Part 4D Chapter B2: Certainty that the Conservation Effort Will Be Effective: Fish Passage, Roads, and Landslides
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Part 4D PECE Criteria Papers

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Dent L. 2005. ***Certainty that the Conservation Effort Will Be Effective: Fish Passage, Roads, and Landslides Oregon Plan Assessment Part 4D, ODF B2.*** (Dent L 2005b) http://nrimp.dfw.state.or.us/OregonPlan/

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Introduction

The purpose of this chapter is to provide a brief background on the issues of fish passage, roads and landslides, what we know about the extent to which they still pose a threat to coho recovery, and the effectiveness of measures and management practices in place to address those threats. For a more detailed discussion of Fish Passage please refer to the Part 4J of the Oregon Plan Assessment Technical Report 1 (Dent et al. 2005). For a more detailed discussion on roads please refer to Oregon Plan Assessment Technical Report 2 (Mills et al. 2005).

Fish Passage: Background

One of the goals of the Oregon Plan is to improve access to both fish habitat by juvenile and adult salmon. The image that comes to mind when considering fish passage is usually that of adult salmon migrating upstream to native spawning grounds. Less thought of, but perhaps equally important, is the upstream movement of *juvenile* anadromous fish as well as *resident* fish. These younger and/or smaller fish have been observed to make upstream migrations and are thought to do so for a number of reasons including to avoid predation or to seek appropriate habitat for given life stages. State regulations require that all stream crossings pass both juvenile and adult fish (ORS 509.580-910). State measures and guidelines describe methods to install and upgrade stream crossings to accommodate all life history stages of native fish. See ODFW criteria for a summary discussion and legal references (ODF&W 2005).

Barriers to fish passage can result from both natural features such as waterfalls and steep channels or from artificial structures such as stream crossings, tide gates, hatchery facilities, and impoundments. Artificial barriers to fish passage commonly result from culverts at stream crossings. To accommodate juvenile fish passage, culverts must be installed so that velocities through the pipe are less than or equal to the velocity in the natural channel. This can be achieved with a number of strategies that provide areas where the young or very small fish can retreat from fast flowing water and rest before moving upstream again.

Roads and Landslides: Background

Another goal of the Oregon Plan is to reduce sediment inputs associated with road construction and use. The Oregon Plan also addresses the effects of landslides on sediment and large wood recruitment for aquatic habitat.

Sediment is delivered to streams via hillslope and channel erosional processes. In general, hill slope erosional processes include: (1) surface erosion such as rill, gully and sheet erosion; and (2) mass soil movement erosion such as soil creep, earthflows, and debris flows. In Coastal watersheds mass soil movements dominate sediment delivery to streams (Swanson et al. 1987). In the absence of land management and development, surficial processes are much less significant. This is due in part to high infiltration rates, dense canopy cover, and low intensity precipitation events (Harr, 1976). The exception is with roads that create permanent, highly compacted, unvegetated features on the landscape and thus can be chronic sources of fine sediment.

The use of gravel-surfaced roads is the primary source of sediment from forest management activities in the western United States. This is especially true during wet season use when they can be a major source of fine sediment and associated stream turbidity (Megahan and Ketcheson

1996, Reid and Dunne 1984, Mills et al. 2003). A number of research and monitoring studies have investigated this issue. In general lower quality rock results in greater sediment production and delivery of very fine particles (Bilby 1985, Duncan and Ward 1985, Folz 1996, Bilby et al 1989). Research and monitoring has also shown that use of durable surfacing, road drainage practices, vegetated ditches and traffic control such as required under current Best Management Practices (BMPs), can minimize sediment delivery to streams (Bilby et al. 1989, Bilby 1985, Sullivan 1985, Mills et al. 2003).

Road-associated changes in sediment delivery have no correlation to a natural process, so sediment from roads represents an increase over background. The effects of increased sediment delivery from roads depend upon numerous factors. Most fine sediment from surface erosional processes is delivered during common rainfall events and is relatively chronic. Such fine sediment may not deposit in riffles, but in quieter margins or pools in streams (Bilby 1985). Road-related landslides and stream crossing failures can result in significant sediment impacts from the volume of material in the failed fill and also by scouring headwater channels for some distance. These types of sediment inputs tend to be episodic and are often the result of large rainfall events.

The greater the disturbance area associated with the road, and the closer to streams, the greater the risk of sediment delivery. The disturbance area is directly related to road width and hillslope steepness where the road is constructed. High-risk factors for forest roads include road surface erosion, road-fill failure, and the proximity and hydrologic connection of road segments to streams. Roads can also directly alter stream channels and fish habitat, especially when roads are constructed parallel to streams and within the floodplain.

The nature and timing of sediment delivery, the type of material delivered, and the prior condition of the steam influence the extent to which additional sediment delivery to streams will have a negative effect. Excessive fine sediment deposited in stream channels can cause decreased survival of salmonid eggs and alevin by reducing water flow through streambed gravel, thereby suffocating the eggs or preventing the eggs from hatching. Massive increases in fine sediment can reduce pool frequency, depth, and volume. Alternatively, habitat can potentially be enhanced if mass erosion delivers material to streams where coarse sediment is limiting (Coats et al. 1985, Megahan et al. 1980, Botkin et al. 1995, Everest et al. 1987, Hicks et al. 1991).

Of mass movement processes in the Coast Range, debris flows are the most common and of primary focus relative both to public safety and impacts on aquatic resources. Debris flows are defined as shallow, translational, rapidly-moving landslides commonly transported via stream channels. Debris flows are common throughout most of the coast range and overwhelm the sediment budget of both managed and unmanaged watersheds (Dietrich and Dunne 1978; Swanson et al 1987). They are the most prone to being influenced by forest management activities particularly forest roads and timber harvest because of their shallow and channelized nature. Of all the mass movement processes, debris flows are considered the greatest hazard to public safety because of their size, frequency in time and space, and the speed with which they move (Skaugset et al. 2002).

The effects of debris flows on aquatic species and habitat vary through space and time. On one end of the spectrum debris flows can cause direct mortality to fish and dramatically alter aquatic habitat through scour and fill processes, and transport of wood. Erosion may be accelerated and decreases in cover may occur (Lyons and Beschta 1983, Kaufmann 1987, Lamberti et al. 1991). At the other end of the spectrum, debris flow deposits can provide increased cover and habitat complexity from structure such as boulders and wood. Short-term impacts such as scoured tributary channels may be balanced with longer-term benefits such as debris flow deposits at tributary junctions that are associated with high quality aquatic habitat (Benda and Cundy 1990, Everest and Meehan 1991). Reeves et al. (1995) have suggested a long-term perceptive that embraces the dynamic nature of aquatic habitat. They propose a scenario in which aquatic habitat undergoes successional stages similar to forest succession in which habitat varies from “low” to “high” quality throughout space and time. This paradigm accepts that disturbance is an important component of aquatic ecosystem “health” and landslides and debris flows are examples of key disturbance regimes.

Potential landscape-scale effects of forest management may influence both the quantity and quality of landslides. If relatively high percentage of the high-risk areas in a given watershed is in a very young age class (<10 years), the risk of landslide occurrence may be increased (Robison et al. 1999). The quality of landslides can also be influenced at a landscape-scale if relatively large portion of the land area in upper reaches of a watershed is in a young age class. Younger forests will not provide as many of the larger key pieces of wood to areas where landslides and debris flows occur as compared to what an older forest would provide (ODF and DEQ 2002).

There have been multiple studies that have examined the differences in landslide rates between forested and recently harvested sites. Some studies in this ESU have documented that erosion rates are higher in young clearcuts than in unmanaged stands by 1.2 to 3.7 (Swanson et al. 1977, Ketcheson and Froehlich 1978, Robison et al.1999). Robison et al. (1999) documented higher erosion rates in stands less than 10 years old as compared with older forest stands. Some studies have evaluated the mechanistic role of vegetation in preventing landslides (Montgomery and Dietrich 1997).

Channel erosion is another important component of the sediment budget for streams. In gently sloping watersheds, and in the absence of debris flows, channel scour and bank erosion are the primary drivers of sediment transportation downstream (Skaugset et al. 2002).

Independent Multidisciplinary Science Team

As part of the Oregon plan, an Independent Multidisciplinary Science Team (IMST) was formed to provide scientific overview of the program. What follows is a summary of general comments from IMST regarding chronic and episodic failures, landslides, and fish passage. Also included are specific recommendations from IMST to the Oregon Department of Forestry (ODF) regarding road regulations.

The IMST (IMST 1999) had these general comments with regard to the likelihood that Oregon Department of Forestry’s practices were likely to address road and landslide-related issues.

Chronic sediment from roads

> “Implementation of the guidelines should reduce the introduction of chronic sediment. Fine sediment production increases with road construction, use and maintenance. There is a strong scientifically sound basis for site-level management of sediment production and movement to streams.”

Chronic Sediment at the Landscape Level

> "The reported relationships between road density and sedimentation provide only qualitative guidance for landscape-level planning and management. Monitoring and more case history analyses will provide a stronger basis for policy." (IMST 1999)
>
> - In recognition of this fact, ODF has a draft report (Mills Draft 2004) with recommendations for monitoring and characterizing roads in terms of *critical road locations* rather than road density.

Episodic Road Failure

> "The scientific and technical basis for what is needed in road maintenance and retirement is well developed and known. Refinements can occur through the monitoring and event analysis programs that are already part of ODF programs."
>
> - ODF has a long history of monitoring roads and landslides and has an established record of revising rules in response to findings that warrant such changes.

A 1999 IMST report (IMST 1999) had the general comment about managing slope failures and the movement of material into streams.

> "*Slope failure is a natural process and it can have both positive and negative effects on fish habitat. The technical basis for managing roads to reduce or minimize slope failure is well developed. The technical basis for managing non-road-related slope failures is much less well developed, except under extremes of site conditions. Although speculative, we believe maintenance of functional riparian zones along channels where debris torrents may occur can mitigate their destructive force and increase the positive effects they may have.*"

IMST (IMST 1999) had this general comment regarding fish passage:

> "The ODF&W guidelines (OWEB 1999) are believed to be scientifically sound (although not thoroughly tested) and provide an adequate basis for managing fish passage at road-stream crossings."

The IMST made eight specific recommendations directly or indirectly related to the effects of forest roads on the sediment regime or on aquatic habitat. Regulatory responses to these recommendations are described later in this paper. All of them have been addressed in the Oregon Forest Practice BMPs with the exception of a recommendation to bring roads built prior to 1972 up to current standards. This is primarily covered under non-regulatory efforts or regulatory criteria for vacating roads.

Recommendation 8. Develop and implement standards or guidelines that reduce the length of roadside drainage ditches that discharge into channels.

Recommendation 9. Implement the standards and guidelines for the length of roadside drainage ditch between cross drainage structures, especially on steep-gradient roads.

Recommendation 10. Require the flow capacity of cross drainage structures and stream crossing structures and culverts to meet current design standards.

Recommendation 11. Provide for the stabilization of roads not constructed to current standards (including "old roads and railroad grades") in critical locations. Stabilization means reduction or elimination of the potential for failure.

Recommendation 12. Require durable surfacing on wet-season haul roads and require that hauling cease before surfaces become soft or "pump" sediment to the surface.

Recommendation 14. Continue to apply the current best management practices (BMP) approach to the management of forestlands with significant landslide potential, and develop a better case history basis for evaluating the effectiveness of BMP in this area.

Recommendation 16. Oregon Department of Fish and Wildlife (ODFW) and ODF should develop a collaborative program of monitoring to quantify the linkages between parameters of ecosystem condition and wild salmonid recovery.

Recommendation 19. The Oregon Forest Research Laboratory (FRL) in collaboration with ODFW, should develop forest road stream crossing strategies that facilitate the passage of large wood at stream crossings.

The IMST recommendations are generally supportive of Oregon's current BMPs for forest roads. Most of IMST recommendations apply to old roads, and to implement measures that will upgrade these old roads to new road standards. The IMST recommended increasing regulation for new roads (wet season road use-done) and also clarifying drainage standards within existing rules (modification of an existing rule or guidance-done). The IMST also recognized that additional monitoring and research (especially on movement of sediment and large wood past stream crossings) are both critical.

1. (a) What is the nature and extent of the threats being addressed?

This chapter will address two factors that are being evaluated as a risk to coho: fish passage and sediment. Sediment is discussed in the context of roads (both chronic and landslide-related) and debris flows. We also discuss management practices (regulatory and non-regulatory) designed to address these threats to coho. See Mills et al. 2005 and Dent et al. 2005 for a detailed technical discussion of roads and fish passage.

