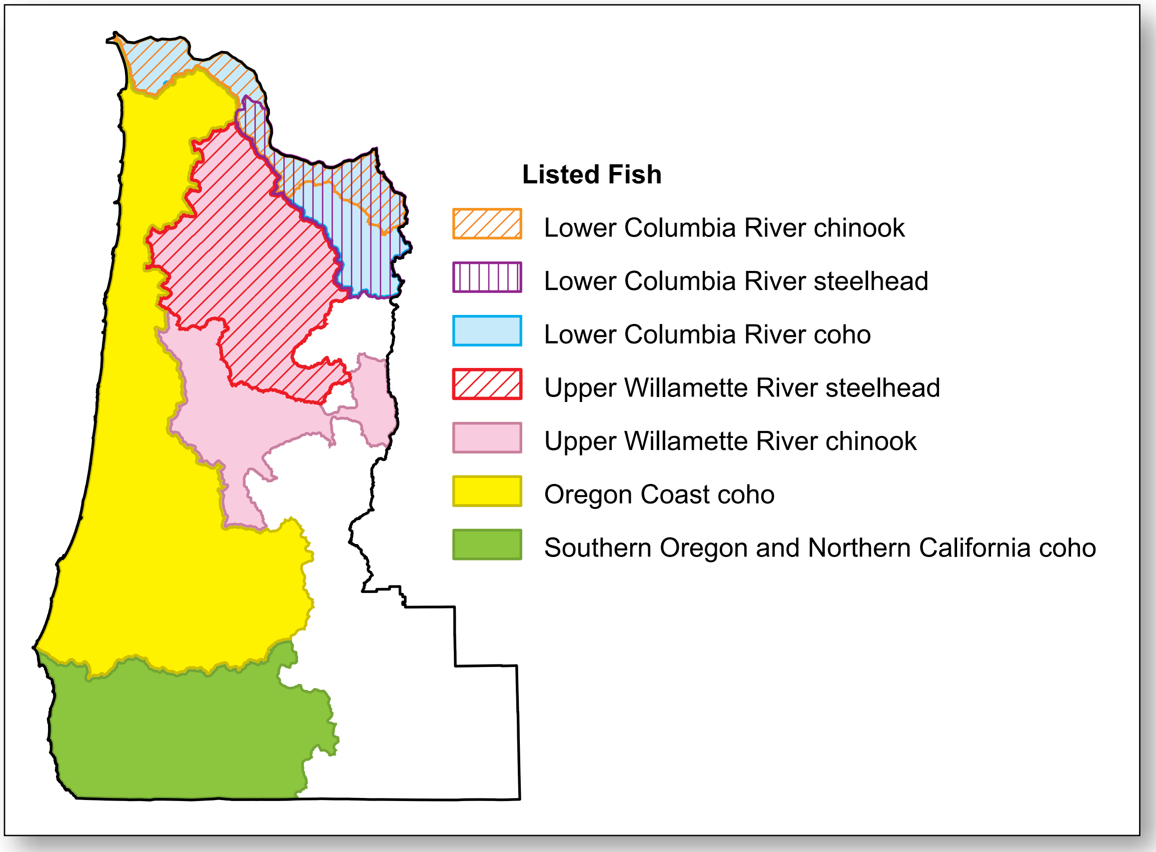
See *Appendix I - Water* for a list of fish species and stream miles on all streams on BLM and non-BLM administered lands in the planning area.

See *Figure 3-94* (*Listed anadromous fish populations and evolutionary significant units within the planning area)* *Figure 3-95* (*Bull trout distribution in the planning area)* and *Figure 3-96 (Lost River and shortnose sucker distribution in the planning area*) for the evolutionary significant unit and distinct population segment boundaries within the planning area.

Evolutionary significant unit

A population of an organism that is considered distinct for the purposes of conservation under the Endangered Species Act. Such a distinct population can be a species, subspecies, variety, geographic race, or population.

Figure 3-94. Listed Anadromous Fish Evolutionary Significant Units And Distinct Population Segments In The Planning Area



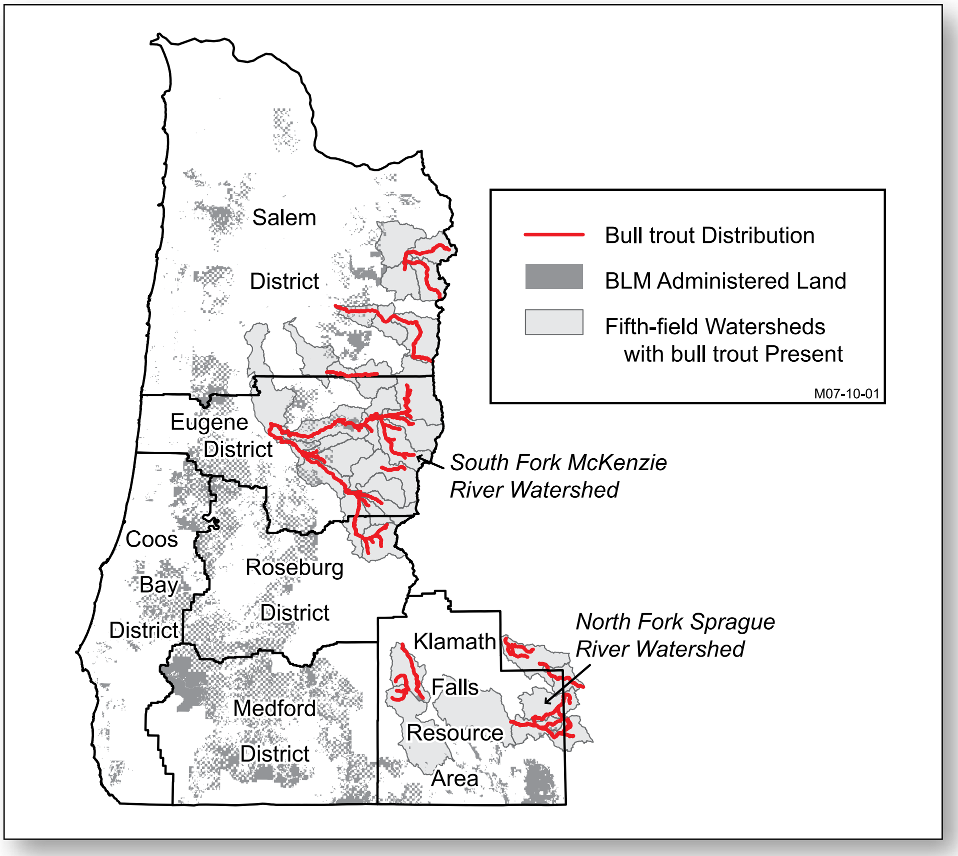


Figure 3-95. Bull Trout Distribution In The Planning Area

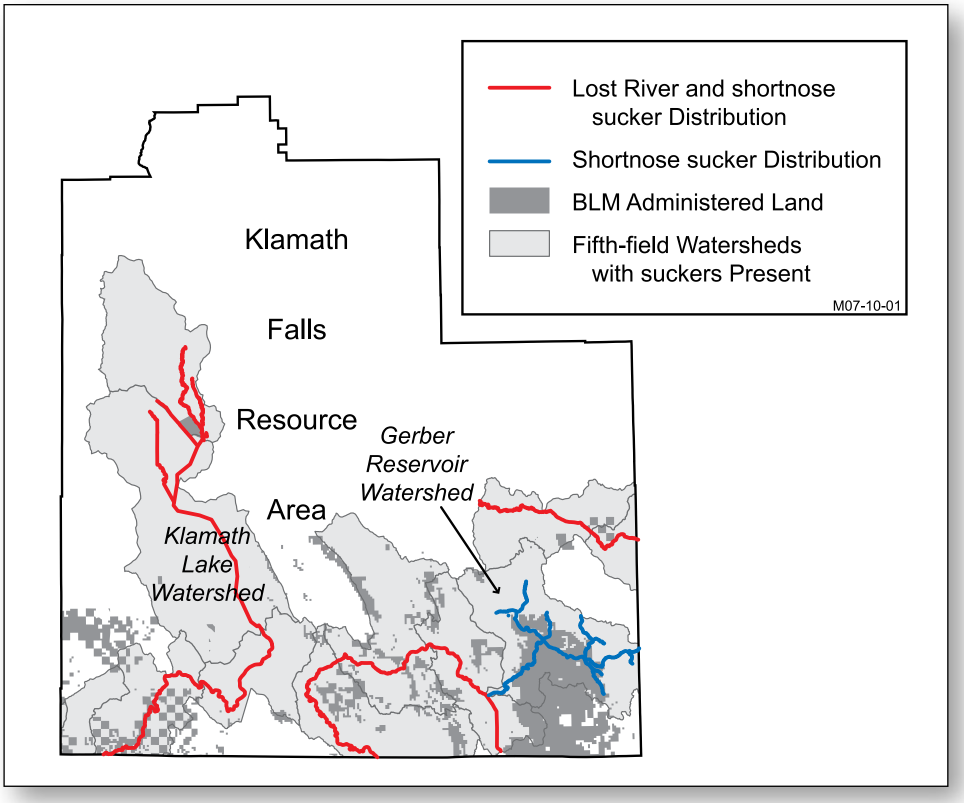


Figure 3-96. Lost River And Shortnose Sucker Distribution In The Planning Area

Fish Habitat

Critical habitat is designated for the following fish species within the planning area (Federal Register 2005d, Federal Register 2008):

- Lower Columbia River Chinook
- Lower Columbia River Steelhead
- Columbia River Chum
- Upper Willamette River Chinook
- Upper Willamette River Steelhead
- Southern Oregon/Northern California Coast Coho
- Oregon Coast Coho

Columbia River and Klamath River bull trout critical habitat is designated only on non-federal lands in the planning area. Critical habitat has not been designated for the Lower Columbia River Coho, Lost River sucker, or shortnose sucker.

The National Marine Fisheries Service Critical Habitat Analytical Review Team (CHART) rated fifth-field watersheds in Oregon and Washington as having a high, medium, or low conservation value for Endangered Species Act listed salmonids (USDC NOAA 2005). As described in the final rule, the Critical Habitat Analytical Review Team information was used to support the designation of critical habitat and for the development of recovery plans for Endangered Species Act listed salmonids (except Southern Oregon/Northern California Coast Coho). In general, watersheds with medium or high conservation values were designated as critical habitat. Out of 748 fifth-field watersheds containing anadromous fish habitat, 678 (90%) have a medium or high conservation value. Three figures on fifth-field watersheds and high intensity potential for coho, chinook and steelhead (a few pages later in this section) provide illustrations of Critical Habitat Analytical Review Team watersheds and their conservation rating for each evolutionary significant unit and distinct population segment.

This analysis (see the *Fish* section of *Chapter 4*) determines the effect of each alternative on fish habitat using current fish distribution data. Designated critical habitat for listed fish is encompassed within this analysis because the distribution data used for all fish species is greater than the extent of designated critical habitat.

Fish populations are cyclic by nature and trends can be driven by a variety of factors. Those fish species within the planning area that have been listed as threatened or endangered have been listed as a result of the following factors (Good et al. 2005):

- habitat degradation and loss
- hydropower development
- over-harvest
- hatchery propagation

A biological review team, consisting of scientists from the National Marine Fisheries Service and the Southwest Fisheries Science Centers, updated biological information for the listed salmon and steelhead evolutionary significant units and distinct population segments. This team made conclusions regarding the current and future major risk factors for each evolutionary significant unit (Good et al. 2005). See *Table 3-62 (Major risk factors by evolutionary significant units and distinct population segments).*

Habitat degradation is a factor of decline for all the listed fish species and is a major risk factor that continues to threaten fish populations.

Currently, the Lost River and shortnose sucker occupy only a fraction of their historic range and are restricted to a few areas in the Upper Klamath Basin (i.e., the drainages of the Upper Klamath, Tule, and

Table 3-62. Major Risk Factors By Evolutionary Significant Unit And Distinct Population Segments

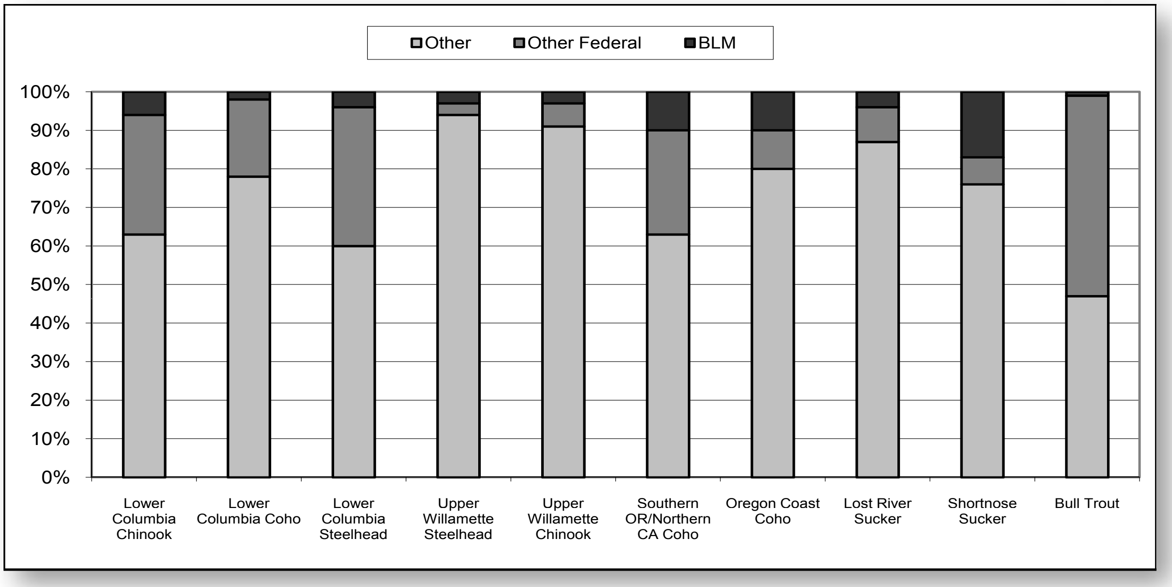
Evolutionary Significant Units and Distinct Population Segments	Major Risk Factors
Bull trout	• Barriers • Habitat degradation
Lower Columbia River chinook salmon	• Habitat degradation • High hatchery production
Lower Columbia River chum	• Unknown
Lower Columbia River coho	• Habitat degradation • High hatchery production
Lower Columbia River steelhead	• Dams • Habitat degradation • High hatchery production
Oregon Coast coho	• Habitat degradation • Over-utilization (fish harvest) • Disease or Predation
Shortnose and Lost River suckers	• Habitat degradation • Water quality
Southern Oregon and northern California coho	• Habitat degradation
Upper Willamette River chinook salmon	• Dams • Habitat degradation • High hatchery production
Upper Willamette River steelhead	• Dams • Habitat degradation

Clear lakes). Poor water quality, reduced suitable habitat for all sizes and ages, and the impacts of non-native fish continue to threaten remaining Lost River and shortnose sucker populations (USDI USFWS 2003d). Although numerous factors have contributed to the decline of these species, habitat degradation is considered the primary cause. Streams, rivers, and lakes have been modified by channelization and dams. Grazing in the riparian zone has eliminated streambank vegetation and has added nutrients and sediment to river systems (USDI USFWS 2003d).