Roads: Fish Passage

For a detailed discussion of data sources, methods, and approach used to quantify the nature and extent of fish passage issues please see Dent et al. 2005. A brief description of the key findings from that study follow.

Throughout the ESU, 10-11% of coho streams is estimated to have limited access by fish (Dent et al. 2005). Dent et al. (2005) discussed the quality of inaccessible habitat in terms of intrinsic potential. Intrinsic potential for winter habitat was modeled from geomorphic and flow characteristics of streams (Burnett et al. in review). Based on model results, each stream segment was characterized as high intrinsic potential (High IP) or low intrinsic potential (Low IP). Eleven percent of Low IP streams and 10% of High IP streams were estimated to have limited access. While 10-11% is a relatively low number, the access status of 28-32% of coho stream miles was estimated as unknown at the time of the analysis (Table 1).

The trends are similar for non-coho streams. Approximately 16% of stream miles are estimated to have limited access, while access is estimated as unknown for 40% of non-coho stream miles. The higher percentages for non-coho streams likely reflect greater overall miles of non-coho streams and a greater number of crossings on these streams (Table 1).

Table 1. Percent of stream miles within access status categories by habitat type for the ESU.

Habitat Type	**Open**	**Limited**	**Unknown**
Non-Coho Streams	44%	16%	40%
Low IP Streams	57%	11%	32%
High IP Streams	61%	10%	28%
All Streams	47%	15%	38%

Roads: Chronic Sediment and Road-related Landslides

Two other coho assessment papers have discussed current conditions with regard to sediment throughout the ESU (DEQ 2005, ODF&W 2005). DEQ demonstrated that sediment remains a water quality concern in the North Coast Coho ESU. Results from DEQ (2005) analyses also demonstrate that while this is the case, water quality from long-term data sets suggest overall water quality is either remaining constant or improving over time. The former is supported by an evaluation of data reported by ODF&W (2005) that demonstrates no changes in percent fines in riffles from 1997 to 2003. However, both the DEQ (2005) and ODF&W (2005) analyses suggest that fine sediment deposition in riffles remain relatively high in coho streams. These trends are consistent throughout the ESU.

Road surveys conducted after the 1996 storm event estimate road density in this ESU to be about 2.8 miles/mile^2 (Robison et al. 1999). By this estimate there are about 30,746 miles of road in the ESU. The estimated miles of road by ownership are shown in Table 2. Future monitoring and research is needed to understand the potential risks that these roads have for sediment delivery to streams. The IMST and others have commented that metrics such as road density or miles of road do not provide an adequate index of risk to water quality and aquatic habitat. It is more informative to demonstrate the miles or densities of roads in critical locations (near streams, on steep slopes) and the conditions of those roads.

Monitoring conducted in the mid-1990s concluded that about one-third (29-39 percent) of active and inactive roads on state and private lands can deliver sediment to streams by ditch delivery (Skaugset and Allen 1998). For the portions of the road network where sediment delivery has occurred it was associated with unfiltered ditch delivery and/or inadequate number of cross drains on steep roads.

More recent data (Robben and Dent 2002) suggests that over 95% of roads are not located in critical locations (i.e. locations likely to increase threats associated with road-related turbidity or landslides). In total, 148.4 miles of existing road and 38.5 miles of new road were surveyed for BMPs that establish standards for effective road surface drainage. There were 2,495 total applications of 33 rules in this section. Compliance was 97.6% for all applications of road construction and maintenance rules. These findings suggest an improvement over the 1998 observations.

Table 2. Estimated miles of road by ownership class in the ESU.

Ownership Class	*Miles of Road	**Relative Percent
State Forested	2800	9
Private Industrial Forest	9900	32
Private Non-industrial	6300	20
Federal	11,746	38
Others	307	1
TOTAL	**30,746**	**100**

* = Road miles estimated assuming 2.8 miles/mi^2, a road density determined from ground based surveys of multiple landowners in 1996 (Robison et al. 1999).

** = Relative percent is based on the relative percent of ownership in each ownership class in the ESU.

Road-related landslides occur during large storm events. Surveys after the 1996 storm indicate road-related landslide rate of approximately 0.5 slides/road mile (Robison et al.1999). The majority of these were fill slope failures. Washouts were counted separately and were estimated to be 0.35 washouts/mile. The study focus was in Northern Oregon in regions with the highest storm stream flows and landslide rates, mostly in the Oregon Coast. The greatest landslide rates were observed in Tillamook followed by Mapleton.

Debris Flows

Debris flows are ubiquitous in the Oregon Coast range (Skaugset et al. 2002) and overwhelm the sediment budget of managed and unmanaged watersheds (Dietrich and Dunne 1978, Swanson et al 1982). They are also most prone to being influenced by forest management activities particularly forest roads and timber harvest because of their shallow and channelized nature. Of all the mass movement processes, debris flows are considered the greatest hazard to public safety because of their size, frequency in time and space, and the speed with which they move (Skaugset et al. 2002). They also are an important source of large wood delivery to stream channels.

The occurrence of debris flows is driven by storm events. The most recent storm event to generate wide spread landslides and debris flows in the ESU was in 1996. Landslide rates that delivered to stream channels from the 1996 storm event were estimated to vary widely throughout the storm area (Robison et al. 1999). Robison et al. (1999) estimate densities varied from 0.4 – 24.4 landslides per mile^2. Over 32% of the total stream miles surveyed had high impacts due to landslides.

There have been multiple studies that have examined the differences in landslide rates between forested and recently harvested sites. Some studies in this ESU have documented that erosion rates are higher in clearcuts than in unmanaged stands by 1.2 to 3.7 (Swanson et al. 1977, Ketcheson and Froehlich 1978, Robison et al.1999). Robison et al. (1999) documented higher erosion rates in stands less than 10 years old than in older forest stands. Some studies have evaluated the mechanistic role of vegetation in preventing landslides (Montgomery and Dietrich 1997).

(b) How Does the Conservation Effort Reduce Threats to Coho?

The conservation effort reduces the threats associated with fish passage and sediment using two approaches: regulatory and non-regulatory.

Fish Passage

Regulatory and Non-Regulatory Approaches

Fish passage laws in Oregon pre-date statehood (1850's) but the most current statute was passed in 2001. This statute re-wrote everything on passage (except screening and bypass) and applies to everyone in the state. Under this current fish passage statute (ORS 509.580-910), ODF&W has authority for fish passage and has subsequently adopted procedural rules (OAR 635 division 412). See ODFW criteria for a summary discussion and legal references (ODF&W 2005).

In 1994 the Oregon Department of Forestry revised stream crossing rules to specifically require both adult and juvenile fish passage (OAR 629-625-0320 2a and 2b and OAE 629-625-600 8) (ODF 2004) on all newly constructed or reconstructed forest roads. The first detailed guidance on how to design stream crossings to pass juvenile fish was available from ODF in June 1995 (Robison, 1995). A memorandum of understanding (MOU) was signed in 1997 as part of the Oregon Plan. The parties to the agreement included: Oregon Department of Transportation (ODOT), Oregon Department of Fish and Wildlife (ODF&W), Oregon Department of Agriculture (ODA), Division of State Lands (DSL), Federal Highway Administration (FHA), and the Oregon Department of Forestry (ODF) (ODOT, 1997). The MOU demonstrates agreement between these agencies to use the same criteria and guidelines when designing or consulting on projects that may affect juvenile and adult fish passage.

ODF&W established guidelines to accommodate juvenile fish passage based on physical abilities of fish to swim upstream. Fish swimming abilities vary by age and species, as do timings of upstream migration. The intent is to accommodate the basic requirements for reproduction, habitat and refuge of the "weakest fish," usually juvenile fish as small as two inches in length, at times when fish usually move (OWEB 1999). Fish swimming abilities vary by age and species, as do timings of upstream movements.

In addition to these legal requirements, and as part of the Oregon Plan, private, state and federal landowners made a commitment to repair existing crossings to bring them up to the same standards. The goal was to achieve these upgrades on all known fish passage barriers by 2012. For a more detailed discussion of these Oregon Plan non-regulatory activities and time lines see attachment 3 of Chapter A1 (Morgan 2004).

Dent et al. (2004) compiled data from private, state, county, and federal landowners to estimate how many fish passage projects have taken place in coho habitat. Oregon Plan fish passage projects are improvement projects that are not otherwise required by law. These are implemented on existing roads across all ownerships. Approximately 76% of Oregon Plan fish passage projects took place in coho habitat (Table 3). Fifty-one percent were in Low IP coho habitat and 25% were in High IP coho habitat.

Table 3. ESU: Number of Oregon Plan fish passage projects and other crossings that pass fish by habitat type (from Dent et al. 2004).

Habitat Type	**Oregon Plan Fish Passage Projects** Number (% of those that pass fish)
Non-Coho	186 (24%)
Low IP Coho	404 (51%)
High IP Coho	198 (25%)
All Streams	788

Reducing the Threat

Dent et al. (2004) estimate that in 2004, 43% of all stream crossings pass fish, 20% limit fish passage, and 37% remain unknown in terms of their ability to pass fish. These rates vary slightly depending on habitat type (Table 4).

Dent et al. (2004) estimate that Oregon Plan activities have improved access to 6-10% of coho streams miles (Table 5). They estimate 6% improved access to High IP streams and 10% on Low IP streams. Overall Oregon Plan activities have improved access by an estimated 16% on non-coho streams and by 14% on all stream miles (coho and non-coho streams). We estimate that of all the stream miles with limited access approximately 18% are High IP streams.

Table 4. Percent of stream crossings that pass, limit, or have unknown fish passage status.

Habitat Type	Pass (% of total number)	Limit (% of total number)	Unknown (% of total number)
All X-ings	43	20	37
Low IP	43	20	37
High IP	60	14	26
Non-Coho	29	26	44

Table 5. Estimated percent of stream miles with improved access for the ESU. The range depends on if unknown status is assumed open or closed. (Data Source: OWEB 1997-2003)

Habitat Type	**Percent of miles with Improved Access***	**Average percent improved access**
Non-Coho	12-19%	16%
Low IP Coho	9 – 11%	10%
High IP Coho	6 – 7%	6%
All Streams	11 – 17%	14%

** = Low end of range reflects assumption that unknown are closed. High end reflects that unknown is open.*

While currently there is not a systematic program for evaluating Oregon Plan fish passage projects, agencies and researchers have been evaluating stream crossings to determine the likelihood or ability to pass fish. Two studies done by the Oregon Department of Forestry evaluated compliance with fish passage guidelines on state and private forestland (Dent and Allen 2000; Paul et al. 2002). ODF randomly selected stream crossings installed from 1996 to 1998. Results suggest that 72-77% of stream crossings were successfully implemented to meet state guidelines in 2000 and 2001 (Paul et al. 2002). The most common reason for sites not meeting the guidelines during both reporting years were installing culverts at too steep a gradient for the chosen strategy, selecting strategy that was inappropriate for the channel gradient, and high outlet drops.

Based on the conditions assumed to provide fish passage (OWEB 1999), 71-74% of crossings installed on forest roads from 1996 to 1998 had a high likelihood to pass juvenile fish. Likelihood depended on whether all design flows or all flows except low design flows were considered (Paul et al. 2002, and Dent and Allen 2000). Bridges and open arches had the highest success rate (100%), followed by those that created a simulated streambed within the culvert (76-93%). The use of bare culverts at very low gradients (<0.5%) and baffled culverts had the lowest success rate for fish passage, at 55% and 25% respectively. The most common reason for the lack of success was not achieving the low gradients needed to reduce velocities (when this was the intended strategy), lack of sediment retention in planned stream simulation strategies, and/or creating outlet jumps.

A 1998 literature review by the Washington State Transportation Center (TRAC) indicated that the role of turbulence and velocity profiles in limiting the ability of fish to pass through culverts was under-studied and poorly understood. TRAC (Kahler and Quinn 1998) reported that fish were able to exceed both the theoretical limitations and laboratory performances and pointed to a need for field studies. Based on the results of a small number of studies they concluded that crossings that simulated natural streambeds should not create a barrier to fish passage. They reported that countersunk culverts (embedded) have proved to be better for fish passage than culverts with or without other modifications for fish passage. They tempered this conclusion with the concern that the steepest culverts had not experienced high flow events (> 10-year flood event) and thus long-term effectiveness is uncertain (Kahler and Quinn 1998). Baffled culverts were found to improve passage of coho and resident trout.