Recovery plans have been established for populations of the bull trout (Federal Register 2005d), Lost River sucker, and the shortnose sucker (USDI USFWS 1993). Recovery plans are in progress for the other evolutionary significant unit and distinct population segments.

Past management activities have degraded aquatic and riparian conditions and contributed to declines in fish populations. Aquatic habitat improvement projects have been completed, but additional opportunities exist across the landscape to continue improving conditions and further contribute to restoring impaired ecological processes (see *Aquatic Restoration* later in this section). The BLM can contribute to improving fish habitat, but the BLM within the planning area is rarely the predominant landowner in a fifth-field watershed. See *Figure 3-97* (*Percentage of miles of fish-bearing streams by ownership and evolutionary significant unit/distinct population segment within the planning area.*). Limiting factors (habitat and non-habitat) for listed fish species may continue regardless of the BLM's contribution to improving habitat trends because of the other influences on the populations and their habitat.

Figure 3-97. Percentage of miles of fish-bearing streams by ownership and evolutionary significant unit and distinct population segments within the planning area



* Data not available for cutthroat trout and other fish species that would have a greater extent than anadromous fish on BLM-administered land because of their occupancy above barriers for anadromous fish.

Because of BLM's land ownership pattern, the BLM's ability to influence aquatic habitat depends not only on the overall amount of land ownership in a watershed, but also on the location of the ownership relative to areas such as high intrinsic potential streams. High intrinsic potential (HIP) streams are streams that have a greater potential to provide high-quality habitat for salmonids. High intrinsic potential is a topographical approach developed by Pacific Northwest Research Station scientists using empirical evidence and attributes of topography and flow to determine the potential of a stream to provide high-quality juvenile salmonid habitat. See *Appendix I - Water*.

The Pacific Northwest Research Station assisted the BLM with development of the Intrinsic Potential model for all chinook, coho, and steelhead streams on BLM-administered lands and non BLM-administered lands within the planning area. This coordination was done to provide comprehensive information on the location of stream reaches having the greatest potential to provide high-quality habitat for salmonids, which was generally missing within the planning area. The BLM is solely responsible for interpretation of the results. The high intrinsic potential model is used in the FEIS to evaluate the location of the high intrinsic streams relative to BLM land ownership patterns, the BLM's ability to influence high intrinsic potential stream channels that have a greater intrinsic potential to provide high-quality habitat for salmonids (Burnett et al. 2007), and the potential and feasibility of aquatic restoration relative to landscape characteristics. See *Figure 3-98 (Percent of high intrinsic potential stream miles by ownership)* and *Figure 3-99 (Percentage of miles of high intrinsic potential streams by ownership and evolutionary significant unit/distinct population segments)*. High intrinsic potential streams have not been determined for Bull trout, Lost River suckers, shortnose suckers, or other special status fish species.

High intrinsic potential reflects the potential of the stream channel to support fish, but is not an indicator of current fish presence or current fish productivity. Current fish distribution or productivity may not correlate with high intrinsic potential streams because of poor water quality, or the current stream condition may lack habitat complexity, or fish passage barriers may prevent fish from reaching high intrinsic potential stream reaches. Therefore, lower intrinsic potential reaches in some locations currently have greater fish densities and productivity than high intrinsic reaches.

Figure 3-98. Percent of High Intrinsic Potential Stream Miles By Ownership

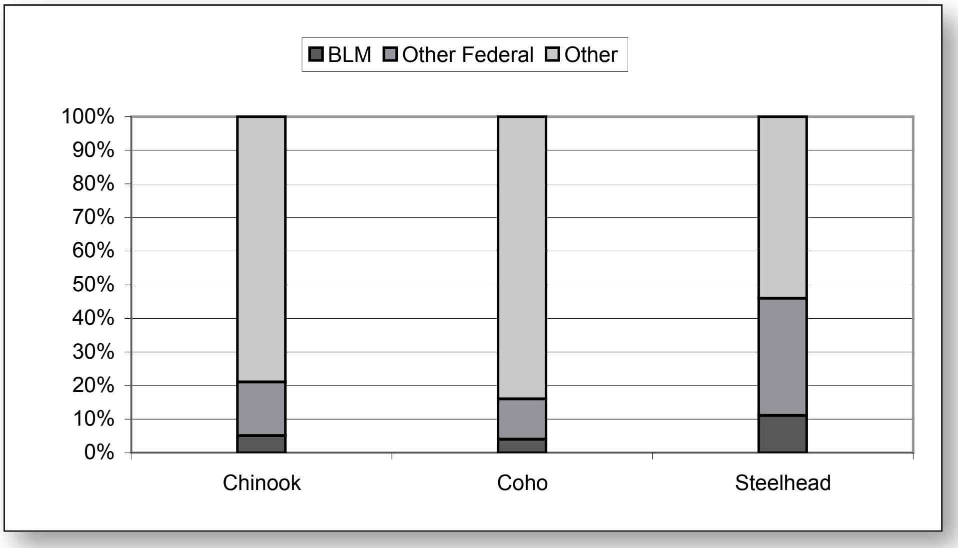
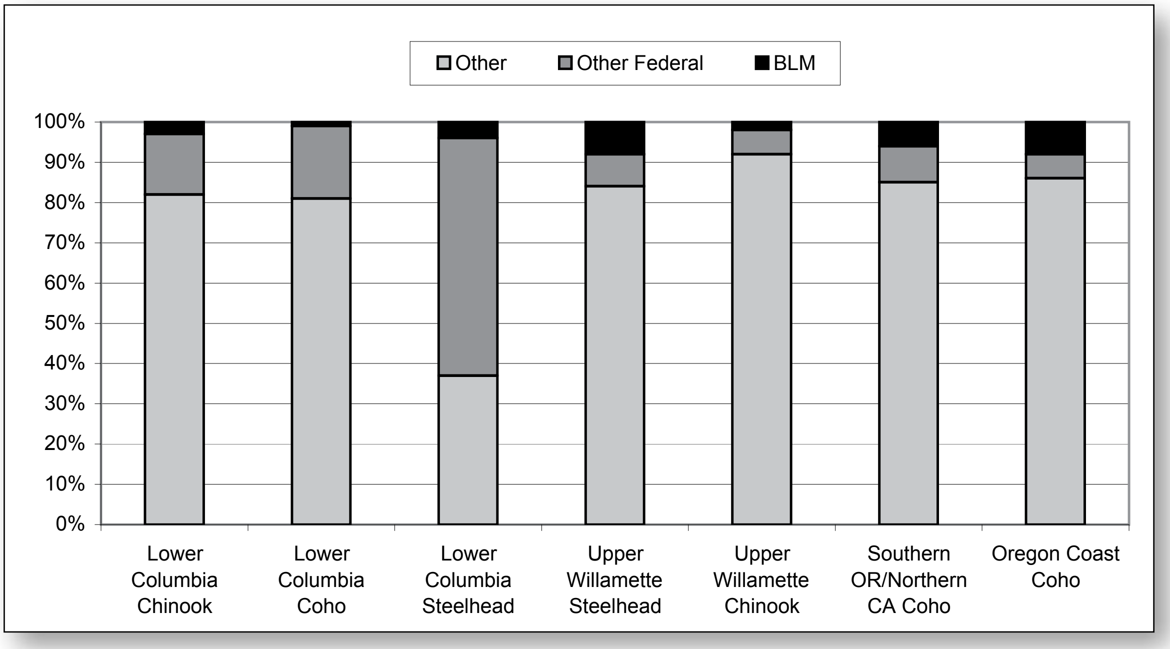
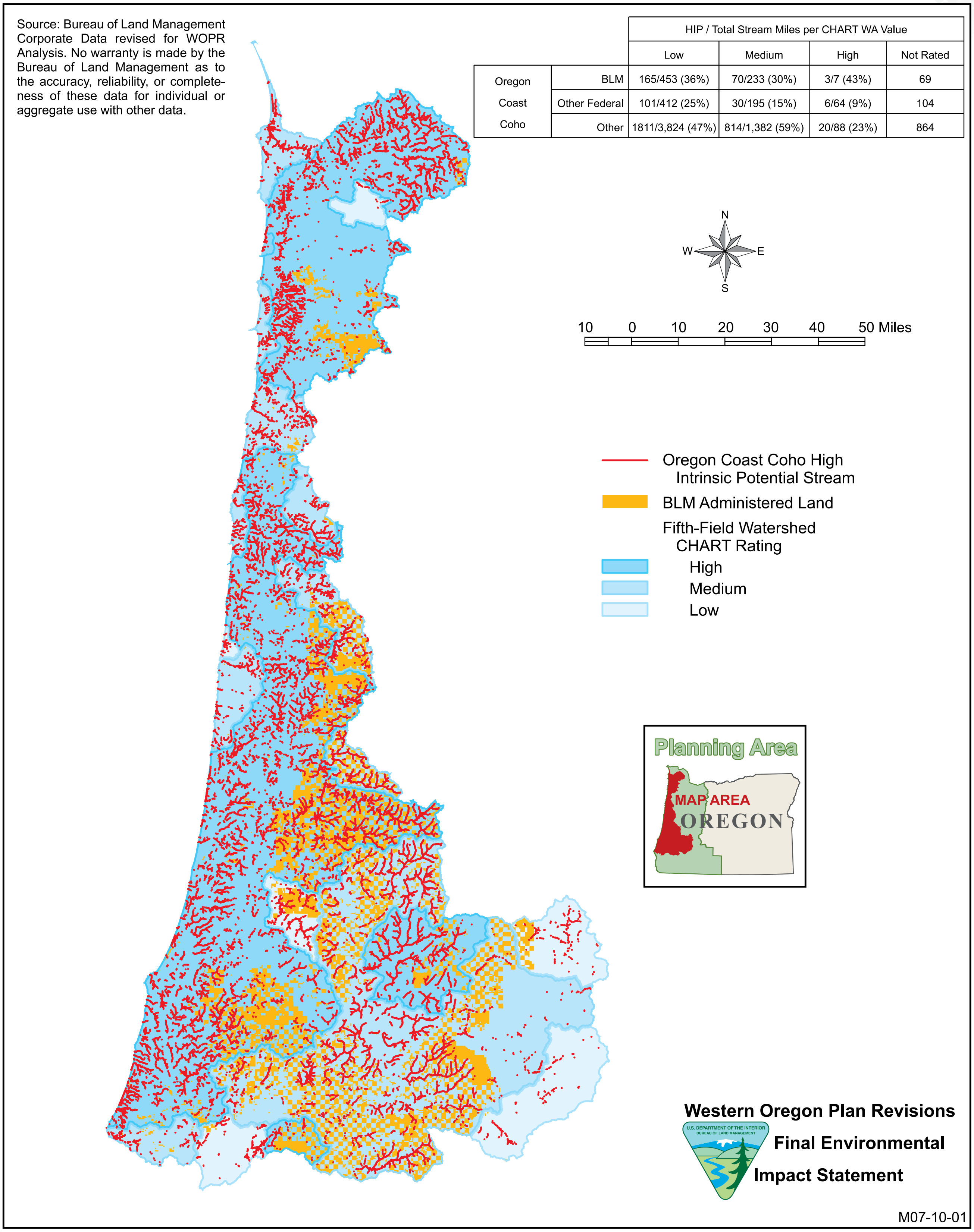


Figure 3-99. Percentage Of Miles Of High Intrinsic Potential Streams By Ownership And Evolutionary Significant Units/Distinct Population Segments Within The Planning Area



High intrinsic streams are not always the same as the fifth-field watersheds with high conservation value ratings that were identified by the National Marine Fisheries Service Critical Habitat Analytical Review Team (CHART). See *Figures 3-100, 3-101, and 3-102 (Comparisons of CHART-rated fifth-field watersheds and high intrinsic potential streams for coho, chinook and steelhead*). These figures show that on BLM-administered lands, the greatest percent of high intrinsic potential stream channels occurs in watersheds with a low or medium conservation value (or not rated), and the lowest amount of high intrinsic potential streams occurs in watersheds with a high conservation value.

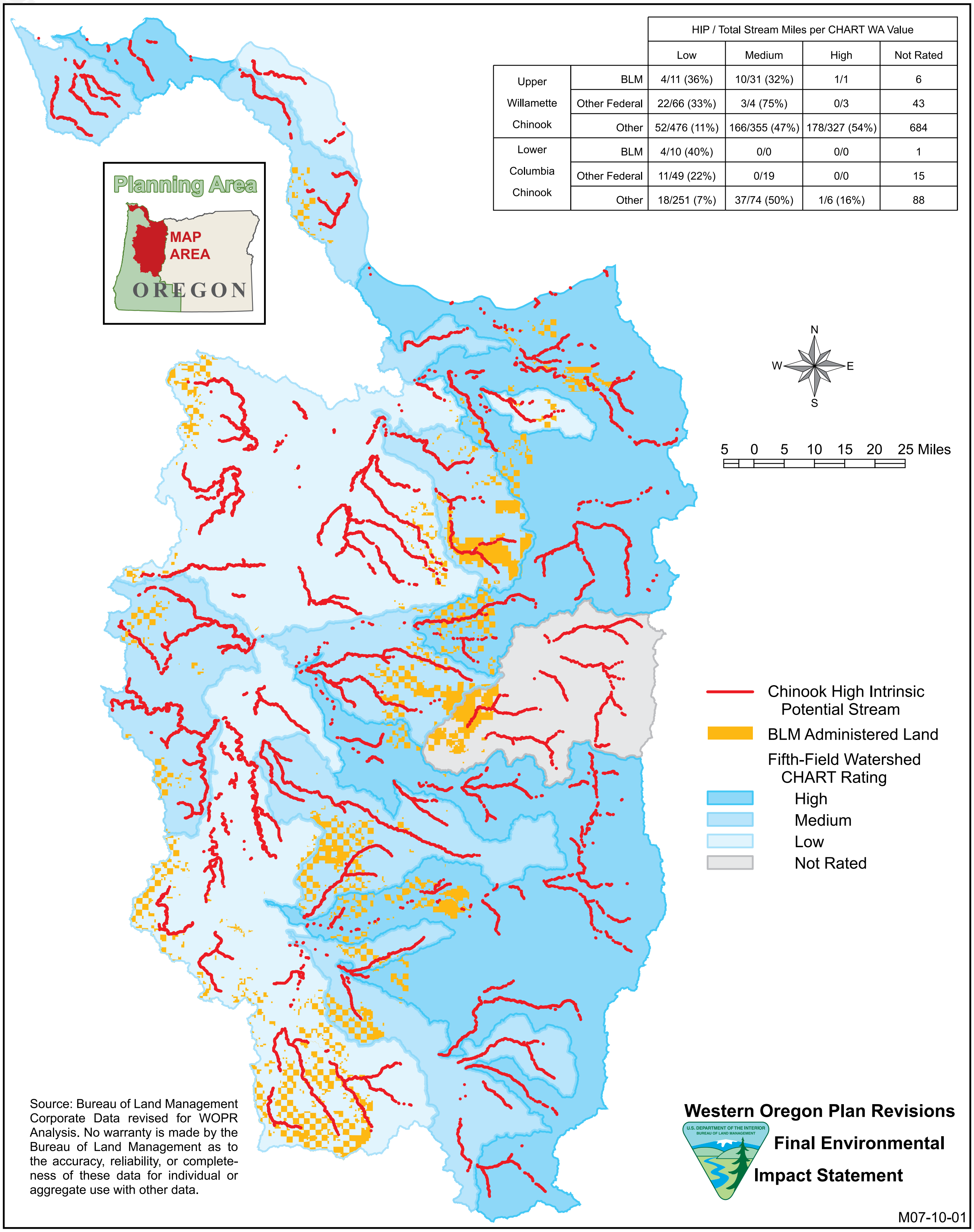
Figure 3-100. Comparison Of CHART-Rated Fifth-Field Watersheds And High Intrinsic Potential Streams For Coho



Source: Bureau of Land Management Corporate Data revised for WOPR Analysis. No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.