In recent years there has been a movement to design, install, or retrofit existing tide gates to improve fish passage (Charland 1998). Unfortunately, few studies have been carried out to determine the effectiveness of such designs (Giannico and Souder 2004).

Providing juvenile fish passage requires innovative engineering approaches that bridge the gap between biological needs and infrastructure needs. While the science is fairly clear that juvenile fish do indeed move up and downstream, less clear is how successful the stream crossing solutions are at providing juvenile fish passage and on how the fish-friendly crossings will endure over time. More monitoring and research is needed to determine the effectiveness of stream crossing strategies both in the short and long term.

In summary:

- ⇨ Oregon's regulatory program requires that all stream crossings pass juvenile and adult fish.

- ⇨ The Oregon Plan couples non-regulatory efforts with regulatory requirements to address stream crossings that pre-date recent guidance and regulations.
- ⇨ Oregon has incorporated state of the art science on fish passage into guidelines for complying with the laws and non-regulatory measures.
- ⇨ 43% of all stream crossings in the ESU are estimated to pass fish.
- ⇨ 72-77% of crossings on private and state forested land are estimated to pass fish.
- ⇨ 76% of Oregon Plan fish passage projects were implemented in coho habitat.
- ⇨ Oregon Plan projects are estimated to have increased access to 6 – 11% coho stream miles.
- ⇨ Limited research on effectiveness suggests strategies within Oregon guidance have a high degree of certainty to pass fish.
- ⇨ Monitoring on forestland suggests that implementation of Oregon fish passage guidelines results in a 71-77% likelihood of passing fish.
- ⇨ More research is needed to further validate the fish passage strategies in the field.
- ⇨ IMST recommended that the state document the progress of non-regulatory efforts to improve fish passage on stream crossings installed prior to 1994 (IMST 1999). Results from Dent et al (2004) suggest that non-regulatory fish passage improvement projects have improved, albeit modestly, access to coho streams.
- ⇨ Limited monitoring, research, and literature reviews confirm IMST comment that the strategies are likely to pass fish (Dent and Allen 2000, Paul et al. 2002, Kahler and Quinn 1998), but more field validation is needed.

Regulatory Approach Privately Managed Forest Land

Chronic Sediment and Road-related Landslides

Oregon's Forest Practices Act (Oregon Revised Statutes 527.610 to 527.992) provides the legal authority for Oregon's forest practices rules and their enforcement. These are Oregon Administrative Rules (OAR's), Chapter 629, with specific rules for roads in Chapter 625, and rules for planning in Chapter 605 (ODF 2004). Specific practices cover road location, design, construction, maintenance, vacating and use during wet periods. These rules are enforceable BMPs designed to minimize sediment delivery to channels. The primary goals of the road rules are to protect (1) the water quality of streams, lakes, and wetlands; (2) fish and wildlife habitat; and (3) forest productivity.

A brief description of the administrative rules is provided below. The regulations address IMST Recommendations and establish road construction and maintenance practices identified in the research as ways to reduce the effects of roads on aquatic habitat. Following each regulatory description is a parenthetic statement identifying either the IMST recommendation or research finding that is addressed. The full IMST recommendations are provided in the Background section of this paper.

The Forest Practices Rules recognize three types of roads:

- *Active**:*** Roads used for removing commercial forest products (regardless of the year constructed).

- *Inactive:* Roads used for forest management purposes other than log hauling (regardless of the year constructed).
- *Vacated:* Roads that have been purposely "put to bed", stabilized, and are impassible.

Planning and Notification: The landowner, logger and/or road builder must notify ODF prior to road construction or reconstruction. If roads cross fish bearing streams, in riparian management areas or on very steep slopes the operator must submit a written plan detailing road design and construction practices at these locations. Roads in these locations are also a high priority for regulatory inspection. Written plans may also be required whenever there is a risk of materials entering waters of the State.

Road Location: Roads must be located away from streams and steep slopes to the extent possible, crossing streams is only allowed for essential access. Essential access is defined in ODF Technical Note #7 as situations when access requires construction through some of the critical locations. This may occur when roads must cross these locations, extra effort is required to align roads to more suitable ground as quickly as possible, and to completely avoid the most sensitive critical locations.

The ODF Board of Forestry (BOF) approved a *Critical Road Locations Approval Policy* in March 2002. This policy is authorized by OAR 629-625-0100 and 0200. Before roads are constructed or reconstructed, the Department will work with operators and landowners to locate these roads away from critical locations to the extent possible. Critical locations include high landslide hazard locations (process for identification described below under debris flows), slopes over 60 percent with decomposed granite-type soils, within RMAs or within 50 feet of stream channels or lakes, or within wetlands. These are locations where direct impacts to streams are likely even when the best forest road building techniques (the road design and construction rules) are all used correctly. *(IMST Recommendation 14; Research finding: Decreases in proximity of roads to streams, landslide prone areas and other "critical" locations will decrease sediment delivery risks)*

The critical road location policy was originally built on the ODF's prior approval authority embodied in OAR 629-625-0100 and on the actual standards for practices described in OAR 629-625-0200. Oregon HB 3264 (2003) removed the requirement for operators to obtain prior approval, including approval of written plans. However, ODF holds that it has the authority to still require written plans for roads to be located in critical locations, based on its previous authority to require written plans whenever prior approval was required. In addition, OAR 629-605-170 requires written plans for operations near fish use streams, domestic use streams, significant wetlands, large lakes, and certain wildlife sites. The standards for actual road location practices as described in OAR 629-625-0200 were not affected by the 2003 legislation. The written plan is now used as a communication tool to help ensure that ODF, the landowner, and the operator all are familiar with rule requirements, site conditions, and landowner objectives (that was always one of the primary purposes of the written plan). The actual standards for the operator's road location practices are contained in OAR 626-625-0200. Based primarily on sections (2) and (3) of that rule, ODF has the authority to implement the critical road location policy described in Forest Practices Technical Note Number 7. That note is outdated where it refers to the now-inactive prior approval requirement.

ODF may take enforcement action for failure to file a required written plan, and/or for failure to follow a specific practice described in rule (e.g., in OAR 629-625-0200). Enforcement action may include (1) a written statement of unsatisfactory condition (essentially a warning of citations to come if the operator does not take specific remedial action) where damage is very minimal or has not yet occurred, or (2) a citation, order to cease further violation, and order to repair damage, along with the potential for civil penalties, where significant damage has occurred. ODF also has the authority to seek criminal prosecution when operators blatantly disregard forest practice regulations, or where the monetary gain from noncompliance exceeds the allowable civil penalty amount; ODF finds that this enforcement option is needed only rarely, but it is available. ODF finds that most landowners and operators are cooperative, and that the up-front communication process leads compliance in most instances; the written plan can help with this process. Regardless of whether a written plan is required, ODF field foresters screen notifications of operations for the effects operations might have on protected resources, and work with landowners and operators before and during the operation to help ensure compliance.

*Design of roads to minimize disturbed area**:*** Roads must be of minimum width, using grade and alignment changes to reduce excavation and filling. These rules result in the vast majority of roads with running surfaces of 12-16 feet wide, with a total disturbed area of 16 to 30 feet wide. *(Research finding: Decrease disturbance area decreases sediment delivery risks)*

Stream crossing design: Rules require minimizing the number of stream crossings, and where crossings are necessary ensuring the structure allows passage of adult and juvenile fish (see Oregon Plan Technical Report OPTR2 Dent et al. 2005) and very large flood flows (50-year return interval). Rules also require keeping construction equipment and debris out of streams, except as essential for construction. (*IMST Recommendation 15)*

Road Surface Drainage: These rules were modified in 2002, and a technical guidance note was drafted in 2003. Rule modifications changed priority drainage criteria and increased emphasis on cross drainage to direct drainage waters to undisturbed forest soils and not streams. Forest Practices Technical Note 8 includes specific guidance for complying with this new rule and criteria for locating and spacing culverts. *(IMST Recommendations 8 and 9; Research finding: Reduced hydrologic connectivity to streams reduces sediment delivery)*

Road Maintenance and Repair: Road maintenance is required on all active and inactive roads. Regardless of when a road was constructed, if the road has been used as part of an active operation after 1972, it is subject to all maintenance requirements within the current rules. Culverts must be kept open with adequate surface road drainage and filtering of fine sediment to prevent delivery of road drainage and sediment to streams. If the road surface becomes unstable or if there is a significant risk of sediment running off of the road surface and entering the stream, road activity must be halted and the erodible area must be stabilized. Note that abandoned roads constructed prior to 1972 and not used for forest management since that time are not subject to Forest Practices regulatory authority. *(IMST 14; Research finding: Road maintenance and traffic control during wet periods reduces sediment delivery)*

Road Vacating: All roads in use since 1972 must either be maintained or vacated by the operator. Vacated roads must be effectively barricaded and self-maintaining, in terms of diverting water away from streams and off of the former road surface, where erosion will remain unlikely. Methods for vacating roads include pulling stream crossing fills, pulling steep side cast fills, and cross ditching. It is up to the landowner to choose between vacating a road and maintaining a road. If a road is not vacated, the operator is required to maintain the road under the current rules whether it is active or inactive, however they are not required to bring the design up to current standards outside of the normal maintenance and repair schedule. *(IMST Recommendation 11; Research finding: Reduces sediment inputs from roads no longer in use by requiring maintenance or proper vacating practices; issues pertaining to "legacy roads" are addressed with non-regulatory approaches)*

Wet season road use: These are new rules adopted in 2002. They address road use in wet weather to:

1. Ensure that durable surfacing or other effective methods are used on road segments that can deliver sediment to fish or domestic use streams; and
2. Require operators to cease heavy truck traffic on roads when the road surface is breaking down (only for segments that are delivering sediment to fish or domestic streams).

(IMST Recommendation 12; Research finding: Decreases sediment inputs that can occur during wet-weather use by increasing rock quality and controlling traffic)

Old roads versus new roads: Construction and maintenance under current Best Management Practices (BMPs). Many active and inactive roads were constructed prior to current BMPs. The design standards of these older roads pose a higher sediment delivery risk than roads constructed under current design standards. Roads built under older standards are not required to be brought up to current design standards until either a segment needs to be reconstructed or the road shows immediate signs of failure that would damage waters of the state (i.e., collapsing culverts, actively moving hillslopes, drainage waters causing gullying, etc.). For example, design standards for stream crossings were recently changed. This change did not immediately require that operators replace all older culverts with new larger culverts. However, as the older culverts are replaced as part of the overall road maintenance required under the rules, they must be replaced with culverts that meet the new standards.

Debris Flows

Risks associated with landslides are addressed by (1) identifying high landslide hazard locations and (2) avoiding road construction and interactions with these critical locations. Current rules that restrict harvesting around these areas are geared towards public safety with practices that, in part, may be odds with aquatic habitat goals. The board of forestry is also considering rule revisions that address aquatic habitat processes such as large wood recruitment from debris flows. The most recent changes to the regulations (in 2002) were to implement a policy for avoiding the construction of roads in critical locations such as steep slopes that may have a moderate to high risk of slope failure (OAR 629-625-0100 and 0200). New rules were also adopted to guide evaluation and management around landslide prone areas that pose a risk to public safety (OAR 629-623-0000-0800) (*IMST Recommendations 13*).

The process for identifying high landslide hazard locations is described in detail in Technical reports #2 and #6 (ODF 2003a and b respectively). These are available at the following web links:

Tech Note #2: http://www.odf.state.or.us/pcf/Pub/fp/LandslideHazNote2.pdf
Tech Note #6: http://www.odf.state.or.us/pcf/Pub/fp/LandslideTechNote6.pdf).

What follows is a brief description.

High landslide hazard locations are specific sites that are subject to initiation of shallow, rapidly moving landslides due to steepness, shape, and geology of the site. Note that high landslide hazard location identification is based on physical slope characteristics and is independent of proposed harvesting or road building practices. The specific criteria for determination of these sites is found in 629-623-0100 (3) as:

a) The presence, as measured on site, of any slope in western Oregon (excluding competent rock outcrops) steeper than 80 percent, except in the Tyee Core Area, where it is any slope steeper than 75 percent; or

b) The presence, as measured on site, of any headwall or draw in western Oregon steeper than 70 percent, except in the Tyee Core Area, where it is any headwall or draw steeper than 65 percent.

c) Notwithstanding the slopes specified in (a) or (b) above, field identification of atypical conditions by a geotechnical specialist may be used to develop site specific slope steepness thresholds for any part of the state where the hazard is equivalent to (a) or (b) above.

Planning and Notification: Operators (the landowner, logger and/or road builder) must notify ODF prior to road construction or reconstruction as described above, if roads are on very steep slopes. The operator must submit a written plan detailing road design and construction practices at these critical locations. Roads in these locations are also a high priority for regulatory inspection.

Road Location: This is described above. (the road design and construction rules) are all used correctly. (*IMST Recommendation 14*; *Reducing road-related landslides)*

Road design in landslide prone locations: This includes identification of high landslide hazard locations along proposed road locations, and using grade and alignment changes to minimize road length on these steep slopes. In the limited locations when this is not possible, rules require keeping fill off steep slopes and out of streams by use of full-bench end-haul road construction techniques. These rules were adopted in 1983, and were the geotechnical emphasis of the forest practices program between 1984 and 1996. Full-bench end-haul is the standard now and forest landowners know to use these techniques on steep slopes. In 1996, ODF's emphasis shifted to public safety. (*IMST Recommendations 14; reducing road-related landslides*)

Harvest Restriction and Leave Tree Requirements for High Landslide Hazard Locations: These rules (629 623-0100-0800) are designed to address public safety and are not geared towards protection of aquatic habitat. However, overlap with aquatic goals include rules that describe situations in which upslope harvesting is restricted (629 623-0100-0400) and large standing trees must be left along likely depositional reaches of debris torrent-pone streams (629 623-0100-0600). (*IMST Recommendation 13* where *public safety and fish habitat concerns overlap, large wood recruitment from upland sources during debris flow events, and reducing travel distance*)

Managing small non-fish bearing streams: The Board of Forestry approved draft rule language in April of 2004 for increased protection for some small non-fish bearing streams to improve the "quality" of landslides that could deliver to fish-bearing streams. (*IMST Recommendation 13; Increases large wood recruitment from upland sources during debris flow events*)

Regulatory Approaches for State Managed Forest Lands

Chronic Sediment, Road-Related Landslides, and Debris Flows:

State forests managed roads must comply with the rules and regulations described above. The State Forests Management Program (FMP) uses a blended approach of landscape and site-specific strategies to minimize sediment input to streams and achieve other goals for riparian and aquatic habitat. The IMST cited this approach as necessary to achieve a high likelihood of restoring and maintaining properly functioning aquatic ecosystems (IMST 1999). What follows is a brief summary of upland strategies. For more information on aquatic and riparian strategies please see Part 4D, ODF Chapter B1 Riparian Report (Dent 2005). For more detailed discussion of roads see the Oregon Plan Technical Report 1 (Mills et al. 2005).

Landscape Strategies. The FMP describes a number of strategies for managing at the landscape level to achieve desired riparian and aquatic conditions. These include: Watershed Analysis, Salmon Anchor Habitat Strategies, Slope Stability and Road Management Strategies. The following is a brief description of each of these strategies.

Watershed analysis is described as a critical process for refining and planning management activities related to implementation of the forest management plan. State Forests has developed a watershed analysis manual (ODF 2004) that describes the goals for watershed analysis, a process for implementing the analysis, and a process for incorporating watershed analysis findings into implementation plans. The goal for each watershed analysis is to evaluate if the aquatic ecosystem is in a properly functioning condition. If it is not, then limiting factors will be identified and the analysis will evaluate if existing ODF strategies are likely to remedy the limiting factors. If they are not, then other measures that ODF can take to address the limiting factors will be described. In this way, watershed analysis provides a tool for adapting FMP strategies at a watershed scale to create the desired future conditions for riparian and aquatic ecosystems.

FMP describes a Salmon Anchor Habitat (SAH) strategy for managing salmonid species of concern. Seventeen watersheds in the Tillamook and Clatsop State Forests were selected as SAH because they are considered to currently support the best existing habitat and relatively high salmonid production. These watersheds are managed to reduce short-term risk to salmonids while balancing multiple purposes of state forests. The strategy implements additional management restrictions within riparian areas, around small non-fish bearing streams, and basin-specific caps on clearcut harvesting. See Part 4D, ODF Chapter B1 Riparian Report (Dent 2005) for more details.

Landslides are a common natural geologic process that affect riparian and aquatic habitat. The general goals of the FMP slope stability strategies are to minimize road-related landslides and chronic erosion, and to manage uplands to ensure that large wood is available in the track of potential debris flows. This will be achieved through management at three levels. (1) Through the watershed analysis the state will complete a broad-level assessment of landslide hazards. (2) At the district level, implementation planning and annual operations planning will utilize geotechnical expertise in evaluating alternatives that can minimize or avoid risk in high and moderate hazard areas. (3) During project planning at the design level, ODF will utilize geotechnical expertise to minimize or avoid risk in high and moderate hazard areas. The analyses will work in conjunction to promote desired functions such as delivery of large wood to downstream reaches.

State Forests recognizes road management as one of the most critical forest management activities with the potential to impact riparian and aquatic conditions because of their permanent nature and their potential connectivity to stream systems. The State Forests program implements all forest practices road construction and maintenance rules as described above, using 12 (following) guiding principles as its policy on how to apply forest practices to State Forest management plans:

1. The amount of road on state-owned forest land will be the minimum necessary to achieve the goals of Forest Management Plans.
2. New roads will be located to provide the best protection to natural resources and meet the objective of the road.
3. High-risk sites will be avoided wherever possible. Where high-risk sites cannot be avoided, state-of-the-art design and construction practices will be used.
4. New roads will be located, designed and built for economically efficient and effective forest operations.
5. Roads will be designed to meet access needs, have low impacts on natural resources and the forest, and for economical construction and maintenance.
6. Temporary roads will be used to meet short-term access needs. When the need no longer exists, the temporary road will be vacated.
7. Forest roads on state-owned forest lands will be designed constructed and maintained to provide effective and efficient drainage of surface water.
8. Juvenile and adult fish passage will be provided where roads cross fish-bearing streams.
9. Waste areas for depositing excess road excavation material will be located on stable sites.
10. Rock pits and quarries will be designed and developed to provide for environmental protection and site reclamation.
11. An active road maintenance program will be used to protect capital investments, minimize adverse effects to water quality and aquatic habitat, and provide for safe use of the road.
12. Roads that are determined to be unnecessary for forest management will be vacated. In addition, roads that are causing or likely to cause serious environmental problems, very near fish-bearing streams, or have very high maintenance costs will be considered for vacating.

Reducing the Threat

Reducing the Threat: Chronic Sediment and Road-Related Landslides

In general research and monitoring has established that sediment delivery to streams via road surface erosion is minimized when roads are managed using BMPs as have been described in the above regulatory approaches. Examples include minimizing connectivity with stream systems, maintaining durable surfacing and controlling traffic during heavy precipitation (Bilby et al. 1989, Ketcheson and Megahan 1996, Mills et al. 2003). Recent studies also suggest that the size and occurrence of road-related landslides has decreased under current forest practice rules (Robison et al. 1999).

These road-related administrative rules have continually evolved in response to changes in scientific knowledge. Since the first adoption of forest practices administrative rules in 1972, major revisions to the road rules occurred in 1978, 1983, 1994, and 2002. ODF has prioritized road and landslide monitoring. Findings from these studies and available research have been incorporated into rule revisions to reduce the threats to salmon habitat associated with sediment. Below is a summary of recent monitoring findings.

Data available from 1996 demonstrated that about one-third (29-39 percent) of active and inactive roads on state and private lands can deliver sediment to streams by ditch delivery (Skaugset and Allen 1998). This project also found a general lack of filtering of drainage waters near streams, and that steep-gradient roads tended to have cross drainage structures at wider spacing than lower-gradient roads.

More recent data (Robben and Dent 2002) suggests that over 95% of roads are not located in critical locations (i.e. locations likely to increase threats associated with road-related turbidity or landslides) (Table 6). This is the case for both new and old roads. However, old roads were more commonly in RMAs while new roads were built on steep slopes. This likely reflects a shift in policy that calls for building ridge-top roads and minimizing road construction in midslope areas and along streams. In total, 148.4 miles of existing road and 38.5 miles of new road were randomly selected then surveyed for BMPs that establish standards for effective road surface drainage. There were 2,495 total applications of 33 road rules. Compliance was 97.6% for all applications of road construction and maintenance rules. These findings suggest an improvement over the 1996 observations.

Robben and Dent (2002) concluded that the greatest source areas of sediment delivery were from 36 road construction and maintenance practices that were not in compliance with the rules. Specific sediment source areas were ineffective road drainage design (11), inadequate road drainage maintenance (10), eroding stream crossing fill (10), unstabilized road waste (4), and an unstable road prism design (1) (Robben and Dent 2002). Since this monitoring, the road drainage rules were modified, and a technical note on road drainage was written to further reduce the threats to aquatic habitat.

Table 6. Percent of New and Existing Road Lengths in Each Location Category

Road Age	Number of Units	Total Length (ft)	Percent of Total Length	Percent of Total Road Length Located in Each Category Highest Res. Impact → Lowest Res. Impact					
				High Risk Site	High Water	Seeps Springs	RMA	Slopes >65%	Other
New Roads	80	203,100	21%	0.6%	0.0%	0.6%	0.0%	3.1%	95.6%
Existing Roads	144	783,500	79%	0.6%	0.1%	0.1%	1.4%	1.2%	96.6%

Wet season road use can be the most significant forest practice-associated source of chronic turbidity and fine sediment to streams. Monitoring on federal lands had shown that the use of quality aggregate (gravel) road surfacing produces only 6 to 25 percent of the fine sediment produced by roads rocked with poor quality aggregate (Folz 1996). The Oregon Department of Forestry completed a study of turbidity associated with wet season road use (Mills et al. 2003). Results from this monitoring project indicate that: 1) the length of roadside ditch draining to streams; 2) traffic levels; and 3) the percent of fines in gravel surfacing can be managed to reduce turbidity increases associated with wet season road use (Mills et al. 2003). This study was used to design the recent changes (2002) to the forest practices rules that address all of these components.

The following are conclusions from Robison et al. (1999) regarding road-related landslides. These findings include the most current information addressing the adequacy of the forest practice rules in reducing the threats associated with landslides and forest roads.

- Landslides associated with forest roads made up a smaller percentage of the total landslides in the ODF study than road-associated landslides did in most previous studies.
- The road-associated landslides identified during the ODF study were smaller, on average, than road-associated landslides in past studies. However, these road-associated landslides were still four-times larger on average than those landslides not associated with roads.
- Landslides that delivered sediment to stream channels rarely occurred on roads crossing slopes of less than 50 percent, especially when those roads had well spaced drainage systems and fills of minimal depth.
- Road fill placed on steep slopes creates an increased landslide hazard even where no drainage water is directed to those fills.
- Road-drainage waters directed onto very steep slopes create an increased landslide hazard even when there is no road fill placed on those very steep slopes.
- In the ODF study, washouts were a significant problem in Tillamook. Washouts were often related to undersized culverts (installed prior to current rule requirements).
- Based on the lower numbers of road-associated landslides surveyed in the ODF study and on the smaller sizes of these landslides (as compared with previous studies), current road management practices are likely reducing the size of road-associated landslides as well as the number of landslides.

Summary

- ⇨ ODF has a strong regulatory program that requires notification of road construction in and around critical locations such as streams and landslide-prone areas.
- ⇨ The regulations are an enforceable BMP program designed to minimize effects on water quality and aquatic habitat.
- ⇨ ODF has a strong monitoring program that facilitates adaptive management and rule revision processes to improve resource protection.
- ⇨ The ODF regulatory and management programs decrease sediment input to streams by:
  - ✓ decreasing the proximity of roads to streams and landslide-prone areas
  - ✓ decreasing disturbance area associated with roads
  - ✓ reducing hydrologic connectivity to streams
  - ✓ controlling traffic during wet periods when hauling is contributing to erosion and delivery of sediment to streams
  - ✓ requiring the use of high-quality rock surface on roads. Monitoring and research demonstrate that durable surfacing can reduce sediment delivery by 75 to 90 percent or more
  - ✓ requiring maintenance or proper vacating practices for roads no longer in use

Reducing the Threat: Debris Flows

Identifying High Landslide Hazard Locations. A systematic process for identifying locations where landslides might occur is the first step in managing the risk. The science and technology for identifying debris flow-prone terrain and channels is available (Montgomery and Dietrich 1994) and key drivers from that science have been incorporated into ODFs approach. Robison et al. (1999) documented that at least 78% of the landslides that occurred in the 1996 storm event were identified as "high risk sites" for landslides - confirming the value of that identification process.