		HIP / Total Stream Miles per CHART WA Value			
		Low	Medium	High	Not Rated
Oregon Coast Coho	BLM	165/453 (36%)	70/233 (30%)	3/7 (43%)	69
	Other Federal	101/412 (25%)	30/195 (15%)	6/64 (9%)	104
	Other	1811/3,824 (47%)	814/1,382 (59%)	20/88 (23%)	864

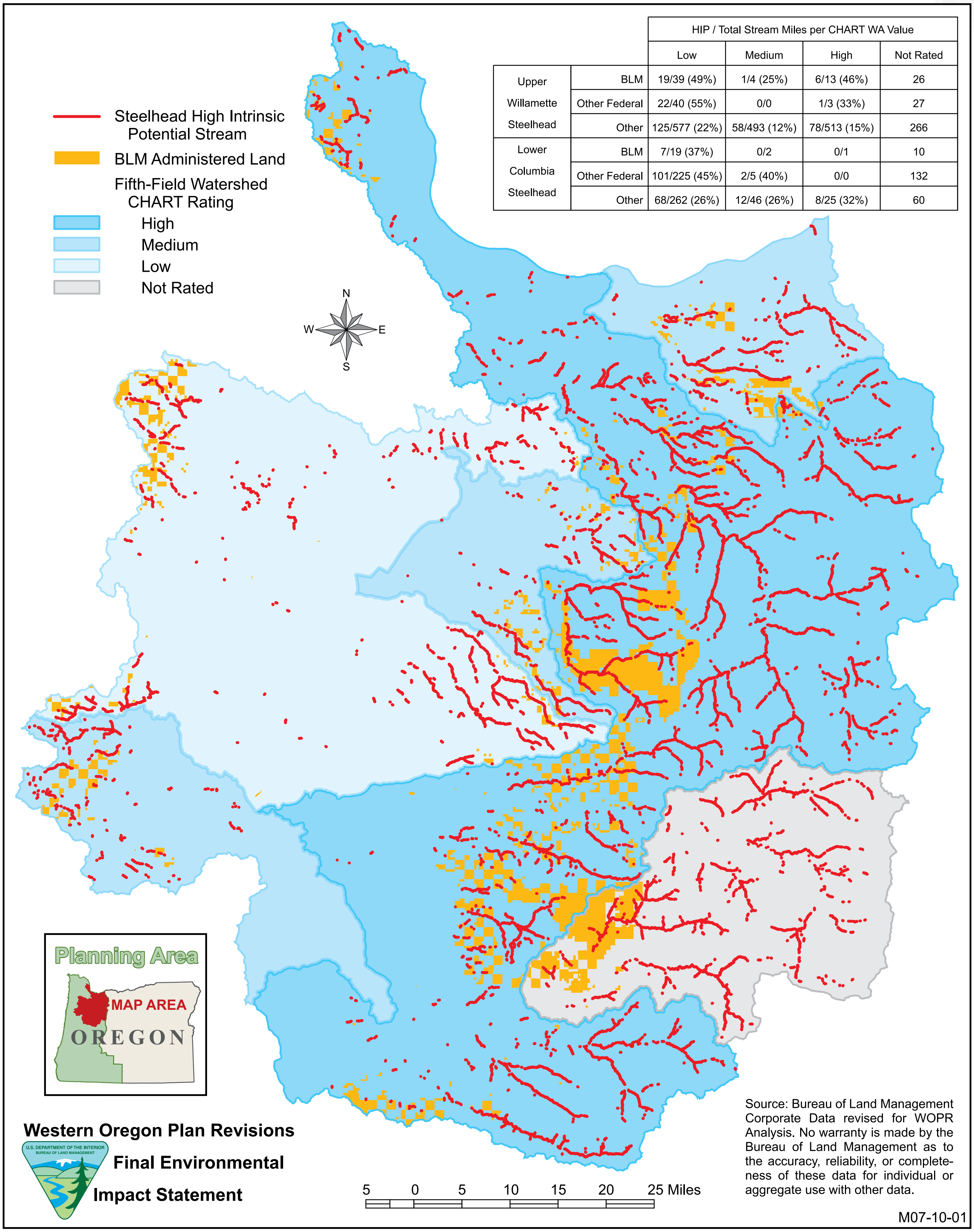
Figure 3-101. Comparison Of CHART-Rated Fifth-Field Watersheds And High Intrinsic Potential Streams For Chinook



		HIP / Total Stream Miles per CHART WA Value			
		Low	Medium	High	Not Rated
Upper Willamette Chinook	BLM	4/11 (36%)	10/31 (32%)	1/1	6
	Other Federal	22/66 (33%)	3/4 (75%)	0/3	43
	Other	52/476 (11%)	166/355 (47%)	178/327 (54%)	684
Lower Columbia Chinook	BLM	4/10 (40%)	0/0	0/0	1
	Other Federal	11/49 (22%)	0/19	0/0	15
	Other	18/251 (7%)	37/74 (50%)	1/6 (16%)	88

Source: Bureau of Land Management Corporate Data revised for WOPR Analysis. No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.

FIGURE 3-102. COMPARISON OF CHART-RATED FIFTH-FIELD WATERSHEDS AND HIGH INTRINSIC POTENTIAL STEAMS FOR STEELHEAD



		HIP / Total Stream Miles per CHART WA Value			
		Low	Medium	High	Not Rated
Upper Willamette Steelhead	BLM	19/39 (49%)	1/4 (25%)	6/13 (46%)	26
	Other Federal	22/40 (55%)	0/0	1/3 (33%)	27
	Other	125/577 (22%)	58/493 (12%)	78/513 (15%)	266
Lower Columbia Steelhead	BLM	7/19 (37%)	0/2	0/1	10
	Other Federal	101/225 (45%)	2/5 (40%)	0/0	132
	Other	68/262 (26%)	12/46 (26%)	8/25 (32%)	60

Source: Bureau of Land Management Corporate Data revised for WOPR Analysis. No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.

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For this analysis, high intrinsic potential is used to identify streams with the greatest potential to support salmonids, as well as areas where BLM-administered lands would have the greatest influence on fish habitat. High intrinsic potential is primarily used in the analysis because it is based on empirical evidence from published studies regarding relationships between stream attributes and juvenile fish. Conversely, the National Marine Fisheries Service CHART rated fifth-field watersheds using a delphi multi-factor scoring system approach, based on the presence of primary constituent elements in the watershed, information regarding fish populations in each watershed, and the "benefit of designation." The benefit of designation is determined on the likelihood that Section 7 consultations, which are required by the Endangered Species Act, occur in the watershed. The benefit of designation is based on a watershed's profile, which is used to determine if the watershed has "low leverage." Low leverage watersheds are those with less than 25% federal ownership, no hydropower dams, and no consultations likely to occur on instream work (USDC NOAA 2005). These attributes were chosen because "federal lands, dams and instream work all have a high likelihood of consultation, and activities undergoing consultation have a potential to significantly affect the physical and biological features of salmon and steelhead habitat" (USDC NOAA 2005). If watersheds were determined to have low leverage, the benefit of designation was lowered or watersheds were excluded from designation (USDC NOAA 2005).

Key Ecological Processes

Aquatic ecosystems are dynamic environments, changing over time due to natural disturbances. Recognizing that dynamic processes such as periodic large disturbances can have big impacts on aquatic ecosystems represents a relatively new perspective (Naiman et al. 1992). This perspective implies that aquatic ecosystems and their conditions vary because of such periodic events as wildfires and large storms, and the subsequent floods, hillslope failures, landslides, and debris flows (Haynes et al. 2006b). This analysis focuses on the key ecological processes that shape fish habitat over time, rather than static conditions at one point in time.

The following are examples of key ecological processes that shape aquatic and riparian habitat in the planning area:

- tree growth and mortality (which affect stream shade, nutrient input, and large wood delivery)
- hydrology (water flow and temperature)
- sediment routing

Large wood, stream temperature, sediment, and stream flow have the greatest influence on the ability of aquatic habitat to support fish populations (Meehan 1991, OWEB 1999). In forested landscapes, the important delivery mechanisms of large wood and sediment to stream channels are landslides, debris flows, and floods. In nonforested landscapes, the important processes are water flow, water temperature, and sediment routing.

Large Wood

Large woody debris (large wood) refers to coniferous or deciduous logs, limbs, or root wads that intrude into a stream channel. This analysis included both the large wood (greater than 20 inches in diameter) and small wood (trees less than 20 inches in diameter) contribution to stream channels. In addition to large wood, small wood (trees less than 20 inches in diameter) can also be functional in stream systems, depending on stream size. Small wood is considered functional if it is "pool-forming" (Beechie et al. 2000). The correlation factors shown on *Table 3-63 (Functional piece size and stream channel width)* are used to determine small functional wood by stream size for the wood delivery model.

However, because decay rate and probability of displacement are a function of size, the larger diameter trees have a greater influence on fish habitat and physical processes in fish-bearing stream channels than smaller

Table 3-63. Functional Piece Size And Stream Channel Width

Stream Width (feet)	Functional Wood Diameter (inches)
15	4.5
20	6.0
30	9.0
40	12.0
50	15.0
>50	>20.0 (referenced as large wood or "key piece")

Source: Beechie et al. 2000

pieces (Dolloff and Warren 2003). Additionally, larger pieces are necessary in larger fish-bearing stream channels to trap and store smaller pieces of wood. In general, trees greater than 24 inches in diameter and 50 feet in length are considered large wood west of the Cascade Mountains, and trees greater than 12 inches in diameter and 35 feet in length are considered key pieces east of the Cascade Mountains (Foster et al. 2001, USDC NOAA and NMFS 1996). For this analysis, trees greater than 20 inches in diameter are considered to be large wood for larger, fish-bearing streams to maintain consistency with the structural stage classification of forests. That classification uses the density of trees greater than 20 inches in diameter as a threshold for the definition of mature & structurally complex forests (see the *Forest Structure and Spatial Pattern* section of *Chapter 3*).

Large wood is an important component of aquatic habitats, from headwater channels to estuaries in forested ecosystems (Dolloff and Warren 2003). Large wood accumulation within stream channels is necessary for many functions including:

- providing cover for fish
- sediment storage for food supply and spawning grounds
- nutrient retention
- pool formation
- formation of off-channel habitat

For many aquatic organisms, particularly fish, large wood is an important factor in creating and maintaining deep water or pool habitat. See *Figure 3-103* (*Example of deep pool and habitat diversity caused by large wood)* and *Figure 3-104* (*Example of a stream with high wood volume*). Salmonids inhabit pools as refuges from high water velocities. Juvenile salmonids use pools and side channels created by wood as overwintering habitat. Large wood can capture and store sediment, which provides spawning habitat (Dolloff and Warren 2003). Large wood is also an important source of cover that makes fish more difficult for predators to see. Stream complexity is important for many fish, particularly aggressive species such as salmonids, which do not tolerate close proximity to each other. Wood partitions the habitat and visually isolates fish, allowing more fish per unit of available space (Dolloff 1986).

In forested ecosystems, the abundance and survival of salmonids is often closely linked to the abundance of large woody debris, particularly during winter (Meehan 1991). In general, streams with high amounts of large wood and complex habitats tend to have more fish species and higher populations than those lacking complexity (Dolloff and Warren 2003). Many studies have established that improved habitat complexity correlates to improved fish survival and production (Hartman et al. 1996, 237, 243, 248; Reeves et al. 1993, 314; Bustard and Narver 1975; Tschaplinski and Hartman 1983, 452; Murphy et al. 1986, 1526; Hartman and Brown 1987, 262). Researchers have documented an increase in the density of salmon following the addition of wood to stream reaches. Roni (2001) reported a 180% increase during summer and 332% increase during winter in the density of juvenile coho following the addition of wood to 30 streams in Washington and Oregon. Similarly, Cederholm et al. (1997) showed a 20-fold increase in juvenile coho during winter in

Figure 3-103. Example Of Deep Pool And Habitat Diversity Caused By Large Wood

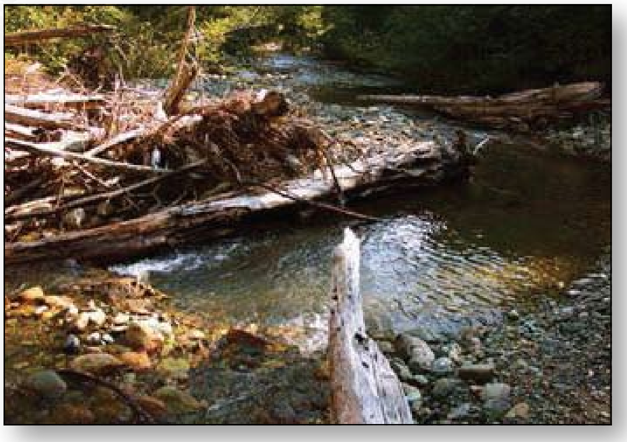


Figure 3-104. Example Of A Stream With High Wood Volume

response to the addition of wood. Reeves et al. (1997) found that the number of steelhead did not increase in response to wood additions, but that smolts were significantly larger.

Past management practices throughout the Pacific Northwest have reduced the abundance of large woody debris in channels throughout the region. Historically, large wood source areas did not produce large wood all the time, but rather fluctuated both spatially and temporally. Natural disturbances such as fires, wind, and floods do not affect all of the landscape equally. Because of the dynamic spatial effects of natural disturbance regimes, large wood loading and stream habitat features across natural landscapes vary greatly. At any one time, some stream channels may have large amounts of large wood and highly complex habitats, but other channels, even in the same watershed, may lack wood and have simplified habitats (Reeves et al. 1995). Prior to the 20th century, large channels and large rivers such as the Willamette River as described by Sedell and Froggatt (1984) were full of wood or blocked by wood jams and accumulations.

Wood loading in large Pacific Northwest rivers has generally declined to 1/100th of historical amounts (Sedell and Froggatt 1984). Rivers were cleared of large wood and boulders during settlement to improve access for transportation. Large wood was later removed from rivers and streams as a stream-cleaning regime, because log jams were believed to obstruct fish migration. Smaller streams were cleared through a splash-damming process in which a dam-break flood was induced to transport trees. These torrents scoured sediment and wood from streambeds and banks and left many channels scoured to bedrock (Sedell and Luchessa 1982, Montgomery et al. 2003).

The decline in beaver populations from trapping also reduced the large wood found in streams and consequently reduced the complexity of aquatic habitats. Dam building by beavers provides accumulations of large wood and pools, which are an important component of high-quality habitat for fish species (ODFW 2005b, Pollock et al. 2003, Nickelson et al. 1992). By 1900, trapping had nearly extirpated beaver in the Pacific Northwest (Naiman et al. 1998). The decline in beaver populations resulted in incised channels and also loss of riparian and wetland areas and loss of channel complexity, which are important to fish and invertebrate production. For example, the greatest reduction in the productive capacity of coho smolt has been associated with the extensive loss of beaver ponds (ODFW 2005b). A 94% reduction in smolt production potential in a western Washington basin is attributed to the loss of beaver pond habitat (ODFW 2005b).