Leave Trees around Landslide Prone Areas. While research has established that the rates of erosion are higher in younger stands than in older stands, it has also established that landslides occur with or without forest management and supply both sediment and structure such as large wood and boulders (Dietrich and Dunne 1978, Swanson et al 1987). Therefore changes in forest practice rules and regulations are being considered that will create an environment so when landslides do occur they are beneficial to aquatic habitat. Non-regulatory measures are already in place to achieve this goal. However, the marriage between science and management strategies to reduce threats is not as well developed and requires more research and monitoring.

For example, the effectiveness of leave trees in and around potential landslide locations is not well understood. A study by Martin (1997) suggests no significant difference in erosion rates with the use of headwall leave areas. However forested headwall areas were exposed to greater periods of time with landslide producing storms, giving the potential to inflate the relative forested erosion rates. Therefore the strength of findings from this research is tempered by differential exposure to landslide-generating storm events. This is often the case for landslide studies as results are dependent on the occurrence of or lack of occurrence of storm events.

Leave Trees in Debris Flow Paths. An analysis from Robison et al. (1999) suggests debris flow travel distance is reduced in part by the presence of large diameter trees along debris flow paths. Acknowledging that the forest practice rules are geared towards public safety, it stands to reason that the practice would also be beneficial to aquatic habitat. There have been modeling exercises to predict wood delivery and accumulations in streams over long periods of time with varying landscape conditions (Benda and Sias 1994). The output generally demonstrates great variability through time and space. An evaluation of leave tree management practices with such models, while not available at this time, will ideally inform management and monitoring strategies in the future.

Large Wood Recruitment. Landslide-delivery of wood to streams is addressed in detail in Part 4D, ODF Chapter B1 Riparian Report (Dent 2005). In general current research establishes that landslides and debris torrents can provide major contribution of wood to streams (10-60%). However, there is no scientific or monitoring data on if the High Landslide Hazard requirements to leave trees on headwalls are reducing the threats to coho associated with debris flows. Nor is there data on effectiveness of forest practice rules that are geared towards public safety. However, it stands to reason that in the event of a debris flow, a landslide that contributes wood as well as sediment and boulders could better mimic historic processes.

Summary

- ⇨ ODF has a strong regulatory program that requires notification of road construction in and around critical locations such as streams and landslide-prone areas.
- ⇨ The regulations are an enforceable BMP program designed to minimize effects on water quality and aquatic habitat.
- ⇨ The program reduces the threats associated with landslides with a systematic approach for identifying high landslide hazard locations.
- ⇨ The program reduces the threats associated with road-related landslides by avoiding road locations in critical landslide-prone areas.
- ⇨ Monitoring suggests that the numbers of road-related landslides has decreased although they remain larger than non-road related landslides.
- ⇨ Rule revisions currently in draft format would potentially decrease threats associated with landslides by increasing large wood delivery from small non-fish bearing streams during episodic events when sediment is also delivered by debris flows.
- ⇨ Harvest restrictions currently emphasize public safety. However, commonalities include the retention of large trees along depositional reaches of debris flow paths and harvest restrictions on steep slopes where debris flows are likely to initiate.
- ⇨ Watersheds designated as Salmon Anchor Habitat may further reduce threats associated with landslides by increasing retention of trees along non-fish bearing streams which could increase large wood recruitment associated with debris torrents.

Road Restoration and other Non-regulatory Actions

There are non-regulatory actions identified under the Oregon Plan relating specifically to roads. The three major elements of this project are (1) surveying roads using the Forest Road Hazard Inventory Protocol (OWEB 1999b), (2) prioritizing problem solutions, and (3) repairing problem sites identified through the protocol. Road repairs were prioritized for roads near coho streams and in areas with old roads on steep slopes. The following is a description of the types of activities implemented under the Oregon Plan to reduce the threat to coho recovery associated with road-related sediment and blockages to fish passage.

Road condition survey - Consistently identify and prioritize hazards that present a risk to aquatic resources, and locate those road segments or points needing repair work.

Fish passage improvement - Allow adult and juvenile passage at a structure (usually a culvert) that was identified by the survey as a barrier to either adult or juvenile fish.

Structure replacement to pass the 50 year peak flow - Improve passage of flood flows with a margin of safety that will greatly reduce washout risk.

Filtering cross-drains added - Direct road drainage to the forest floor instead of into streams. This has at least two positive effects, reducing hydrologic change, and keeping chronic fine sediment (and associated turbidity) from reaching streams.

Other cross-drainage structures added - Reduce ditch and road prism erosion by reducing volume and velocity of drainage waters.

Culvert outlet protection - Correct problems caused by culvert outlets that were installed so that water falls a long distance onto erodible, sometimes resulting in significant erosion.

Durable surfacing roads - Reduce or eliminate turbidity associated with hauling timber during rainy periods, in order to comply with the turbidity Water Quality Standard. *Note, when this project began, this was not explicitly required by forest practices rules, though is now. Monitoring and research demonstrate that durable surfacing can reduce sediment delivery by 75 to 90 percent or more.

Rocking road ditches - Stop down-cutting and erosion of the ditch caused by excess flow. This is done to allow decrease turbidity of drainage water that flows into culverts where installing extra cross-drain culverts would cause other environmental problems.

Sidecast pullback – Sidecast is weak, unconsolidated fill on steep slopes and can present a high debris flow risk when located above streams. Sidecast is pulled back to reduce the risk of rapidly moving landslides. This can be very effective when all sidecast is removed, and when drainage waters are directed away from these slopes.

Large landslides stabilized - Re-open a road and reduce typically chronic erosion. These are slump type features that often involve all of the road and some of the slopes above and below the road.

Vacating - Permanently stabilize all elements of the road prism for roads with no future use planned. Vacating includes removal of stream crossings and re-establishing stream bed to pre-road conditions to the extent possible, installing permanent drainage ditches across the road, removal of steep fills, and where necessary, revegetation of exposed surfaces.

Closing - Temporarily block a road to traffic, with road maintenance as needed to address any sediment problems that develop.

Relocation - Move roads away from streams or landslide prone slopes. This includes vacating the original road. This can be a very effective repair/restoration activity.

Legacy Reconstruction - Re-open an old road and bring it up to current standards (juvenile fish and 50 year plus peak flow passage at crossings), disconnecting drainage from streams, sidecast and landslide stabilization.

Grass seeding - Reduce erosion of exposed surfaces. While re-vegetation occurs naturally and quickly along the northern portion of this ESA, in drier areas re-establishment can be difficult, thus the utility of seeding. Of activities reported, this is least beneficial for existing roads, as it is most effective on new roads with bare slopes.

Leave Trees On Small Type N Streams – Landowners establish 20 foot RMAs on small non–fish bearing streams, where they are not otherwise required. The goal is to increase potential large wood delivery to fish bearing streams when landslides and debris flows occur.

Reducing The Threat: Road Restoration and Other Non-regulatory Actions
The road hazard identification and risk reduction project includes a detailed survey to identify hazards and risks to streams, and specific repairs that are above and beyond FPA road maintenance minimums and towards new road standards. Road repairs were prioritized for roads near coho streams and in areas with old roads on steep slopes. This project has been applied extensively on Private Industrial (32% of the ESU) and State (9% of the ESU) forestlands, for a total of 41% of the ESU. These activities have been applied on limited non-industrial forestlands (20% of the ESU). Any road repair activities that might have occurred on Federal lands (38 percent of the ESU) were not consistently reported to the Oregon Watershed Enhancement Board and therefore are difficult to compare. The following summaries are all non-regulatory actions implemented on existing roads.

One measure of reducing the threat is to evaluate how much work has been done. Work reported to OWEB from 1997 through 2003 is summarized in Table 7 (state forests), Table 8 (private industrial forests) and Table 9 (private non-industrial forests). These data were compiled by OWEB, and include information directly as reported, and include no monitoring or other data verification. Note that the fish passage summarized in these tables includes only work that also meets 50-year flow requirements, and does not summarize treatments such as wiers or outlet pools.

State Forests Discussion: There are **988** square miles of State Forests land in the Coastal Coho ESU-or 9 percent of this ESU. Table 7 includes all state forests-reported road surveys and improvement in the Coho coastal ESU. Note that at least for road surveys it appears the program has significantly underreported actual road surveys. This ESU includes most of the Oregon's state forestlands, yet only reports 570 miles of road surveyed. This despite the fact the Tillamook District alone (about 1/3 of this area) surveyed 1324 miles of road during this time period.

The 117 fish passage improvements equates to 0.12 crossings per square mile of ownership, and replacements are ongoing. Replacement of drainage structures on non-fish bearing streams was a major activity, with 895 replacements, or almost 1 per square mile of ownership. State forests added many cross drains (about 2 per square mile) but reported very few for filtering/drainage disconnection (also believed to be an under-reporting issue). Other common activities include adding durable surfacing (491 miles), and vacating roads (50 miles). Actual completed roadwork is consistent with project objectives and work done on private industrial forestlands.

Private industrial Forests Discussion: There are **3534** square miles of private industrial forestland in the Coastal Coho ESU- or 32 percent of this ESU. As with State Forests, 6973.4 miles of roads were reported surveyed, most before the year 2000 (Table 8). Based on an average road density of 2.8 miles of road per square mile (Robison et. al, 1996), there would be 9,900 miles of road on industrial lands in the ESU, so we estimate that this survey represents about 70 percent of industrial forest roads in the ESU.

There were many structures replaced to improve fish passage (598) and increase peak flow capacity (an additional 2683 above the 598 that include both fish passage and peak flow) with work tapering off in 2001 and 2002, respectively. Fish passage was improved on an additional 26 crossings where the culvert was not replaced (weir or other structure). Cross drainage work was focused more on filtering than work reported on state forestlands. Except for sidecast pullback, most work tapered off by 2003. This makes some sense, as the steeper lands tend to be further from the most important Coho habitat-a priority at the outset of the Oregon Plan.

Table 7. State Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003). These are all non-regulatory actions implemented on existing roads.

	1997	1998	1999	2000	2001	2002	2003	Totals
Miles of Road Surveyed	129	379	2	13	27	20	0	**570**
Fish Passage Structures	13	20	9	9	33	11	22	**117**
50 year peak flow	201	186	85	163	60	111	89	**895**
Filtering cross drains added	11	24	8	47	26	11	20	**147**
Other cross drains added	612	275	50	501	126	75	144	**1,783**
Culvert outlet protection	7	6	6	21	35	40	29	**144**
Miles of Durable surfacing	114.79	50.62	44.81	127.58	70.16	37.43	46.03	**491.41**
Miles of Ditch Rocking	0.04	0.00	0.00	0.00	0.00	0.08	0.00	**0.12**
Miles of Sidecast Pullback	0.91	1.72	1.38	1.06	0.57	3.16	8.28	**17.07**
Large Landslides Stabilized	10	1	4	0	0	0	0	**15**
Miles of Roads Vacated	3.53	5.98	5.20	7.08	5.52	13.38	8.99	**49.67**
Miles of Roads Closed	3.88	4.95	3.24	1.64	0.49	1.55	0.00	**15.74**
Miles of Roads Relocated	0.53	1.00	0.00	0.00	0.04	0.00	0.01	**1.58**
Miles of Legacy Road Reconstruction	13.69	1.23	0.00	0.00	0.00	0.00	0.00	**14.92**
Miles of Grass Seeding	38.61	27.70	0.00	0.00	5.33	28.63	39.24	**139.51**

Almost 50 miles of road were vacated. Prior to 1999, 43 miles of legacy road were reconstructed to current standards (beginning in 1999, specific repairs were summarized). Of note, very few roads on either state forests or private industrial forests were relocated (for example, away from streams). Since work appears to be tapering off, this may suggest repairs are nearing completion, and suggests its time to consider broad-scale effectiveness monitoring.

Non industrial lands discussion: There are **2240** square miles of private non-industrial lands in the Coastal Coho ESU-or 20 percent of this ESU. Most of these are at least partially forested, with some lands principally in agriculture. Overall, much less work occurred on these lands (Table 9 lists only the forested portions of these lands). In 2003, OSU, ODF and OFRI conducted short courses, in part, as a response to the low levels of road survey mileage and repair activity reported by non-industrial landowners. Most of the repair work on non-industrial lands was replacement of stream crossings that impaired fish passage. Of note, most of the road vacating (almost 2 miles) occurred in the last 2 years.

Table 8. Private Industrial Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003). These are all non-regulatory actions implemented on existing roads.

	1997	1998	1999	2000	2001	2002	2003	Totals
Miles of Road Surveyed	1332.04	1750.77	2200.56	413.02	600.15	159.86	417.00	**6973.40**
Fish Passage Structures	78	132	115	95	90	54	34	**598**
50 year peak flow	217	395	522	397	455	573	124	**2683**
Filtering cross drains added	74	275	311	274	255	267	136	**1692**
Other cross drains added	550	644	725	884	753	680	391	**4627**
Culvert outlet protection	10	42	32	7	6	32	26	**155**
Miles of Durable surfacing	50.01	77.76	128.00	98.50	78.76	73.88	25.28	**532.20**
Miles of Ditch Rocking	0.03	0.17	0.00	0.00	0.48	0.04	0.08	**0.80**
Miles of Sidecast Pullback	10.21	13.30	7.38	2.54	1.29	12.38	11.30	**58.40**
Large Landslides Stabilized	8	7	5	4	2	3	6	**35**
Miles of Roads Vacated	5.31	11.84	40.38	16.03	23.36	12.76	3.10	**112.78**
Miles of Roads Closed	9.64	5.64	11.16	11.52	15.77	2.92	0.00	**56.65**
Miles of Roads Relocated	0.52	0.42	0.49	0.25	0.40	0.42	0.00	**2.49**
Miles of Legacy Road Reconstruction	37.94	5.40	0.00	0.00	0.00	0.00	0.00	**43.33**
Miles of Grass Seeding	37.43	0.00	41.46	24.45	13.15	27.08	8.01	**151.58**

Other Lands and Land Uses: There are **4195** square miles of Federal forestland in the Coastal Coho ESU-or 38 percent of this ESU. Federal reports on road activities are shown in Table 10. The federal data available for this report provide two categories: maintenance and decommissioning (Table 10). It is difficult to compare the OWEB data with the federal data. For example, for the OWEB database, landowners are expected not to report maintenance, as it is a regulatory requirement. Furthermore the range of activities reported under decommissioned roads is sufficiently broad as to make it difficult to infer the environmental benefits. For example closing a road has a much different environmental consequence than obliterating a road. We will continue to work with the feral agencies to improve our abilities to consistently evaluate road activities under the Oregon Plan across ownership boundaries.

Cities, highways and roadways, Oregon State University lands, and others make up only a very small portion of the Coho ESU. Specific reports were summarized for the Oregon Department of Transportation (ODOT), local governments, non-forestlands and Oregon State University. Almost all of the reported ODOT and local government projects were for fish passage (54 and 51 projects respectively). Another 55 fish passage projects occurred on other non forest lands. Oregon State University projects were similar to state forests, but on a much smaller ownership, and did not include fish passage projects.

Table 9. Private Non-industrial Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003). These are all non-regulatory actions implemented on existing roads.

	1997	1998	1999	2000	2001	2002	2003	Totals
Miles of Road Surveyed	6.5	11.30	2.40	0.00	6.61	29.32	4.54	**60.67**
Fish Passage Structures	7	5	10	5	3	6	8	**44**
50 year peak flow	1	4	0	0	0	9	0	**14**
Filtering cross drains added	0	0	0	0	0	3	0	**3**
Other cross drains added	1	0	0	0	0	20	0	**21**
Culvert outlet protection	0	0	0	0	0	0	0	**0**
Miles of Durable surfacing	0.06	0.00	0.00	0.49	0.00	3.26	0.00	**3.81**
Miles of Ditch Rocking	0.00	0.04	0.00	0.00	0.00	0.00	0.00	**0.04**
Miles of Sidecast Pullback	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Large Landslides Stabilized	0	0	0	0	0	1	0	**1**
Miles of Roads Vacated	0.44	0.00	0.00	0.14	0.00	0.27	1.00	**1.85**
Miles of Roads Closed	1.00	0.02	0.00	0.00	0.00	0.00	0.00	**1.02**
Miles of Roads Relocated	0.00	0.02	0.00	0.00	0.00	0.00	0.00	**0.02**
Miles of Legacy Road Reconstruction	2.86	0.00	0.00	0.00	0.00	0.00	0.00	**2.86**
Miles of Grass Seeding	0.60	1.00	0.00	0.00	0.00	2.14	0.00	**3.74**

Table 10. Estimate of national forest road maintenance and decommissioning projects within the Oregon Coast Coho ESU for years 2000-2003.

Forest	2000		2001		2002		2003	
	Main.* (miles)	Decom. ** (miles)	Main. (miles)	Decom. (miles)	Main. (miles)	Decom. (miles)	Main. (miles)	Decom. (miles)
Siskiyou	83	1	47	3	45	0	125	0
Siuslaw	1180	9	1526	13	586	15	2058	11
Umpqua	3120	13	1893	19	1198	1	1503	14
Totals	**4383**	**23**	**3466**	**35**	**1829**	**16**	**3686**	**25**

* = Roads Maintained – Minimum maintenance actions focus on drainage, safety, and subgrade. Of note, many of the same roads are maintained on a yearly basis. Therefore, 2003 road miles can include the same roads maintained in 2000-2002 along with roads not maintained during those times.

** = Road decommissioning – Decommission actions range from road closures to obliteration.

The same principles apply for reducing road-related sediment with non-regulatory actions as with regulatory programs (Please see the discussion under regulatory programs). The added value of the non-regulatory programs is the application of well-understood BMPs to roads that are not regulated by the regulatory programs and/or additional practices that are not required by the regulatory program. Benefits include:

- ⇨ Identifying hazards to aquatic ecosystems (critical locations such as streams and landslide-prone areas) with the use of a common field protocol and a commitment to repair and improve problems. This further decreases sediment input to streams and barriers to fish passage beyond that required by law. (*road conditions surveys, prioritization, and improvements*)
- ⇨ Decreases fine sediment and road-related landslide delivery to streams by decreasing proximity of roads to streams and landslide-prone areas. (*relocation activities*)
- ⇨ Decreases fine sediment input to streams by reducing hydrologic connectivity to streams and increased filtering of road drainage. (*filtering and other cross-drain activities*).
- ⇨ Reduces erosion and delivery of ditch-sources of sediment (*rocking the ditch*).
- ⇨ Reduces erosion from bare slopes after road construction (grass seeding).
- ⇨ Decreases sediment inputs that can occur during wet-weather use by requiring the use of high-quality rock. Monitoring and research demonstrate that durable surfacing can reduce sediment delivery by 75 to 90 percent or more. (*durable surfacing activities*)
- ⇨ Reduces sediment inputs from roads no longer in use by properly vacating them *(vacating activities*)
- ⇨ Reduces sediment input from roads by limiting access *(closing activities with maintenance*)
- ⇨ Reduces potential for road-related landslides (*sidecast pullback, slump stabilization*)
- ⇨ Reduces sediment inputs, fish passage barriers, and potential landslide-related threats by bringing legacy roads up to current standards (*legacy reconstruction*)

The same principles apply for reducing landslide-related threats with non-regulatory actions as with regulatory programs (please see the discussion on how regulatory programs are reducing the threat). The added value of the non-regulatory programs is the application of additional practices that are not required by the regulatory program, particularly around small non-fish bearing streams. These areas can be important contributors of large wood to downstream reaches. For debris flows, the primary benefit is the retention of trees on small non-fish bearing streams.

About 1/3 of riparian restoration projects (375 stream miles) are described as voluntary leave tree projects. These projects are overwhelmingly applied to forest land-specifically private industrial and state forestland. From 1997 – 2003 voluntary tree retention was applied to 325 miles of private-industrially owned forested streams and 41 miles of state-owned forested streams. There were no reports of voluntary leave tree activities from private non-industrial forestland owners.

These types of projects include: additional conifer retention on fish streams, increased RMA on Small Non-fish stream, leave tree placement & additional voluntary retention, and voluntary no-harvest in RMAs of fish bearing streams.

State and private industrial forestland owners retained additional trees in 541 and 3181 acres of riparian areas. About 20% of the leave tree acres on private industrial forestland were on small and medium non-fish bearing streams (597 acres). About 33% of the acres on state forestland were on small and medium non-fish bearing streams.

Non-regulatory leave tree activities in riparian areas is discussed in detail in the Part 4D, ODF Chapter B1 Riparian Report (Dent 2005).

There is no scientific or monitoring data on if the Oregon Plan measure to leave trees on small Type N streams is effective at reducing the threats to coho associated with debris flows. However it stands to reason that in the event of a debris torrent, a landslide that contributes wood as well as sediment and boulders could better mimic historic processes. To monitor this, the state should model potential wood routing dynamics with and without the Oregon Plan strategy and then monitor its application across the landscape. Ideally, field sites would be distributed broadly to increase the likelihood of capturing a landslide-producing storm event.

Other sources of Sediment

The primary focus of this paper has been on forest roads and landslides. There are other sources of sediment addressed through Oregon Plan measures such as riparian fencing. Riparian fencing is discussed in more detail in Part 4D, ODF Chapter B1 Riparian Report (Dent 2005). Fences are constructed along riparian areas to prevent cattle and other livestock from entering riparian and aquatic areas. The practice is often combined with planting tress and/or woody shrubs.

Reducing the Threat: Riparian Fencing: This practice reduces the threat by preventing bank erosion caused by livestock grazing in riparian areas. Bishaw et al (2002) found that fencing out cattle provided stream bank protection within one year of the practice. Another study evaluated 106 livestock exclusion Oregon Plan projects and found that most livestock exclusion fences were intact (83%) and had greater riparian regeneration survival rates than areas with damaged fences (Anderson and Graziano 2002).

2. What are the incremental objectives and timelines for achieving the objectives of the conservation effort?

<u>Privately Managed Forest Land</u>

Many forest roads built prior to the development of the FPA or prior to the current BMPs pose increased sediment risk to fish habitat. Forest landowners are implementing a non-regulatory program to identify risks from these older 'legacy' roads and to address those risks.

Objectives:

The objectives of the Road Erosion & Risk Project are to make improvements to non-regulatory road elements such as road fills, stream crossings, and drainage and surface problems to improve fish passage and habitat, and water quality. Actions are prioritized to:

- Address and repair older roads not consistent with current standards and with imminent threat to waters of the state.
- Replace stream crossing structures that block fish passage.
- Remove fills that have a high potential to fail and enter waters of the state.
- Reduce washout hazard.
- Add cross drainage for filtering near stream crossings.

Key Accomplishments and Timelines:

- Develop protocol with ODFW, OSU, and the Oregon Forest Industries Council (OFIC) – ***completed 1997.*** The protocol addresses risks from road surface, fill and cut slopes, and stream crossing structures. The protocol was developed in two test basins (Scoggins Creek and Kilchis River). Transfer of protocol was accomplished through training sessions.
- Develop assessment plan among cooperators – ***completed 1997.***
- Develop database through OWEB – Watershed Restoration Inventory – ***completed 1997.*** Tables 8 and 9 provide the numbers and types of projects reported from 1997 to 2003. The target date for completion of all projects identified in the survey is ***January 1, 2012.***
- The Forest Road Management Guidebook was ***published in 2000.***
- Oregon Forest Resources Institute's ***2002 Illustrated Manual*** to Oregon's Forest Protection Laws devotes an entire section to roads and stream crossings.
- Review plan and evaluate progress to date ***2005-2006***..

<u>State Managed Forest Land</u>
The FMP for Board of Forestry Land (BOFL) is anticipated to endure for a decade, and even longer because they are goal-driven plans with strategies that will be most successful in achieving those goals when applied over the long term in an adaptive management context. Ten-year updates that describe how the plan is being applied, and provides insight into how well the goals are being achieved will be provided the State Land Board, Board of Forestry and public. The first such review is planned for 2011. These updates will be a primary mechanism for the Land Board and Board of Forestry to determine if there are portions of a plan that should be amended or if development of a new plan is necessary.

The body of integrated strategies defined in a FMP will apply across the landscape, providing both a coarse-filter or landscape level management focus and the necessary fine-filter emphasis for certain resource values. These integrated strategies will provide diverse forest habitats that are likely to accommodate most native wildlife species associated with forested habitats in the Oregon Coast Range.

Over time, active management targets will achieve a diversity of stand structures across the landscape, or the desired future condition, as described in Chapter A2. These stand structure percentages are the over-arching, long-term objective for the landscape managed under the Northwest (Northwest FMP, pp 4-48) and Southwest plans (Southwest FMP, pp 4-46). Due to the limited amounts of older, more complex stand types present on the state forest landscape, it is anticipated 5 to 10 decades will be required to achieve the targets on all western Oregon state forest lands.