The mining, urbanization, agriculture, and logging activities of the 20th century began to change physical and biological characteristics of streams by removing trees from upland and streamside areas. The ground disturbances and road construction associated with these activities caused increased sedimentation into streams, which directly altered stream channels. Large fires and the subsequent salvage logging such as the Tillamook Burn removed both upland and riparian forests, reducing stream shading and future sources of large wood and increasing sedimentation.

In the past, roads were often constructed along stream channels. Roads constructed along and across stream valley bottoms altered channel morphology, modified natural drainage networks, and limited large wood from migrating downstream from headwater sources to fish-bearing stream reaches (Everest and Reeves 2007). See *Figure 3-105 (Road and stream crossings in the Evans Creek Watershed).*

Although there is high variability in the natural levels of large wood in streams, the amount of large wood in rivers and streams within the planning area is currently far outside the historic range and is hindering the recovery of wild salmonids (IMST 1999). Watershed monitoring completed within 55 watersheds in the area of the Northwest Forest Plan in 2004 concluded that large wood levels are below benchmark values in nearly 70% of the sample (Gallo et al. 2005).

The current amount of large wood in stream channels is a reflection of past management and the availability of trees on the landscape for delivery to stream channels. Most riparian areas have been harvested at least once over the last 150 years (Dolloff and Warren 2003), and the trees in the resultant second-growth forests are generally too small to provide large wood (greater than 20 inches in diameter) to streams. See *Figure 3-106 (Current riparian conditions by BLM district)* for the current riparian condition on BLM-administered lands within the planning area. Stand establishment and young forests generally have few trees greater than 20 inches in diameter. Trees in mature & structurally complex forests contain trees large enough to provide large wood. Within riparian forests, 47% are currently in stand establishment and young forest, and 53% are in mature & structurally complex forest.

In the Coast Range Province, riparian red alder stands have increased in abundance, and large conifer stands have decreased in abundance since the 1930s (see the *Forest Structure and Spatial Pattern* section in *Chapter 3*). See *Figure 3-107 (Changes in western Oregon vegetation types).* A lack of conifers along streams

Figure 3-105. Road And Stream Crossings In The Evans Creek Watershed

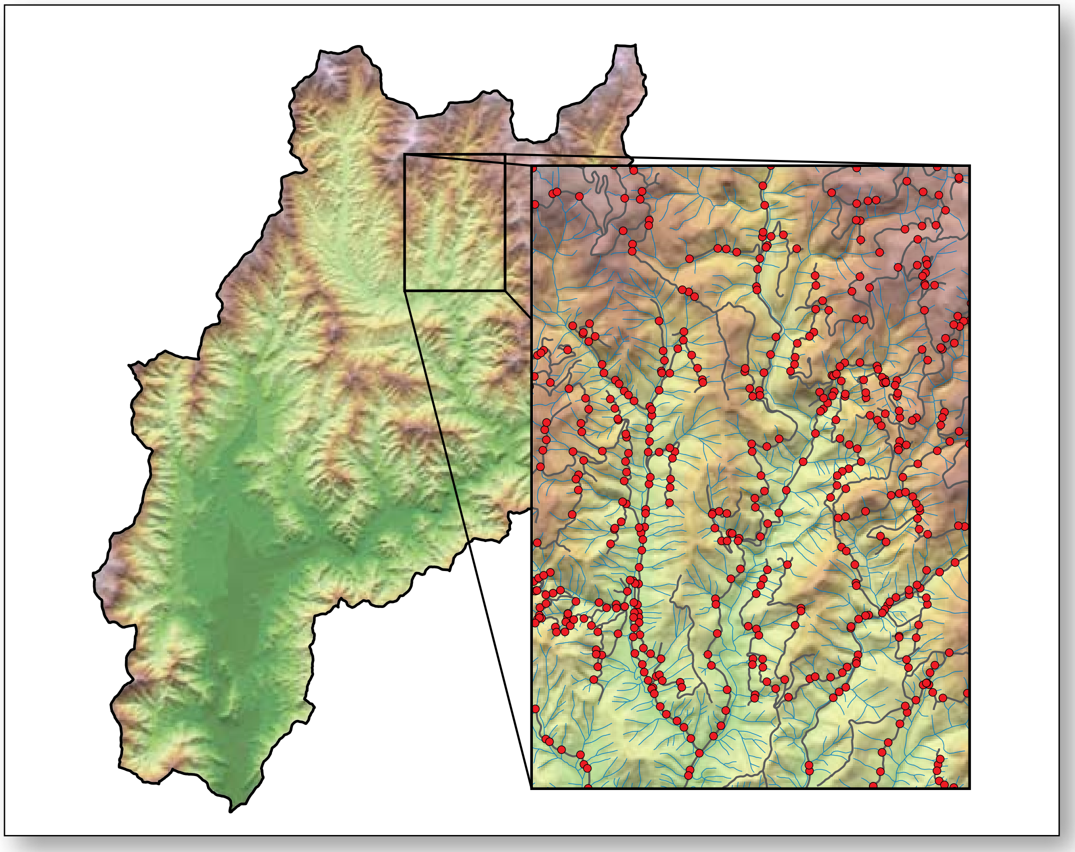
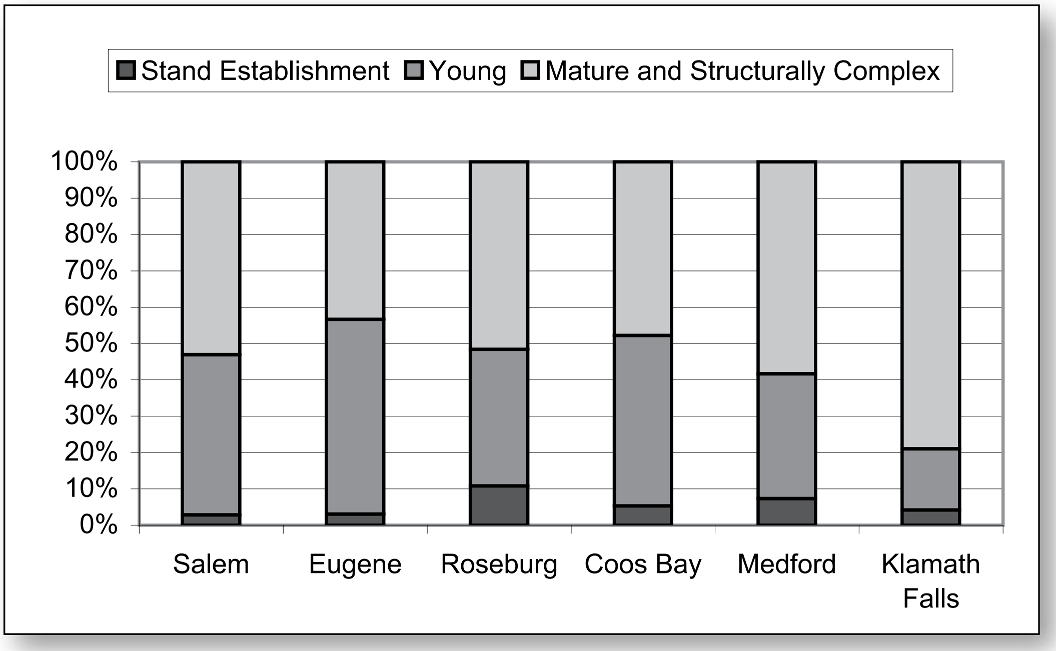


Figure 3-106. Current Riparian Conditions By BLM District



can contribute to simplified aquatic habitat structure, which is a limiting factor for many listed salmonids. Although red alder trees may provide for stream structure in the short term, they cannot provide the larger-diameter, persistent stream structure that conifers can. Red alder trees that fall into streams are more likely to be broken down and transported out of the streams than are conifers (Hyatt and Naiman 2001). Red alder is an important source of nutrients for macro-invertebrates and, subsequently, for fish (Romero et al. 2005). However, key pieces from conifer trees must be available in the stream channel to trap and store smaller trees, such as alder, and the nutrients from the alder input (Findlay et al. 1977).

Large wood is delivered from forests to stream channels from both chronic and episodic events (Naiman et al. 2000). The amount of large wood in stream channels depends on the amount of trees available on the landscape that can be delivered to a stream channel. Not all areas across the landscape have the potential to deliver trees to stream channels. Wood is typically delivered to stream channels from:

Chronic events (events that occur frequently, such as tree mortality along streambanks):

- riparian tree-fall (typically one site-potential tree height from the stream channel)
- valley floors and floodplains (channel migration zones)

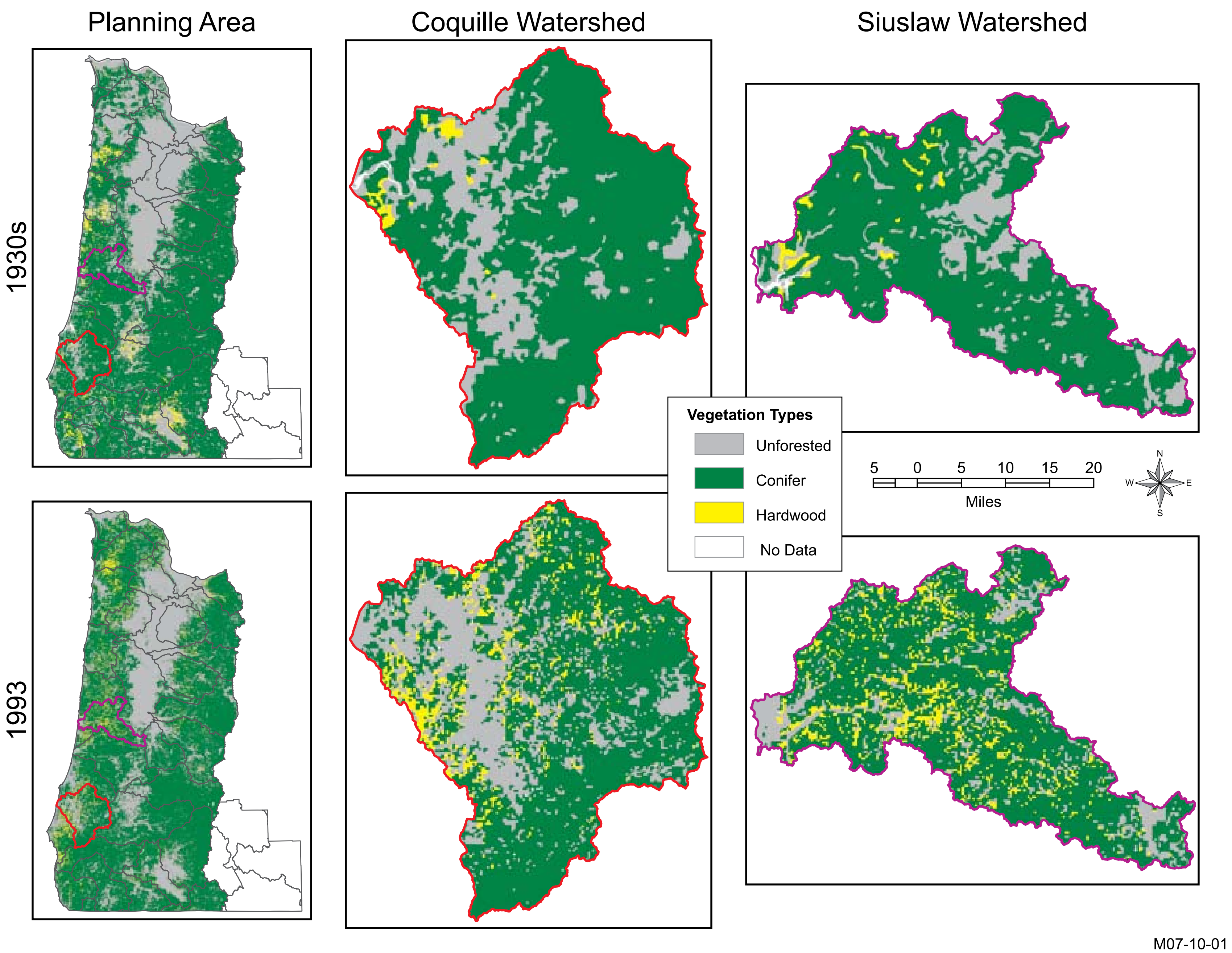
Episodic events (events that typically occur sporadically and infrequently and can deliver large amounts of wood to stream channels (Bilby and Bisson 1998, Benda et al. 2003a and 2003b, Naiman et al. 2000):

- landslides and debris flows

Riparian Tree Fall

Large wood enters stream channels from the adjacent streambank as trees eventually fall over, and, if they are close enough to a stream channel, land in the channel (McDade et al. 1990). Trees along stream edges are also undercut as a result of bank erosion and eventually fall into the stream. The majority of wood that falls into stream channels from adjacent forests occurs within a distance of one tree height away from the channel (FEMAT 1993, p. V-27).

Figure 3-107. Changes In Western Oregon Vegetation Types



For forest lands on the east side of the Klamath Falls Resource Area, large wood enters stream channels primarily from riparian tree fall as a result of windthrow, tree mortality, or bank erosion. The rate at which large wood is supplied to streams depends on the character of adjacent landforms and vegetation patches. In forested canyon settings, large wood recruitment is relatively high, whereas large wood input to streams that flow through meadows and rangelands occurs at lower rates. Instream large wood surveys in east side streams indicate that large wood amounts are higher in constrained reaches than in unconstrained reaches (USDA USFS and USDI BLM 2003).

Landslide and Debris Flows

In forested areas of the Pacific Northwest, shallow landslides (including debris flows) are important mechanisms for delivering sediment and large wood from hillslopes and headwater channels to downstream fish-bearing stream reaches (Keller and Swanson 1979). A ***debris flow*** is a rapidly moving slurry of rock, soil, wood, and water that can travel hundreds to thousands of feet on steep slopes or in steep channels (ODF 2003). Debris flows commonly start as rainfall-initiated translational landslides of shallow soils (Iverson et al. 1997) and are a primary process by which headwater channels are connected to and influence larger streams (Benda and Cundy 1990, Gomi et al. 2002).

Debris flows are natural disturbances in the Pacific Northwest, but can have both short-term negative and long-term constructive effects on aquatic habitat (Reeves 2005). Over short periods, debris flow deposits can have destructive effects, including burial of existing aquatic habitat and direct mortality of aquatic biota, increased fine sediment deposition that can suffocate fish eggs in gravel, increased bed load transport and lateral channel movement due to increased sediment supply that scours fish eggs, loss of aquatic insects, and the dewatering of pools due to channel aggradation (Miller et al. 2003, Benda et al. 2005).