Regeneration	5-15%
Closed Single Canopy	10-20%
Understory	15-35%
Layered	20-30%
Older Forest Structure	20-30%

These targets, along with the remaining FMP strategies are to be applied to the state forest landscape in each Department of Forestry district through the development of implementation plans. Implementation plans will describe how the district is moving towards achievement of the desired future condition through the implementation of the FMP strategies, including the slope stability and road management (Table 11). The State Forests Program cooperated in the development of the road assessment with the Forest Practices Program, and has been implementing ongoing road activities to address identified concerns. In addition, watershed analyses, due to be completed by 2011 on state-managed lands, will assess road and slope stability hazards. These hazards will be addressed on an annual basis during the implementation of management operations. At ten-year intervals (OAR 629-035-0030), an FMP will be reviewed, and adjustments to the strategies made if needed, with the first review scheduled to occur in 2011.

Table 11.State Managed Forest Land Incremental Objectives and Timeline for Slope Stability and Road Management Strategies

Strategy	Description	Schedule
Slope Stability	Assess high, moderate, and low landslide hazard areas through watershed analysis.	Annual watershed analyses, with all completed by 2011.
Slope Stability	Use geotechnical specialists during annual operations planning to evaluate alternatives that minimize, mitigate for, or avoid risks.	Annually during operations planning.
Forest Road Management	Complete inventory of existing roads and road hazards through watershed analysis process.	Annual watershed analyses, with all completed by 2011.
Forest Road Management	Identify priority restoration and improvement projects.	When a watershed analysis is completed.
Forest Road Management	Implement priority restoration and improvement projects.	Annually during operations planning, or as priority determines.
Forest Road Management and Slope Stability	Conduct research and monitoring activities in accordance with goals of the State Forests Research and Monitoring Program Strategic Plan.	Ongoing project development and implementation as needs, partners, and resources are identified.
Forest Road Management	Apply the *Forest Roads Manual* processes and standards during implementation plan development and reviews.	IP developed 2003; revisions as information is acquired, or at a ten-year review (2011 is the first).
Forest Road Management	Identify and prioritize roads for closure and/or abandonment in accordance with the *Forest Roads Manual* standards.	Annually during operations as inventories are completed.
Forest Road Management	Manage roads to protect all resources.	Annually through the AOP process.
Adaptive Management	Review FMP, including road management and slope stability strategies, within adaptive management framework	Ten-year intervals, with the first review in 2011.

As monitoring provides feedback, research is conducted, and IP and AOP activities are accomplished, these adaptive management activities will help determine compliance with and effectiveness of the resource management strategies, and ultimately the achievement of the FMP goals and objectives. The information will be processed through the adaptive management framework, and may lead to improvements in the management plan or practices. During the ten-year FMP review following when 30% in aggregate of layered and older forest structure stands is achieved on lands in the Northwest and Southwest Oregon planning areas, a comprehensive review of landscape management strategy 1 and the array described above will be conducted. The review will evaluate whether the stand conditions meet the habitat needs of native species, and whether the stand structure percentage targets need to be changed.

3. What are the steps for implementing the conservation effort?

Privately Managed Forest Land

The steps for implementing the Oregon Plan are described in the **Oregon Department of Forestry and State and Private Forestry Community Oregon Plan Statewide Work Program.** The steps are listed above in Section 2. During 2005-2006 the ODF and landowners will review the non-regulatory measures, including those for roads and fish passage. We will evaluate how we are doing—trends and effectiveness. For instance, we know that industrial forest landowners have completed many projects. We have monitored these projects for conformance with current standards and have shared information on what works best. Still, we cannot say how much work remains to be completed. Better ways of gathering and sharing information is needed to help us understand how far we have come and how far we have left to go. Numbers of some types of reported projects have decreased recently. We would like to know whether the decrease is due to work having been completed, or whether other issues are involved. If work is nearing completion, how can we document that? If the latter, how can agencies better serve the process to provide meaningful incentives or service needed? We believe that projects conducted by the non-industrial landowners are under reported (Table 9). Improvements are needed to better serve non-industrial landowners, who through conversation, have told us that they would like to improve legacy roads but need financial assistance and/or assistance in reporting what they have already accomplished.

State Managed Forest Land

A management plan is developed following requirements of OAR for BOFL and the Common School Forestland (CSFL) Agreement for CSFL. The BOF then approves the BOFL plan and adopts it as OAR, and the State Land Board approves the CSFL management plan. The State Forests Program develops the district-specific, ten-year implementation plans for BOFL, and annual operation plans for both BOFL and CSFL. The annual operation plans describe the exact location and nature of management activities that are proposed for a given fiscal year (see Chapter A2-Lee 2004) criterion 6 for a discussion of both a IP and AOP). A ten-year review of the management plan is conducted, and adjustments are made to the management strategies if needed. A new implementation plan is then developed and approved, and operation plans are developed on an annual basis. Public involvement in the review of each of these plans is an important component of implementation.

4. Scientifically valid parameters and standards by which progress will be measured and identified

Roads

The Forest Practices Advisory Committee and the IMST both concluded that overall road density is not a good indicator of risk to water or fish. The FPAC and IMST recommendations indicate the following road indices are much better measures of road risks to water quality and fish habitat (Table 12). State standards and guidelines have been established for fish passage. The forest practices act and the state forest management plan have rules, regulations and guidelines that set quantitative and qualitative standards for other road parameters. Finally, under the Oregon Plan, participants agreed to survey roads following a common protocol which utilizes many of these parameters (OWEB 1999b).

Sediment

Methods and indices for monitoring sediment have typically used two parameters: turbidity and percent fines in riffles (Table 12). The DEQ, ODF&W, and EPA have well-established methods for measuring turbidity and fines. DEQ has established standards for turbidity.

Landslides

There is a long history of researching landslides and the interaction with land management, which provide possibilities for predicting associated hazards to aquatic habitat. Yet, there hasn't been a formal approach to establishing parameters and standards by which to measure our progress in managing landslide risk such that the threats to aquatic habitat are reduced. Table 12 offers some suggestions.

Table 12. Parameters and standards to measure progress in reducing the threats to coho recovery associated with roads, sediment, and landslides.

	Parameter	**Standard**
Roads	- Physical Parameters of the culvert (slope, sediment retention, outlet jump, etc.) - Fish presence or absence upstream - Fish Movement	All crossings must pass juvenile and adult fish. Physical characteristics considered likely to pass fish.
	- Miles of roads built in critical locations (landslide areas, near streams, etc)	ODF guidelines on forested lands
	- Diversion/washout potential of structure - Erosion during wet season use	ODF guidelines on forested lands
	- Road drainage connectivity to streams (distance between x-drains, etc.)	ODF guidelines on forested lands
	- Stability of the road surface (rills, gullies, etc.)	ODF guidelines on forested lands
Sediment	-Turbidity	DEQ Standard
	-Percent Fines in Riffles	None
Landslides	-Hazard Rating	None
	-Age/diameter of trees in debris flow path likely to deliver to fish-bearing streams	None
	-Age/diameter of trees in landslide prone areas that are likely to deliver to fish-bearing streams	None

Standards are established in a variety of documents: Forest Practices Act, Forest Practice Rule & Statute Guidance Manual, and various Technical Notes and Forest Practice Notes, the OFRI Illustrated Guide to the Forest Protection Rules, and ODF's Forest Road Management Guidebook. The detailed standards are too voluminous to include in this report, but can be found on the ODF website at http://oregon.gov/ODF/PRIVATE_FORESTS/fpaissues and are referenced in this paper. For example, ODF Technical Note #7 provides technical guidance to assist in placing roads outside of critical locations. It describes procedures for avoiding locations where roads are likely to damage water quality. It also provides information on ensuring access to forestlands. This note is written to help professionals identify critical locations and to reduce and nearly eliminate roads in the six most sensitive critical locations.

5. What are the provisions for monitoring and reporting progress on implementation and effectiveness of the conservation effort?

The Oregon Department of Forestry monitors both private and state managed forestlands. Monitoring is a requirement, by forest practice rule, and the monitoring program managers report findings annually to the Board of Forestry as required under OAR 629-635-0110. The programs also report findings to stakeholder groups, ODF staff, staff from other agencies, and advisory committees.

The Oregon Department of Forestry has a long established history of monitoring road and landslide-related issues. The results of these projects have been reported in sections 1 and 2 of this Chapter. Evaluation of current Oregon Department of Forestry rules has been based in large part on the results of ODF monitoring since practices used in other regions may be very different, and also because road management practices have changed significantly over time. Between 1994 and 2003, the forest practices program completed four major monitoring studies that investigated implementation and effectiveness of forest road BMP's or proposed BMP's. These projects included:

1. Forest Road Drainage Practices - final report in 1998
2. Storm Impacts and Landslides of 1996 - final report in 1999
3. BMP Compliance Monitoring - final report in 2002
4. Stream Crossing Study – final report in 2002
5. Wet Season road use and turbidity - final report in 2003.
6. ODF Road information Management Information System: Pilot Study Report – Draft September 27 2004

Oregon Watershed Enhancement Board has established a mechanism for collecting and housing data from landowners that document their non-regulatory activities and has generated a series of Oregon Plan reports.

6. What are the principles of adaptive management of the conservation effort?

This section will describe principles of adaptive management as described for state forest owned and managed land as well as for lands regulated under the forest practices act (Forest Practices Monitoring Program). As described below, the adaptive management program for state forests is based on 4 principles, 4 strategies, and watershed analysis. Table 13 provides a conceptual model of plan principles and how it will affect change. As described below the adaptive management strategy for forest practices monitoring program (FPMP) for private forest lands relies on scientifically credible information to help revise rules to improve effectiveness and implementation. It has been in place since 1998 and provides a framework for identifying monitoring questions, priorities, approaches, and desired outcomes. Table 14 provides a summary of desired outcomes, strategies, tools and approaches.

State Managed Forest Land

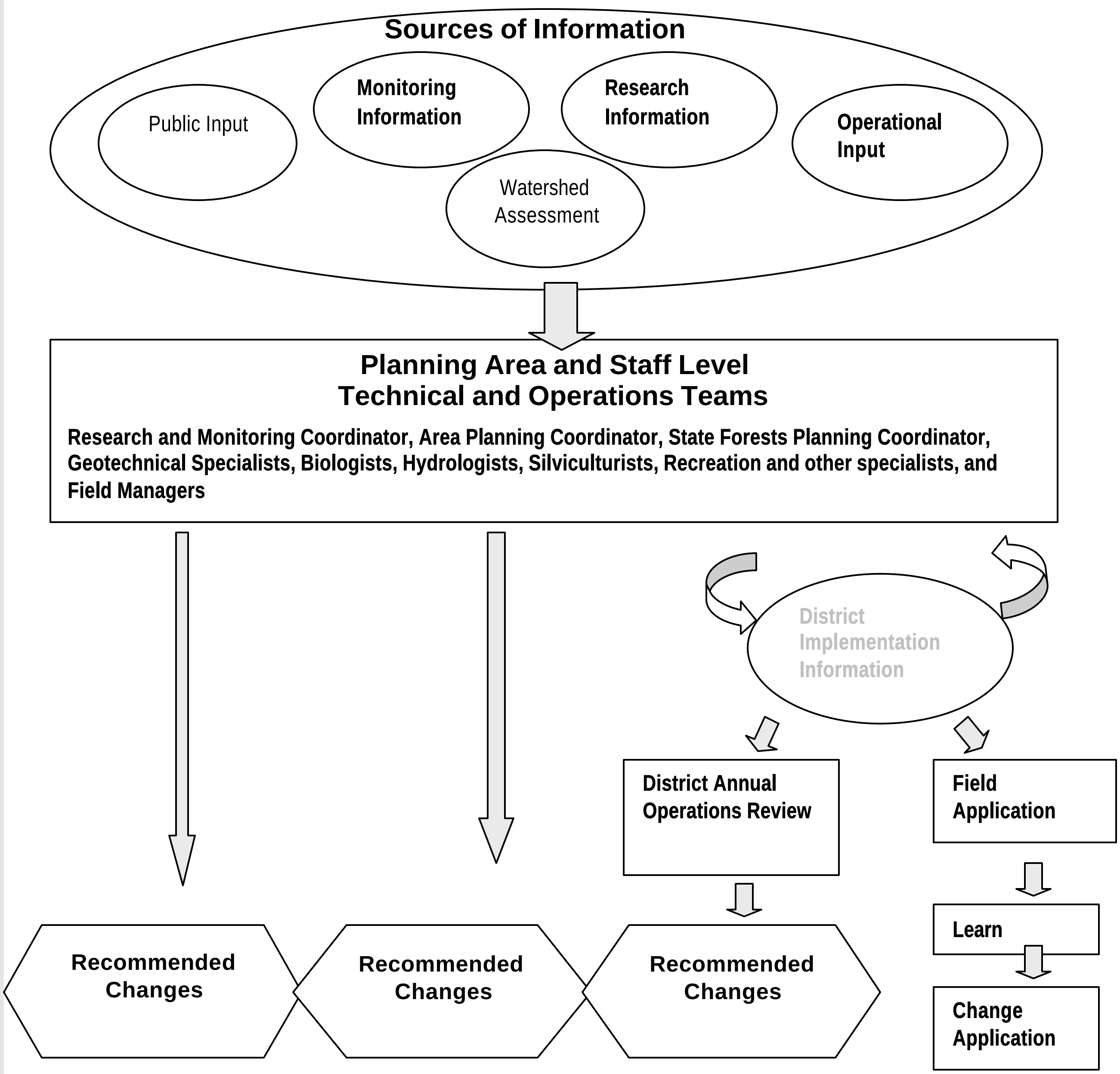
Adaptive management is a primary tenet woven throughout the FMP and is described in detail in Chapter 5 of the FMP (ODF 2001). The FMP will be implemented using a scientifically based, systematically structured approach that tests and monitors assumptions, predictions, and actions and then uses the information to improve management plans or practices.