Over longer periods, constructive effects of debris flows on aquatic systems include the creation of gravel deposits and large pools; deposition of woody debris and of boulders that trap sediments and create complex habitats; formation of wider valley floors that contain larger floodplains; and increased biological productivity (Benda et al. 2005, Benda et al. 2003a and 2003b). For many streams, landslides and debris flows provide a large portion of the instream wood (Reeves et al. 2003) and other materials that contribute to the habitat heterogeneity in fish-bearing streams (Miller and Burnett 2007) and that create complex, productive stream habitats (Reeves et al. 1995, Bilby and Bisson 1998.) For macro-invertebrates and fish, increasing the heterogeneity of habitat conditions including channel width and depth, bed substrate, wood storage, and water velocity, can increase total species richness (Allan 1995). This has been documented in the Oregon Coast Range, where increased wood storage and pool formation at low-order confluences resulted in increased salmonid rearing (Benda et al. 2004).

The frequency, magnitude, and spatial extent of debris flows can vary within and among watersheds (Miller et al. 2003). Headwater streams differ in their susceptibility to landslides and debris flows and the subsequent delivery of large wood to downstream reaches. Research from the Coastal Landscape Analysis and Modeling Study indicates that a small percentage of headwater stream networks encompass the majority of wood contribution to stream channels (Miller and Burnett 2007). *Figure 3-108 (Relationship between intermittent streams and wood contribution to streams)* illustrates the general relationship that the majority of wood contributed to streams from debris flows comes from a relatively small percentage of the headwater channels in a watershed.

Watersheds differ in the frequency and magnitude of debris flows as a result of differences in topography and climate. For example, in the Siuslaw River basin in coastal Oregon, topographic differences between Knowles Creek and Sweet Creek result in large differences in the predicted probability of debris-flow delivery between these two channel systems (Miller et al. 2003). See *Figure 3-109 (Within and among watershed heterogeneity of debris flow probability for the Knowles Creek and Sweet Creek watersheds, Coast Range, Oregon*).

FIGURE 3-108. RELATIONSHIP BETWEEN INTERMITTENT STREAMS AND WOOD CONTRIBUTION TO STREAMS

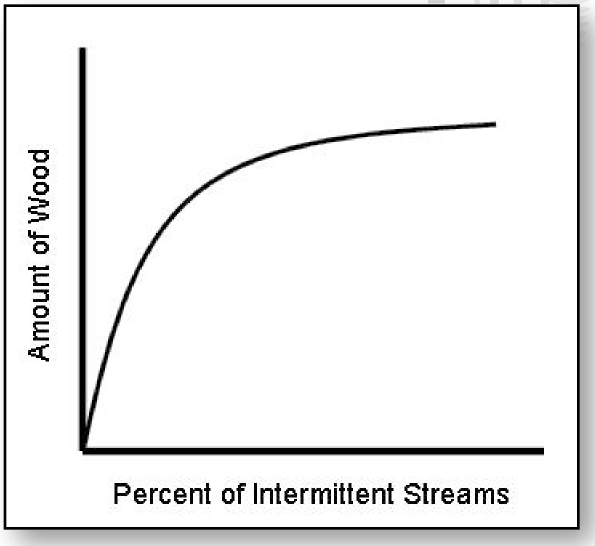
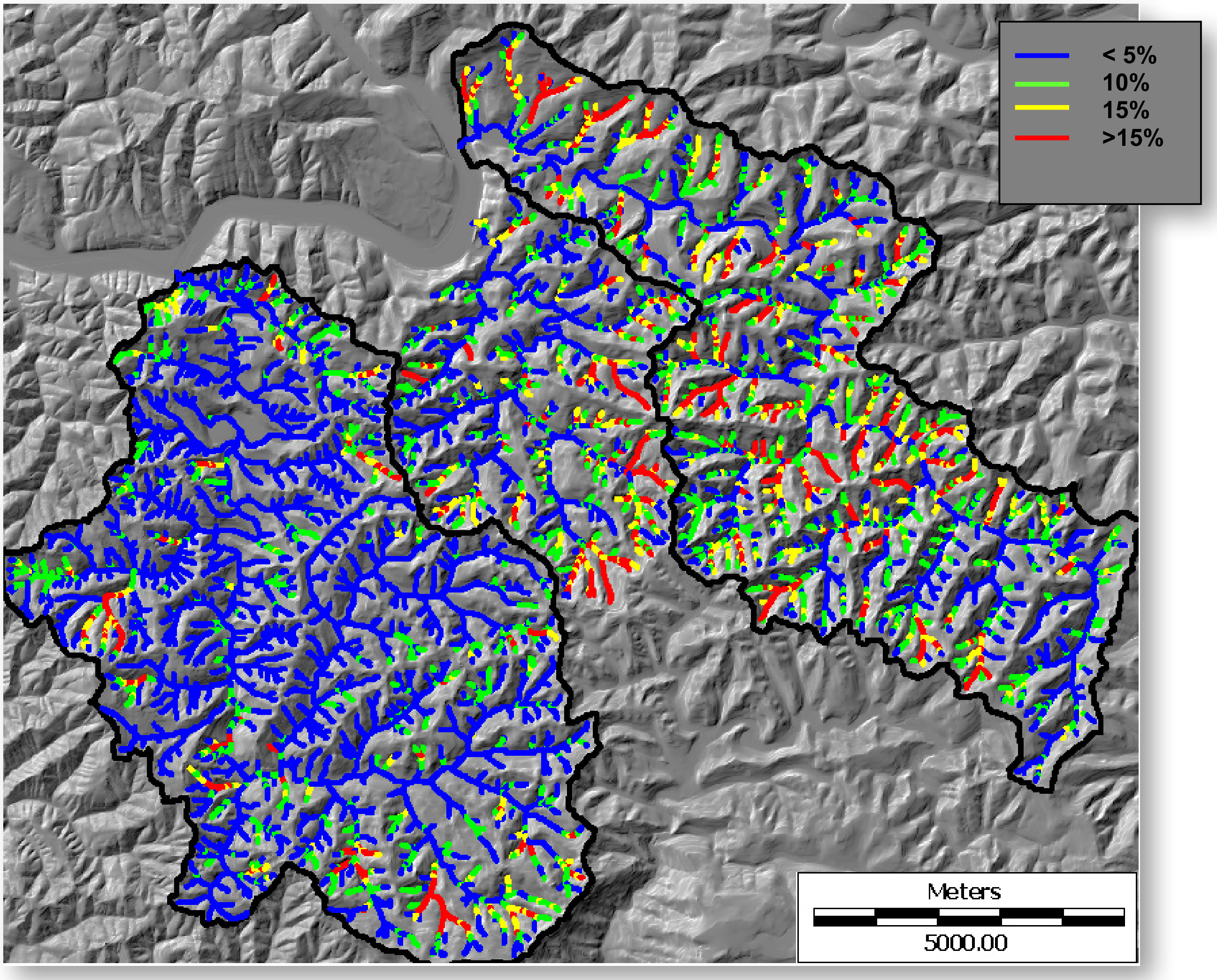


FIGURE 3-109. WITHIN AND AMONG WATERSHED HETEROGENTIY OF DEBRIS FLOW PROBABILITY FOR THE KNOWLES CREEK AND SWEET CREEK WATERSHEDS, COAST RANGE, OREGON

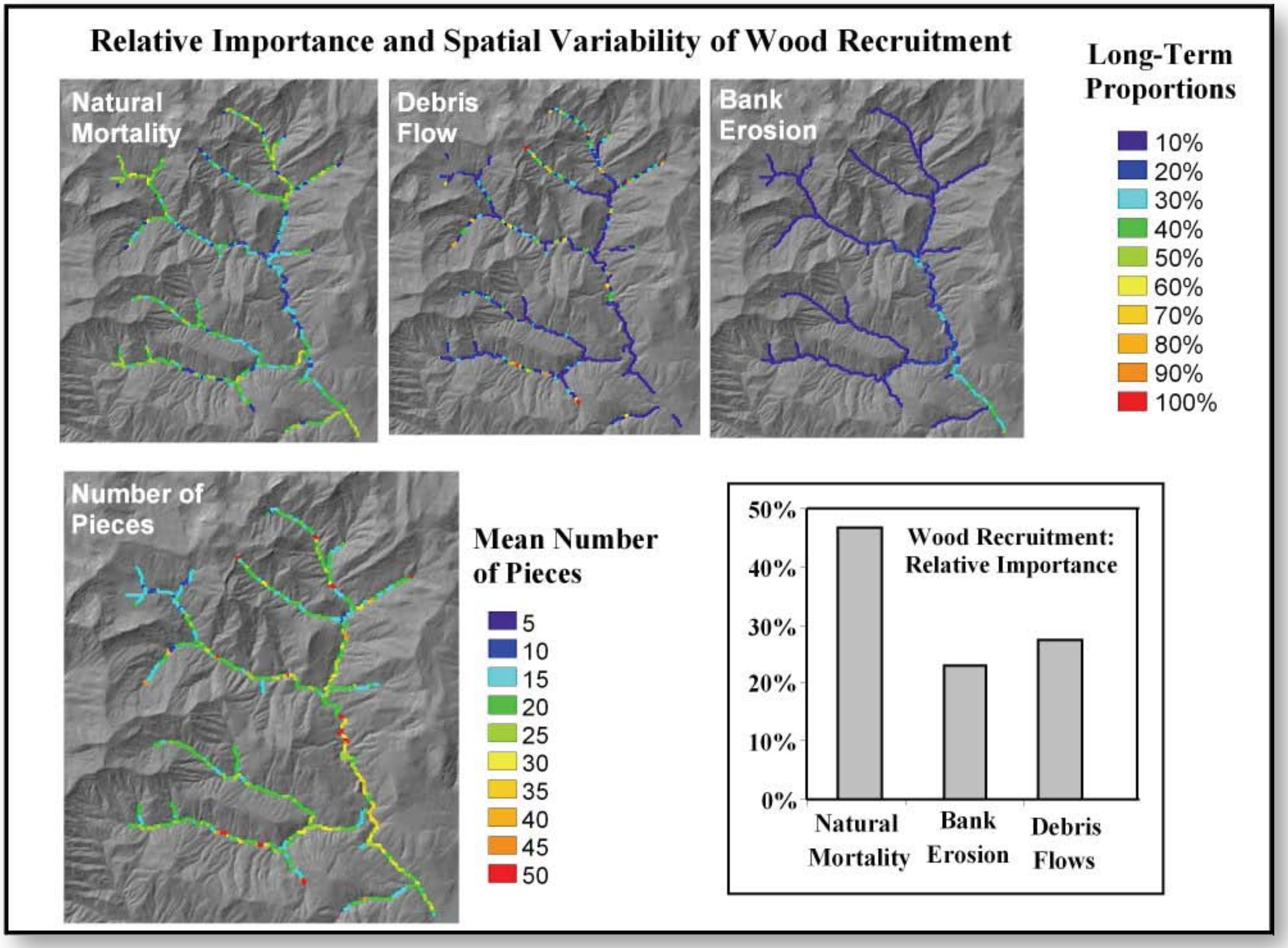


Channel Migration

The channels of some streams, particularly larger streams and rivers in broad alluvial valleys, may migrate across the valley as a result of natural erosional and depositional processes. The channel migration zone is the area where the active channel of a stream is prone to movement over time. In meandering or incising streams, bank erosion can account for a substantial portion of wood input to streams (Martin and Benda 2001, Murphy and Koski 1989). However, large wood contribution from this source is relatively small from BLM-administered lands in the planning area since channel migration in larger rivers comprises a small percentage of the entire stream network.

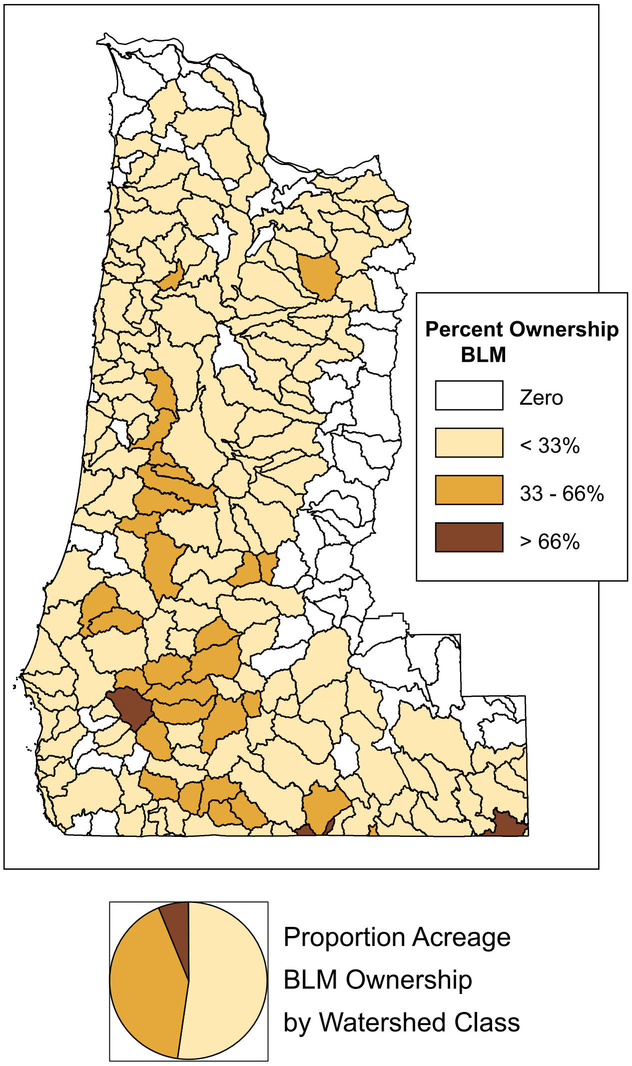
The relative importance of each delivery process varies by province, stream channel, riparian vegetation, position in the landscape, and time (Bilby and Ward 1989). Episodic processes deliver large amounts of wood during infrequent events (windstorms or mass movements), whereas chronic processes (suppression mortality and bank erosion) consistently provide small amounts of wood over extended time periods. Windthrow, debris flows, landslides, and avalanches are the primary delivery mechanisms in steep headwater channels (Bilby and Bisson 1998). Bank erosion and delivery from upstream sources contribute the majority of large woody debris in larger unconfined channels (Murphy and Koski 1989). See *Figure 3-110 (Example of relative importance and spatial variability of wood recruitment processes in the Coast Range)* for the relative rates of wood recruitment from each process in the Coast Range province (USDA USFS 2002 in Benda et al. 2003a and 2003b).

Figure 3-110. Example Of Relative Importance And Spatial Variability Of Wood Recruitment Processes In The Coast Range



The Pacific Northwest Research Station assisted Earth Systems Institute in the development and application of the wood delivery model. The wood delivery model is based on research by Pacific Northwest Research and Earth Systems Institute scientists in the analysis of effects on the aquatic ecosystems. The BLM was responsible for model inputs, quality control, and interpretation of the modeling results. The wood delivery model was developed to compare the potential wood contribution to both fish-bearing and non-fish-bearing stream channels over time between alternatives on BLM-administered lands and non-BLM-administered lands.

Figure 3-111. BLM ownership patterns in the planning area



Other existing wood models and studies focus primarily on riparian sources of wood (Lienkaemper and Swanson 1987, Murphy and Koski 1989, McDade et al. 1990, Robison and Beschta 1990, Van Sickle and Gregory 1990). See Reeves (2005) at http://www.blm.gov/or/plans/wopr/science/scienceforum.php. However, landslides and debris flows can provide a large portion of instream wood in the planning area (Bigelow et al. 2007, Reeves et al. 2003). Therefore, the wood delivery model used for this analysis provides a more comprehensive analysis of wood delivery for the planning area than the other existing wood models. This analysis uses a spatially explicit, topographically based large wood model to estimate potential wood recruitment to streams over entire stream networks. The model incorporates all large wood delivery processes including riparian tree fall, landslide and debris flows, and channel migration tree recruitment. Topographic characteristics from a 10-meter digital elevation model are used to identify all large wood sources across the landscape (Clark et al. 2008, Miller and Burnett 2007). Probabilities of delivery are assigned to every 10-meter digital elevation model pixel across the landscape. For debris flow sources, all initiation points are ranked by their probability of initiating and transporting a debris flow to a fish-bearing channel. See *Appendix I - Water* for a complete description of the large wood model.

Since the BLM is rarely the predominant landowner within a fifth-field watershed in the planning area, the potential large wood contribution from BLM-administered lands is generally less than from other landowners. See *Table 3-64 (BLM land ownership patterns in the planning area)* and *Figure 3-111 (BLM ownership patterns in the planning area)* for the range of BLM ownership watersheds with BLM-administered land.

Highly detailed forest stand data for BLM-administered lands was used for the wood delivery model to determine the potential wood delivery from BLM-administered lands and

Table 3-64. BLM Land Ownership Patterns In The Planning Area

BLM Ownership	Number of Watersheds
Less than 1/3	138
1/3 to 2/3	30
Greater than 2/3	3

for comparison with the No Harvesting reference analysis. However, the highly detailed forest stand data is not 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 for non-BLM-administered lands, as described in *Chapter 3* (*Forest Structure and Spatial Pattern* section). This relative large wood contribution was compared against a maximum potential large wood contribution to show the general relative contribution between ownerships.

The maximum potential large wood contribution is one point of comparison used for determining the biological potential of a watershed to provide large wood to streams. It is calculated as the number of pieces of large wood per year that could be delivered to a fish-bearing stream in a fifth-field watershed if all forested acres in the watershed were in a mature & structurally complex forest. The maximum potential large wood contribution does not account for large disturbance events (fires, floods, etc.) and is not used in the analysis as a benchmark or target condition. It is only used in the analysis to show the relative wood contribution between ownerships over time.

The maximum potential large wood contribution reflects a maximum biological potential and does not necessarily reflect average historic conditions. The average historic conditions at the province scale ranged from 79% in mature & structurally complex forest in the Coast Range and West Cascades provinces, to 45% in a mature & structurally complex forest in the Eastern Cascades province (see *Forest Structure and Spatial Pattern in Chapter 3*).

However, at the scale of an individual fifth-field watershed, the variability in historic amounts of mature & structurally complex forest would have been extremely high, and likely with long periods of time in which the watershed was nearly all in mature & structurally complex forest (Wimberly et al. 2000). These periods of time in which a fifth-field watershed would be nearly all in mature & structurally complex forest, which would correspond to the maximum large wood contribution calculated in the model, would represent the maximum potential for large wood delivery.

Periodic large disturbance events (such as wildfires, large storms, and the subsequent floods, hillslope failures, landslides, and debris flows) would deliver large wood to stream channels and alter the structural stage abundance of the forest. Delivery from disturbance events when the watershed would be nearly all in mature & structurally complex forest would provide accumulations of large wood in streams that would last longer than it would take the watershed to return to mature & structurally complex forest after the disturbance.

The calculated potential large wood contribution for this analysis is not a prediction of actual instream conditions at a specific point in time. The potential large wood contribution is not compared to large wood benchmarks developed by the Oregon Department of Fish and Wildlife, because the potential large wood contribution represents a potential contribution to instream wood based on forest conditions over time, whereas the large wood benchmarks are based on actual reference instream conditions. The model cannot predict actual instream conditions, because large wood input is episodic (delivery events are stochastic and unpredictable) and cumulative (large wood accrues over time). Therefore, this analysis summarizes wood contribution in terms of the proportion wood contribution compared to the No Harvesting reference analysis for BLM-administered lands, and to a maximum potential large wood contribution reference analysis for the relative comparison between ownerships, instead of a comparison with large wood benchmarks. See *Figure 3-112* (*Current potential wood contribution from BLM-administered lands compared to the potential large wood contribution under the No Harvesting reference analysis at year 2106*) and *Figure 3-113 (Current and maximum large wood contribution by ownership)* for the current potential large wood contribution.

Figure 3-112. Current Potential Large Wood Contribution From BLM-Administered Lands Compared To The Potential Large Wood Contribution Under No Harvesting Reference Analysis At Year 2106.

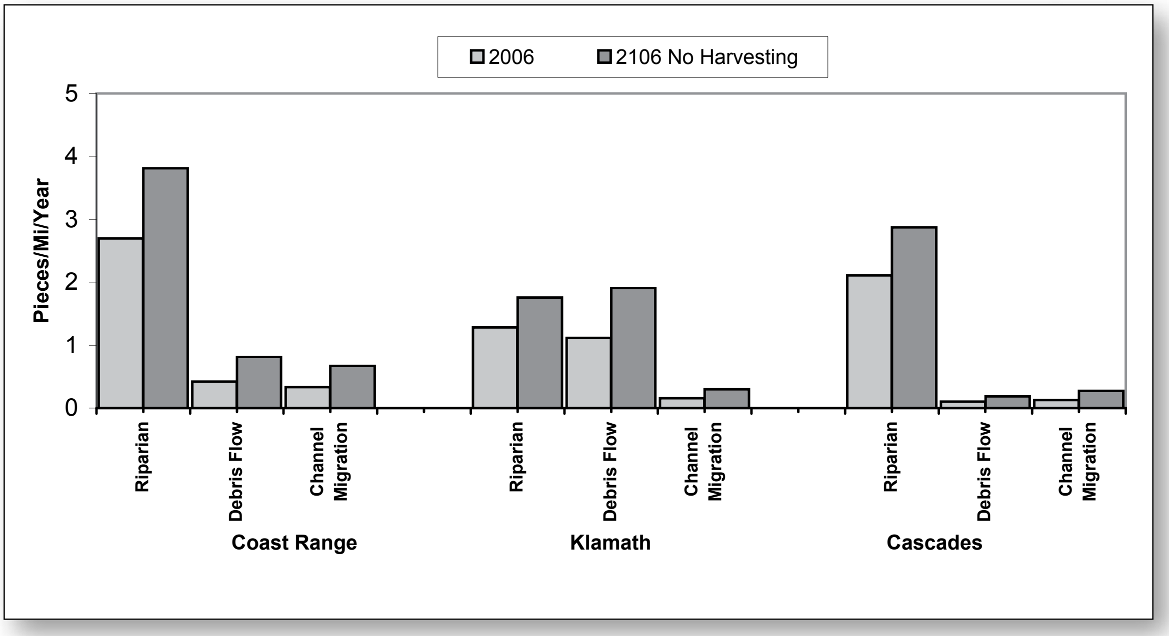
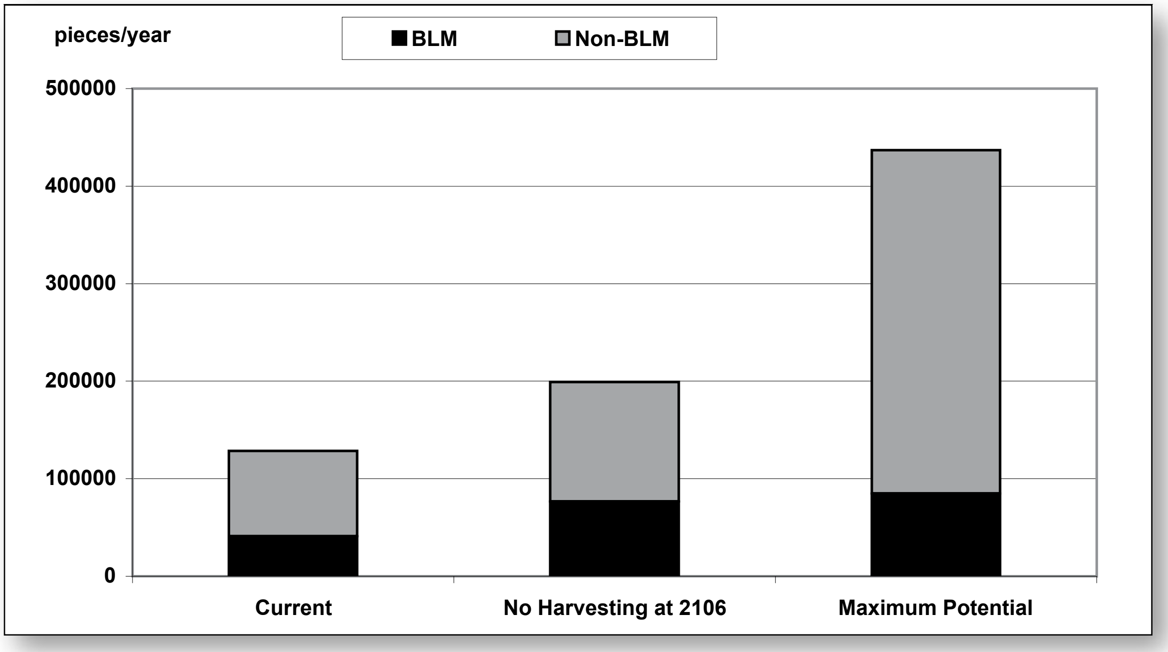


Figure 3-113. Current And Maximum Large Wood Contribution By Ownership



In all watersheds, the current large wood contribution is lower than the maximum potential, because not all forests that are capable of delivery to streams are currently in mature & structurally complex forest, particularly riparian areas. Refer to *Figure 3-106 (Current riparian conditions by district).*

Nutrient Input

Energy becomes available to the stream community from two main sources: photosynthesis by aquatic plants in the stream, and decomposition of organic matter imported from outside the stream (Murphy and Meehan 1991). Riparian vegetation (particularly size, abundance, and overall stand composition) governs the input of light and nutrients to stream channels (Murphy and Meehan 1991).

Riparian vegetation provides organic matter to stream channels from litterfall when leaves, needles, woody debris and insects fall into the stream channel. The supply of organic material contributes to the amount of food produced for fish species in forested ecosystems. The effectiveness of riparian forests to deliver leaf and other particulate organic matter declines at distances that are greater than approximately one-half a tree height (59 to 112 feet) away from the stream channel (FEMAT 1993, p. V-27).

The amount and composition of litterfall is strongly influenced by the forest type, successional stage, and site productivity of forests (O'Keefe and Naiman 2006). The composition and quantity of litterfall change as riparian forests proceed on a successional trajectory driven by changes in the composition, structure, and overall productivity of riparian forests (O'Keefe and Naiman 2006). The rate of input increases with increasing forest basal area during early successional forest growth (O'Keefe and Naiman 2006). O'Keefe and Naiman observed an initial 100-year linear increase in litter production with early forest succession. After the first century, total litter declined approximately 40% as forests shifted to structurally complex forest and were dominated by conifers (O'Keefe and Naiman 2006). See *Figure 3-114 (Total annual litterfall as a function of forest age*).

In general, litterfall composition can also change through the forest succession as litterfall from deciduous trees dominates during the first century and dominates from conifers thereafter. Fish-bearing streams receive food supplies from both nearby (riparian) and distant (headwater) habitats (Wipfli et al. 2007). The relative importance of each delivery process varies. Headwater streams are important sources of nutrients for invertebrate production (Wallace et al. 1997, Stone and Wallace 1998). Headwater streams on BLM-administered lands in the planning area comprise 67% of the stream network; and because of their abundance they may be substantial contributors of invertebrates and organic input to downstream fish-bearing waters. However, to what extent they subsidize food production in downstream fish communities is unclear (Wipfli et al. 2007). Additionally, relative to other sources such as instream production and riparian input directly to fish-bearing streams, the input from headwater streams to fish-bearing streams also may be only a small fraction of the contribution (Wipfli et al. 2007).

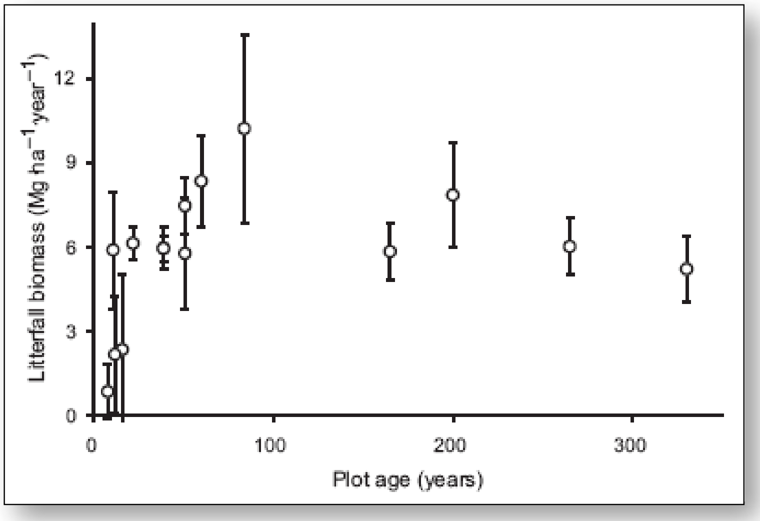


Figure 3-114. Total Annual Litterfall As A Function Of Forest Age (O'keefe And Naimain 2006).

Overall, the input and processing of organic material is better served by a heterogeneous landscape with varying amounts of forest cover, species composition, and age classes than by the creation of a single forest type across the landscape (IMST 1999). However, there are no studies that establish a threshold as to what degree shifts in forest cover affect nutrient input, production, and fish productivity.

The amount of light reaching the stream channel also influences nutrient production within stream channels. Partial or complete riparian forest removal increases macro-invertebrate densities and biomass due to increased solar radiation on the stream channel (Chan et al. 2004, Jackson et al. 2001, and Wipfli et al. 2007). Danehy et al. (2007) found a higher abundance and more biomass of macro-invertebrate assemblages in streams within regeneration harvest units than in mature stands.

Many riparian areas have been harvested at least once over the last 150 years (Dolloff and Warren 2003). Within riparian forests, 47% are currently in stand establishment and young forest, and 53% are in mature & structurally complex forest. See *Figure 3-106 (Current riparian conditions by BLM district)* for the current riparian condition on BLM-administered lands within the planning area. The average historic conditions at the province scale ranged from 79% in mature & structurally complex forest in the Coast Range and West Cascades provinces, to 45% in mature & structurally complex forest in the Eastern Cascades province (see the *Forest Structure and Spatial Pattern* section in *Chapter 3*). Therefore, based on correlations identified in O'Keefe and Naiman (2006), current stream productivity from nutrient input is estimated to be less than average historic conditions from litterfall sources from mature & structurally complex forest, and higher than average historic conditions from increased solar radiation in stand establishment and young forest.

Fine Sediment

Fine sediments (sand, silt, and clay at less than 2 millimeters) enter and leave river channels naturally, but increased suspended sediment (turbidity) and sedimentation (embeddedness) can adversely affect fish (Anderson et al. 1996).

Fish species have the ability to cope with some level of sediment at various life stages (Everest et al. 1987). The effects of fine sediment on fish habitat are generally expressed as the percent of embeddedness at reach scales. Embeddedness is defined as the degree to which larger particles (such as boulders, cobble, and gravel) are surrounded and/or covered by smaller particles (silt, sand). Increases in sedimentation or embeddedness can reduce fish-spawning and rearing habitat, fish egg and fry survival, and food availability (Chamberlin et al. 1991, Hicks et al. 1991).

Thresholds beyond general levels at which these effects occur vary, despite scientific efforts to quantify the relationship between fine sediment and fish species. For example, Suttle et al (2004) suggest there is no threshold below which fine sediment is harmless to fish, and that the deposition of fine sediment in the stream channel, even at low concentrations, can decrease the growth of salmonids. When embeddedness exceeded 35%, survival from egg to emergence of chum salmon was reduced (Koski 1975 in Everest et al. 1987). Studies by Murphy and Hall (1981) in the Oregon Cascades found that juvenile salmonids were tolerant of fine sediment when embeddedness ranged from 26-52%.

Cederholm (1981) found that the survival of salmonid eggs to emergence was inversely correlated with the amount of fine sediment when the percentage of fine sediment exceeded natural levels in the watershed. Cederholm concluded that there was a 2% decrease of egg to emergence survival of salmonids, for each 1% increase in fine sediment over natural levels (Cederholm 1981) at the watershed scale. In the Cederholm study, natural levels of fine sediment were considered to be below 10% embeddedness. The Oregon Department of Fish and Wildlife considers the percent of fine sediment "undesirable" above 15% in streams with volcanic parent material, above 20% in streams with sedimentary parent material, and above 25% in low gradient streams (less than 1.5% gradient) (Foster et al. 2001). The National Marine Fisheries Service considers a stream "not properly functioning" when embeddness levels exceed 30% (USDC NOAA 1996). In other studies, levels that exceed 20% of the streambed are generally considered detrimental to most fish species in the planning area (Everest et al. 1987).

In 1998, the Oregon Department of Environmental Quality reported the results of the Oregon statewide assessment of non-point sources of water pollution. Of Oregon streams considered "impaired" for sedimentation, there were 1,500 stream miles on BLM-administered lands; 2,000 stream miles on Forest Service administered lands; and 7,400 stream miles on non-federal lands (ODEQ 1998).

In 2004, the Oregon Department of Environmental Quality reported the results of stream conditions in western Oregon for all ownerships, as part of Section 305(b) of the federal Clean Water Act (CWA). Fine sediment levels were in four ecoregions in the planning area and rated as good (<22% embeddness), fair (22-35% embeddness), or poor (>35% embeddness). The rating was based on the 10th and 25th percentile of western Oregon reference site scores (ODEQ 2004a and 2004b).

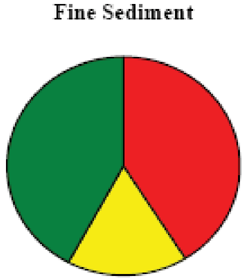
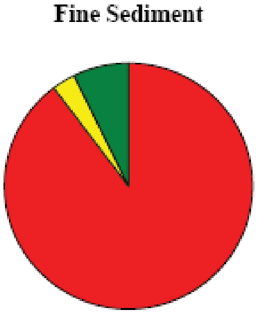
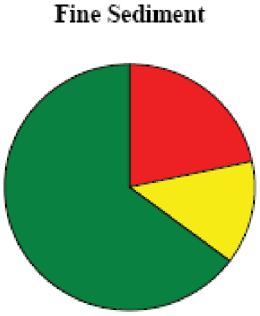
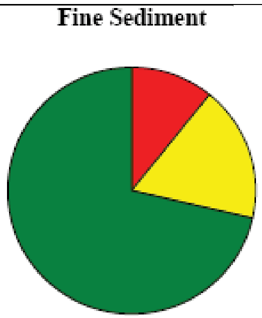
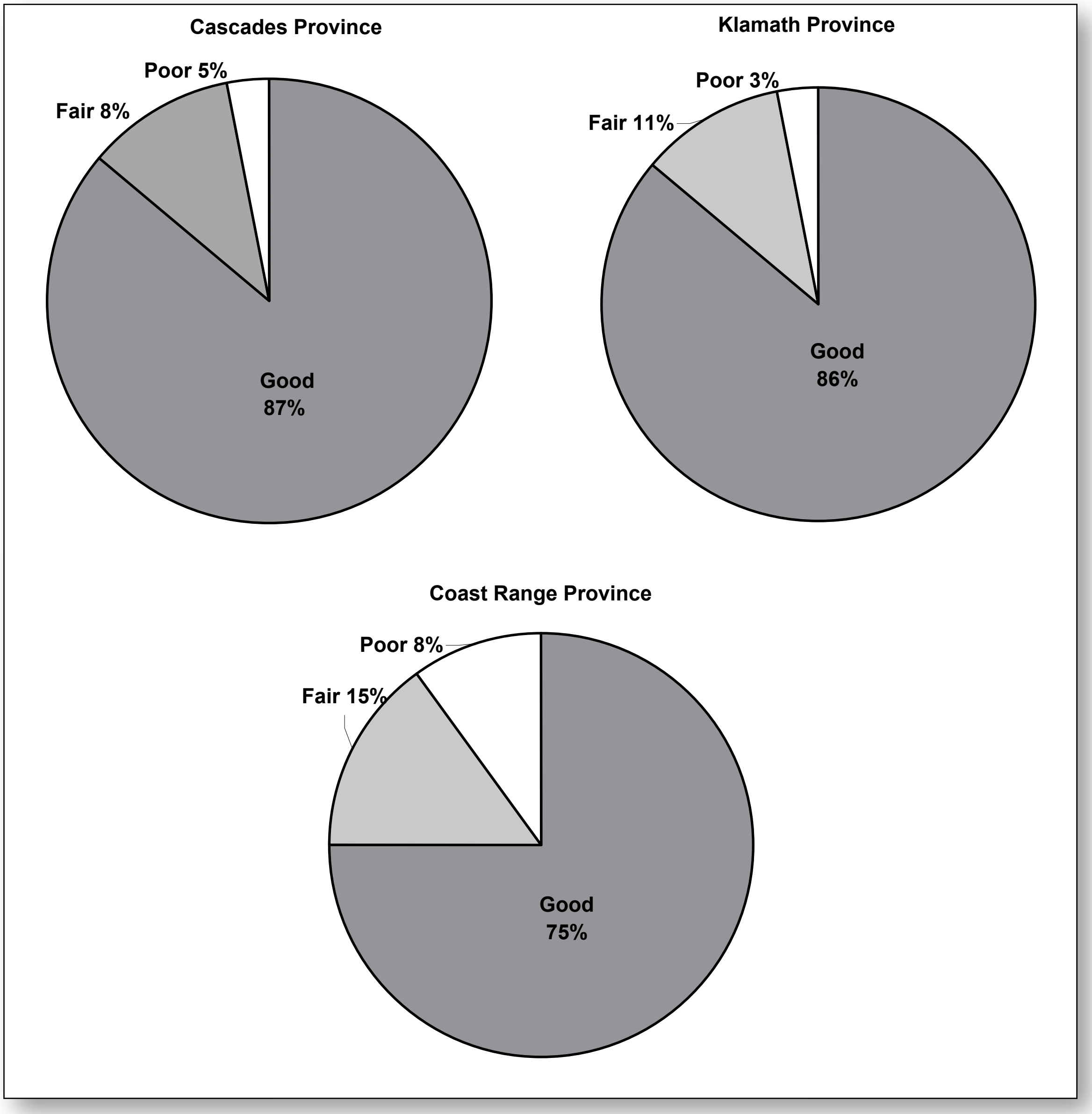
Ecoregion	Good	Fair	Poor	🟩 Good 🟨 Fair 🟥 Poor
Coast Range	42%	17%	41%	
Willamette Valley	7%	3%	90%	
Klamath Mountains	65%	14%	22%	
Cascades	71%	17%	11%	

Figure 3-115. Fine Sediment Levels In Western Oregon Streams, By Ecoregion (ODEQ Data 1994-2001)

The Willamette ecoregion had the lowest number of stream miles (7% rated "good" with fine sediment levels less than 22%). In the other ecoregions, 42% of stream miles in the Coast Range ecoregion, 65% percent of stream miles in the Klamath Mountains ecoregion, and 71% of stream miles in the Cascades ecoregion had fine sediment levels less than 22%. See *Figure 3-115* (*Fine sediment levels in western Oregon streams, by ecoregion [from ODEQ Probabilistic Stream Surveys 1994-2001]*).

However, these results do not represent the current conditions on BLM-administered lands since the data is for all ownerships combined. From 2001 to 2007, watershed monitoring was completed as part of the Northwest Forest Plan 10-year review on BLM-administered lands. Fine sediment was measured in 177 stream reaches in Western Oregon as part of the watershed monitoring. Overall, using Oregon Department of Environmental Quality survey thresholds, 81% of stream reaches on BLM-administered land would be considered "good," having fine sediment levels less than 22%. Average fine sediment levels varied by

Figure 3-116. Fine Sediment Levels In Western Oregon Streams On BLM-Administered Lands, By Province On 177 Stream Reaches.



province, with 75% of stream reaches in the Coast Range; 87% in the Cascades; and 86% in the Klamath having fine sediment levels less than 22%. See *Figure 3-116* (*Fine sediment levels in western Oregon streams on BLM-administered lands, by province [data from NWFP 10-year review])*. Fine sediment data was not collected in the Willamette Valley Province since BLM-administered land comprises a small percentage of land ownership within the province.

For this analysis, sediment yields are calculated at a fifth-field scale and expressed as tons per year (See the *Water* section in *Chapter 3*). Since this output (tons/year) cannot directly be equated to a percent embeddness, using the assumption from Cederholm et al.(1981) provides the ability to utilize a relative increase (>1% above natural levels) to evaluate the effects of fine sediment delivery on fish species at the watershed scale for each alternative. The Cederholm study is also used since it evaluated the effects on salmonids in the Pacific Northwest. Although the assumptions from Cederholm are used, they may over-estimate the actual effects to fish species in some areas, because:

- Fine sediment can be cleaned from the stream bottom gravel by scouring during storm events. High velocity flows tend to carry sediment rapidly out of the drainages, particularly in the Coast Range province. Within the planning area, the amount of fine sediment stored and routed through stream channels is highly variable, and some aquatic systems may function with high background levels of fine sediment.
- Spawning salmonids can improve their chances of reproductive success through behavioral adaptations (Everest et al. 1987). During redd construction (e.g., digging nests in the stream bottom) fish can remove large amounts of fine sediments from the gravel (Everest et al. 1987). For example, in Evans Creek, chinook salmon reduced fine sediments from 30% prior to spawning, to 7.2% after spawning (Everest et al. 1987). Secondly, when a female salmonid has completed spawning and burying eggs, the redd is left with a large pit on its upstream perimeter and a mounded tailspill downstream that contains the eggs. The pit acts as a natural settling basin for fine sediments and may capture up to 0.25 cubic meters of sediment before they reach the tailspill where the eggs are buried (Everest et al. 1987).

Increased concentrations of suspended sediment (turbidity) can also have direct effects on fish behavior, physiology, and growth (Anderson et al. 1996). Sigler et al. (1984) found that turbidities of 25 nephelometric turbidity units caused a reduction in juvenile steelhead and coho growth. Fish may avoid high concentrations of suspended sediment and at lower concentrations cease feeding (Hicks et al. 1991). Bisson and Bilby (1982) found that juvenile coho salmon avoided water with turbidities that exceeded 70 nephelometric turbidity units. The timing of the sediment inputs relative to the biological vulnerability of each fish species is often more important than the absolute quantity of sediment. In most streams, there are periods when the water is relatively turbid, and this sediment is generally mobilized during large storms (Everest et al. 1987). Larger juvenile and adult salmonids and trout species appear to be little affected by ephemerally high concentrations of suspended sediments that occur during most storms (Cordone and Kelley 1961, Sorenson et al. 1977). If sediment is introduced to streams in the absence of a runoff event, then sediment deposition may create localized adverse impacts (Everest et al. 1987). The tolerances of fish species to sediment vary seasonally. For example, Noggle (1978) demonstrated that the tolerance of juvenile coho salmon to suspended sediment was highest in the fall when increased suspended sediment normally occurs in streams.

Currently, there are no stream miles listed by the Oregon Department of Environmental Quality as turbidity impaired that occur on BLM-administered lands (see the *Water* section in *Chapter 3*).

Temperature

The water temperature in streams can affect the biological cycles of fish. The Oregon Department of Environmental Quality has established water temperature standards to protect the beneficial uses of the waters of the state. The beneficial uses most sensitive to water temperature are fish and aquatic life and,

TABLE 3-65. TEMPERATURE STANDARDS FOR FISH SPECIES

Species	7-Day Average Maximum Temperature Standard (degrees Fahrenheit)
Bull trout, spawning and juvenile rearing	53.5
Salmon and steelhead, spawning	55.4
Salmon and trout, rearing and migration	64.4
Shortnose and Lost River suckers	64.4
Cold core-water habitat	60.8

therefore, the temperature standard is based on protecting these uses (Boyd and Sturdevant 1997). See *Table 3-65 (Temperature standards for fish species)* for the temperature standards for several species within the planning area (ODEQ 2004).

The stream temperature standard is 64°F for salmon- and trout-rearing and migration, and sucker species; 55.4°F for salmon and steelhead spawning; and 53.6°F for bull trout. These criteria were established to protect fish use during the warm summer months. The unit for all the criteria in the standard is the 7-day moving average of the daily maximum temperatures. This means that the average of the daily maximum stream temperatures for the seven warmest consecutive days during a year, and any other seven-day period, is calculated and compared to the applicable criterion.

The Oregon Department of Environmental Quality "Core Cold-Water Habitat" designations identify and ensure the protection of colder water habitats that provide more optimal conditions for salmon and steelhead juvenile rearing and that protect summer bull trout sub-adult and adult foraging and migration. In addition, these areas would provide colder holding waters for pre-spawning adults (from Oregon Administrative Rules 340-041-0001 Water pollution division 41). Locations of "Core Cold-Water Habitat" in the planning area can be found at the Oregon Department of Environmental Quality website at: http://www.deq.state.or.us/wq/standards/standards.htm.

The standards are not based on temperature that have lethal effects to fish (usually above 70°F), but on sub-lethal effects (Boyd and Sturdevant 1997). Sub-lethal effects can lead to death indirectly, or they may reduce the ability of the fish to successfully reproduce and for offspring to survive and grow. Sub-lethal effects include an increase in the incidence of disease, a reduced survival rate of eggs, a reduced growth and survival rate of juveniles, increased competition for limited habitat and food, reduced ability to compete with other species that are better adapted to higher temperatures, and other adverse effects (Boyd and Sturdevant 1997).

Sub-lethal effects of temperature on salmonids occur gradually as stream temperatures increase. For example, for salmonids, some these effects begin when stream temperatures are below 64°F, such as increased incidence of disease and a reduction in juvenile growth rates for chinook. Optimal juvenile growth rates for chinook and coho occur at temperature below 58°F to 60°F. At 64°F, temperatures are less than optimal but not yet at levels where growth ceases or direct mortality occurs. In selecting the criteria, this information was balanced with the fact that the unit is a maximum temperature and that if the criteria is met, the fish will be exposed to temperatures above 60°F for only part of the day during a few of the warmest weeks of the summer (Boyd and Sturdevant 1997). The intent is that while this criterion does not eliminate any risk to the fish whatsoever, it keeps the risk to a minimal level (Boyd and Sturdevant 1997). There are currently 569 stream miles on BLM-administered lands (4% of all listed stream miles in Oregon) that are listed by the Oregon Department of Environmental Quality for temperature (see the *Water* section in *Chapter 3*).

Stream Flow

Stream flow is an important element of fish habitat. Stream flow is highly variable in mountainous areas within the planning area and is strongly influenced by the form of precipitation (e.g., rain, snowmelt, or rain on snow) (Naiman and Bilby 1998). For fish species, flow can affect:

- migration
- spawning and emergence
- rearing
- fish habitat (e.g. sediment routing and deposition)

The stream flow regime at the time of spawning is an important factor that determines the ability of migratory salmonids and other fish species to reach spawning areas (Titus and Mosegaard 1992), the amount of submerged gravel (Everest et al. 1987), and the water depth and velocity over gravel beds (Newcombe 1981, Bjornn and Reiser 1991). As stream flows increase, gravel is covered and becomes suitable for spawning (Hooper 1973 in Meehan 1991). However, if flows continue to increase, velocities can become too high for spawning to occur; this would cancel the benefit of increases in useable spawning areas near stream edges (Hooper 1973 in Meehan 1991).

Stream flow also has a major influence on the transport, routing, deposition, and size of gravel available in the stream channel available for spawning fish (Collins 1995, Montgomery et al. 1996).

Salmonid eggs are deposited in gravel beds within the stream channel and generally spend several months in the gravel until emerging. During this time the eggs are relatively immobile, which makes them vulnerable to disturbance of the stream bed. During peak flows, gravel beds can be scoured and transported out of channels (Kondolf et al. 1991). Scour from peak flows is an annual natural process. However, changes in the frequency or magnitude of peak flows can result in stream instability and increased scour. Scour and entrainment of eggs in gravel has frequently been documented (Schuett-Hames et al. 1996, McNeil 1966 in Schuett-Hames et al. 1996, Duncan and Ward 1985, Tripp and Poulin 1986, Lisle 1989, Nawa et al. 1993, Kondolf et al. 1991, and Schuett-Hames et al. 2000). Loss of eggs due to gravel movement occurred frequently in southeast Alaska pink and chum salmon spawning streams. Mortality often exceeded 50% and ranged as high as 90% (McNeil 1966). In the Queen Charlotte Islands of British Columbia, estimated mortality of chum and coho salmon eggs from scour was 80-90% (Tripp and Poulin 1986). Disturbance of more than 75% of the chinook redds was estimated in a southwest Oregon stream due to scour (Nawa et al. 1990).

As a storm event progresses, more water is added to the stream system, increasing stream flow, flow quantity, depth, and erosion power. If stream flow volumes and velocities become large enough, and if sediment and large wood is mobilized, shifts in channel structure and gravel distribution can occur (Swantson 1991). In the planning area, these channel-forming flows typically occur during a 2-year, 24-hour peak flow event (Lisle 1981). When the frequency and magnitude of the flow increases, stream channels can become unstable and streambank erosion increases. These changes typically occur when 5-year flows begin to occur at the 2-year, 24-hour flow interval (Harr 1992). See the *Water* section in *Chapter 3* for fifth-field watersheds in the plan area that currently have peak flows that exceed this threshold.

Aquatic Restoration

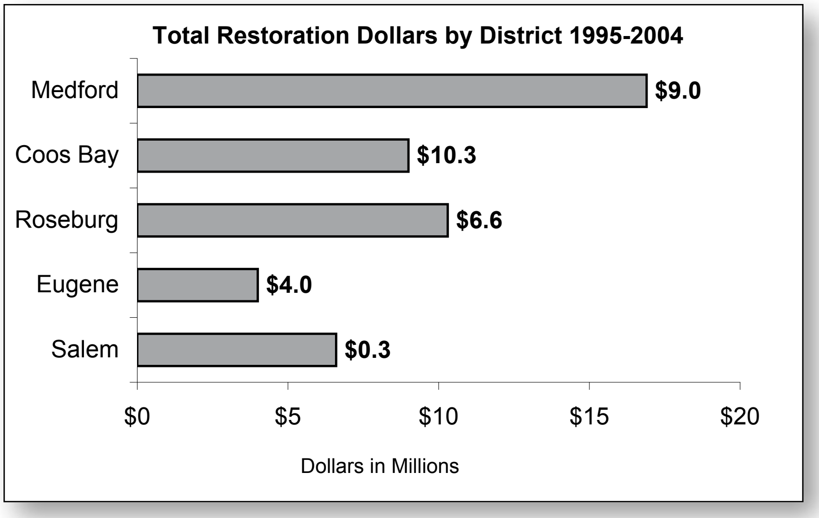
From 1995 to 2004, BLM spent 30.2 million dollars on restoration projects that affect fish habitat on BLM-administered lands in Western Oregon. See *Figure 3-117* (*Restoration funding in planning area 1995-2004*). The BLM has spent approximately 35% of this funding on road projects (mostly rock surfacing) and 49% on fish-passage barriers.

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 *Figure 3-118* (*BLM road control as a proportion of all roads in two representative watersheds*). The checkerboard pattern of BLM ownership generates the need to cross public lands in order to provide access to intermingled private lands and reduces the ability of roads to be decommissioned on BLM-administered lands. *Figure 3-118* shows the amount of BLM road control as a proportion of all roads in two example watersheds.

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 has decreased over the last five years (2000-2005) as projects have been completed.

From 1995 to 2004, BLM replaced 380 fish-passage barriers on BLM-administered lands in the planning area that were fish-passage barriers for anadromous and/or listed fish. As a result, 465 miles of stream became accessible to adult and juvenile fish. See *Figure 3-119* (*Culvert replacements and miles of habitat opened by district, 1995-2004*).

FIGURE 3-117. RESTORATION FUNDING IN PLANNING AREA 1995-2004



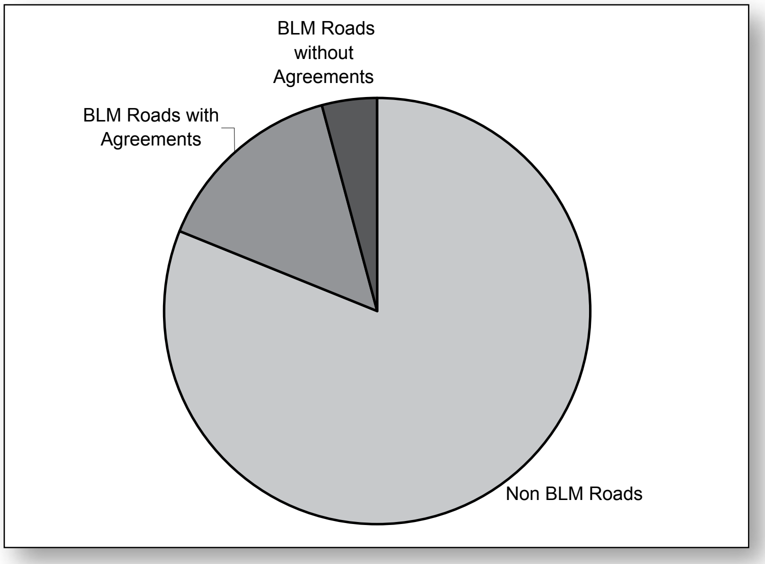


FIGURE 3-118. BLM ROAD CONTROL AS A PROPORTION OF ALL ROADS IN TWO REPRESENTATIVE WATERSHEDS

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. See *Map 3-8* (*Fish passage barriers in Oregon*). Therefore, working with watershed partnerships is critical in order to effectively improve fish passage in these watersheds.

From 1995 to 2004, the BLM implemented instream habitat projects on 110 miles of streams with anadromous and listed fish within the planning area to improve stream complexity. Opportunity for more instream habitat projects exists. See *Figure 3-120 (Miles of treated anadromous or listed fish streams by the BLM districts within the planning area 1995-2004)* for the total stream miles that have been treated by the BLM districts within the planning area and the percent treated of the total miles of anadromous or listed fish-bearing streams.

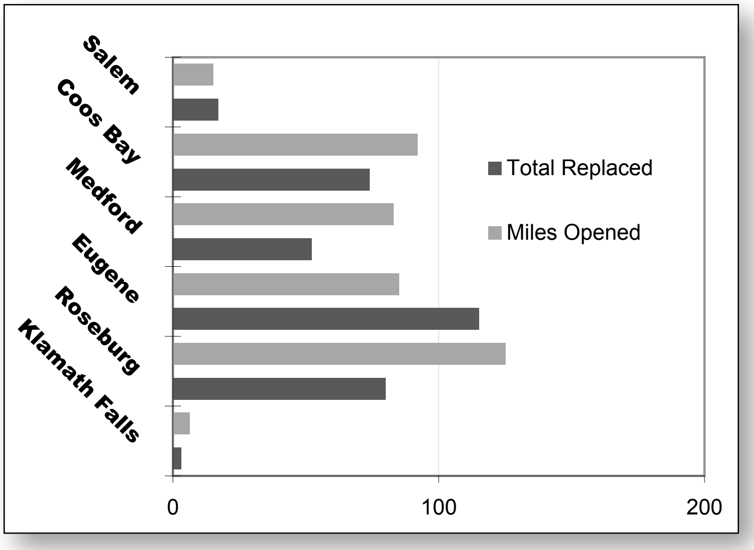
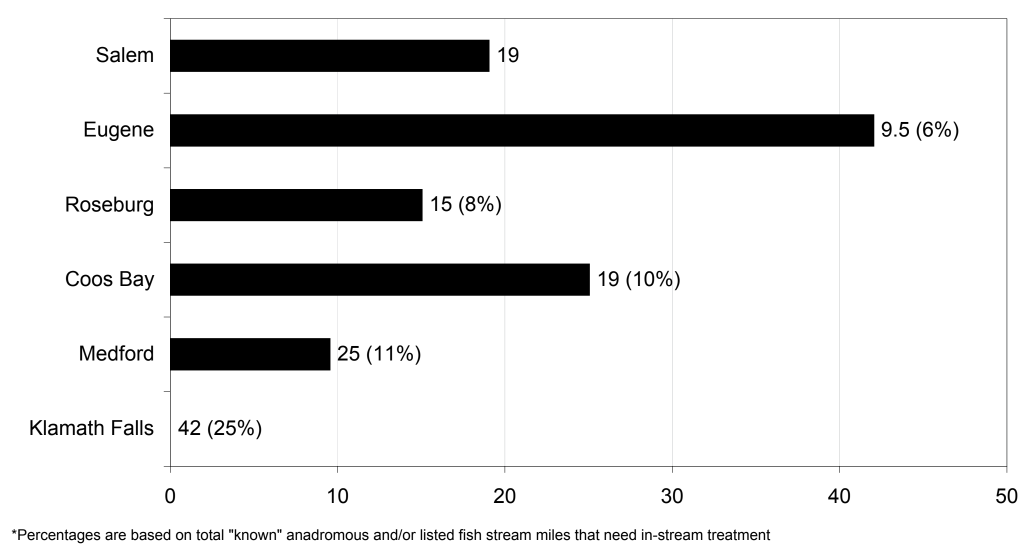
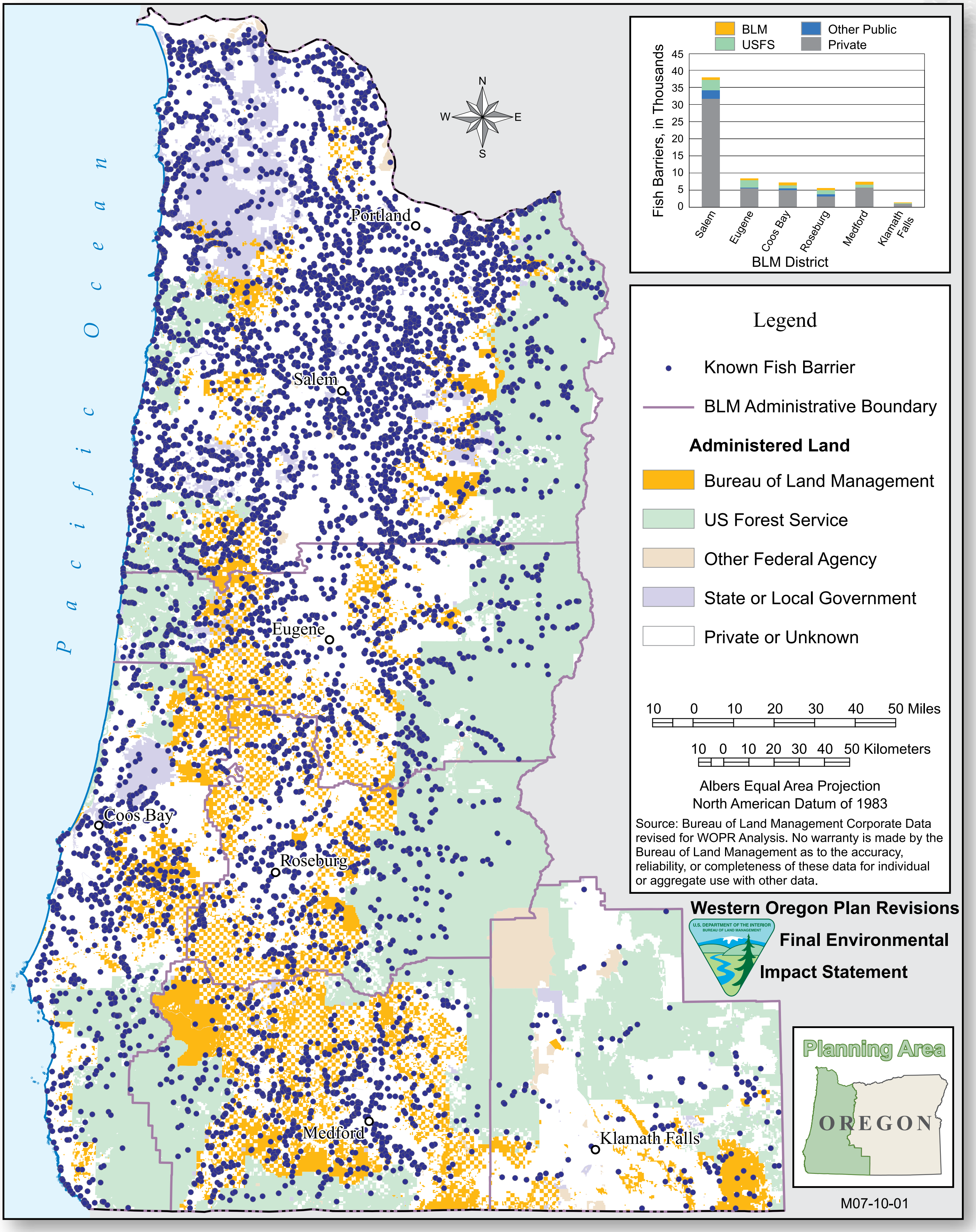


Figure 3-119. Culvert Replacements And Miles Of Habitat Opened By District, 1995-2004

Figure 3-120. Miles Of Treated Anadromous Or Listed Fish Streams By The BLM Districts Within The Planning Area 1995-2004



MAP 3-8. FISH PASSAGE BARRIERS IN OREGON



Albers Equal Area Projection
North American Datum of 1983

Source: Bureau of Land Management Corporate Data revised for WOPR Analysis. No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.