Table 13. Adaptive Management: Affecting Change on State Forests.

	Forest Management Plan & Habitat Conservation Plan	Implementation Plans	Annual Operations Plans	Management Activities
Time Horizon	**Long Term – 10 Years or More**	**Periodic – Maximum 10-Year Interval**	**Annual**	**As Appropriate**
What Might Change	FMP • Stand type percents • Arrangement • … HCP • Owl strategies • Murrelet strategies • …	• Landscape design • Silvicultural approaches, i.e., sequence of treatments, etc. • Management opportunities & objectives • …	• Approaches to meeting objectives, e.g., silvicultural prescriptions • Monitoring projects • …	• Techniques for culvert installation, snag creation, etc. • …
Public Involvement	Formal • BOF meetings • OAR process • Public meetings • Federal processes for HCPs • Technical specialist or citizen input committees Informal • Voluntary participation in monitoring program • Regular reporting processes, including monitoring reports • Public submittal of information	Formal • Public review & comment processes • Public meetings • Technical specialist or citizen input committees Informal • Voluntary participation in monitoring program • Regular reporting processes, including monitoring reports Public submittal of information	Formal • Review & comment period Informal • Voluntary participation in monitoring program • Regular reporting processes, including monitoring reports Public submittal of information	Informal • Voluntary participation in monitoring program • Regular reporting processes, including monitoring reports Public submittal of information
Monitoring	**Framework** Implementation • Are we doing what we said we would do? Effectiveness • Are the management practices producing the desired results? **VALIDATION** • Are the planning assumptions valid, or are there better ways to meet goals and objectives?	**Identify and Implement Projects** Projects: • What is the condition of State Forests based on stand type percentages and habitat availability? • Is active management promoting habitat development by moving stands toward layered and older forest structures? • Are our silvicultural practices used to achieve forest structures sufficient to maintain a full array of forest products? • Is structure based management helping to improve forest health on State Forests • … Protocol development and implementation Data gathering and analysis Evaluation Communication			

Table 13. Adaptive Management: Affecting Change on State Forests (continued).

	Forest Management Plan & Habitat Conservation Plan	Implementation Plans	Annual Operations Plans	Management Activities
What Triggers Change And How				



Who Decides	Board of Forestry/State Land Board, in consultation with appropriate other agencies	State Forester	District Forester	Management Unit Forester

The following key concepts provide the foundation for adaptive forest resource management as it is described in the FMP.

1. Adaptive management is a system of making decisions that recognizes that ecosystems and society are always changing. The FMP describes the need for a rigorous systematic approach for learning from our actions, improving management and accommodating change.

2. Adaptive management is not a replacement for decision-making at any level, but a system for making better decisions. The FMP describes a formal, rigorous approach to management where activities are treated as opportunities for generating information about the system being managed. While the adaptive management approach can resolve disagreements stemming form knowledge gaps, it cannot resolve conflicts stemming from conflicting values. An effective adaptive management program can help managers respond to changes in values but it cannot predict them.

3. Successful adaptive management requires a well designed process including a strong monitoring program: Six steps are described.

   Assessment: Define the scope of the management problem, synthesize existing knowledge about the system, and identify potential outcomes of alternative management actions. Make predictions about outcomes in order to assess which actions are most likely to meet management objectives.

   Design: Design experiments and related monitoring plans that are informative and provide reliable feedback. Chapter 5 describers replicated and non-replicated experiments and other sources of information such as results from research on ecosystem processes, extrapolation of results from small-scale experiments, and retrospective studies.
   Implement: Implement experiments and monitoring as designed. Decide when and what types of deviations are acceptable. Ensure that these circumstances are clear and accepted by all involved. Monitor implementation, and document any deviations from the plan.

   Monitor: Measure environmental characteristics and conditions over an extended period of time in order to determine status or trends in various aspects of environmental quality. Types of monitoring include implementation, effectiveness, and validation monitoring.

   Evaluate: Analyze data and compare actual results to the forecasts made in Step 1. The evaluation should explain why outcomes occurred and include recommendations for future action.

   Adjust: Verify or update the hypotheses used to make the initial forecasts and adjust management actions as necessary. Review the objectives and adjust as necessary to ensure they remain consistent with overall goals and values.

4. Adaptive management requires a well-defined framework for dealing with change. There are four planning levels at which change may be proposed, considered, and initiated: (1) FMP, (2) district implementation, (3) annual operations, and (4) management activity.

The FMP describes 4 strategies for implementation

1. Implement an adaptive management process and framework that provides for change at the appropriate planning level and in a timely manner. The range of decisions that will be made, how they will be made, and who will make them are described. Decisions at the FMP level are long term (10 years or more. District level decisions are periodic, typically no longer than 10 years. Annual decisions are incorporated in the Annual Operations Plans, and individual management activities are decided on an ongoing, sub-annual basis, or as appropriate for the operations. At each level examples of what might change, types of public involvement that will take place and monitoring activities that might support a call for change are provided.

2. Develop and implement a monitoring program designed to evaluate the working hypothesis over time. Review and update a monitoring and implementation plan at least every 10 years. The strategy described the application of monitoring with reference to Oregon administrative rules OAR 629 030 0000 to 0110. The framework involves validating assumptions and hypotheses, evaluating resource conditions, ecological and cultural trends, implementation of management actions and their effects. Key questions are described as well as reporting and information management, coordination and current monitoring.

3. There is a commitment to conduct a comprehensive review of the goals and strategies of the FMP every 10 years following adoption.

4. There is a commitment to conduct a comprehensive review of landscape management strategies when 30% in aggregate of LYR and OFS stand types is achieved on lands in the planning area.

The state forests research and monitoring program is in place to ensure that the levels of research, monitoring, and technology transfer are adequate to meet the information needs required for the adaptive management plan. Most of the elements are covered under #5. What follows is a brief description of Watershed Analysis. A detailed description of each of these concepts and strategies for implementing adaptive management is provided in chapter 5 of the FMP (Pages 5-14 through 5-34).

<u>Watershed Analysis Manual</u>

Watershed analysis is described as a critical process for refining and planning management activities related to implementation of the forest management plan. State Forests has developed a watershed analysis manual (ODF 2004) that describes the goals for watershed analysis, a process for implementing the analysis, and a process for incorporating watershed analysis findings into implementation plans. The goal for each watershed analysis is identify if proper functioning conditions exist along streams. If the aquatic system is not in proper functioning condition, then the analysis will identify the limiting factors. The analysis will evaluate if existing ODF strategies are likely to remedy the limiting factors and if not, if there are other measures that ODF can take to address the limiting factors. In this way, watershed analysis provides an important tool for adapting FMP strategies at a watershed scale to create the desired future conditions for riparian and aquatic ecosystems.

<u>Private Forest Land</u>

The Forest Practices Monitoring Program (FPMP) has been evaluating implementation and effectiveness of the forest practices act since 1988. The program is guided by a Monitoring Strategy that is updated biennially and closely linked with the Oregon Plan (ODF 2002). The strategy is based on the concepts of adaptive management (echoes that described for the State Forests Program) and outlines an approach to different types of monitoring and a list of key questions and priority levels. Monitoring riparian rules is a requirement, by forest practice rule, and the monitoring program manager reports findings annually to the Board of Forestry as required under OAR 629-635-0110. The Board of Forestry considers the findings and recommendations and takes appropriate action with regard to rule revision. The program also reports findings to stakeholder groups, ODF staff, staff from other agencies, and forest practices advisory committees.

The goals of the FPMP are to:

- Evaluate the effectiveness, implementation and assumptions of the forest practices act
- Coordinate with other monitoring and research efforts
- Investigate the cumulative effects of forest practices on forest resources.
- Support efforts to establish benchmarks/criterion used to define the range of desired conditions/regional goals.
- Monitor the implementation and effectiveness of the Oregon Plan.
- Monitor temporal and spatial trends in forest and stream conditions.

Adaptive management is a system of making, implementing and evaluating decisions, that recognizes that there is uncertainty about the outcome of management activities and that ecosystems and social values are always changing. It can be defined as a scientifically based, systematically structured approach that tests and monitors management plans, assumptions, predictions and actions, and then uses the resulting information to improve management plans, policies, or practices.

The success of the adaptive management process depends on

- Commitment to a long-term process
- Deliberate monitoring designs that test policies and practices
- Careful implementation of policies and plans
- Scientifically sound monitoring designs that track indicators at multiple scales
- Analysis of outcomes that consider objectives and predictions
- Incorporating results into future decisions, policies, and practices.

While adaptive management must be flexible to accommodate change, monitoring data and efforts are of the greatest value if there is a structured approach to managing such change. The FPMP desired outcomes, strategies, tools and approaches are summarized in Table 14.

The Forest Practices Monitoring Strategy discusses four types of monitoring (implementation, trend, effectiveness and validation) and sampling approaches that are scientifically based and designed to link with Oregon Plan and other ODF monitoring efforts. The goals of the sampling methods are to:

- capture the range of upland and riparian conditions across the landscape
- address multiple types of monitoring questions at multiple scales
- reflect management under current forest practice rules
- capture the representative range of practices that occur under the current rules

- test effectiveness across a range of stream classifications (Small, Medium, or Large and Fish-bearing, Non-fish bearing and Domestic Water Source)
- represent various landowner types (state, industrial, non-industrial)
- complement other monitoring efforts that are being carried out within the department, by other agencies and states, watershed councils, private landowners, and research communities.

To meet these goals, sampling methods are proposed at multiple spatial and temporal scales:

1. Landscape Trend Sampling: Sampling at the landscape scale is needed to answer integrated questions regarding trends in upland and riparian forest conditions. These studies can be implemented over a long time period and through out the entire state. This level of monitoring will also facilitate coordination with other Oregon Plan activities.
2. Current Forest Practices and the Oregon Plan: This scale of sampling is designed to answer questions about implementation and effectiveness of *current* forest practices at a state-level on a shorter-term scale (3-10 years). This scale will also be utilized to answer questions about Oregon Plan volunteer efforts. Multiple sample designs will be applied.
3. Watershed Effects: This scale of monitoring is designed to answer watershed/sub-basin scale questions for a wide range of time scales (3-30 years). Studies coordinated and funded with other agencies and groups will be designed to address how forest practices affect watershed processes and cumulative effects. There will be opportunities to set up pre-harvest and post-harvest studies within these watersheds, as well as evaluate Oregon Plan projects. Watersheds will be selected on the basis of
    - Available existing data (for example: ODF&W Index Basins)
    - Activity at the local level (watershed councils, Blue Mountain Demonstration Project, TMDLs, Senate Bill 1010 plans)
    - State Forest watershed analysis activities
    - Volunteer OPSW activities
4. Processes/Testing Hypotheses: Distinctions between research and monitoring can be difficult to identify. An important distinction is that research tests hypothesis to define cause and effect relationships, while monitoring tests those known relationships through time and space. In both cases, a scientifically sound process is needed. Research issues and questions will be addressed through contractual and cooperative agreements with university systems. To meet the needs of the Private and Community Forests Program, monitoring is conducted by means of the scientific process.

    A series of monitoring questions, priorities, and protocols are described. The monitoring strategy also describes a peer review process and communication and reporting plan.

Adaptive Management At Work

Information regarding implementation and effectiveness of the landslide- and road-related forest practices have been used to revise rules and regulations to increase effectiveness in protecting water quality and aquatic habitat. Road-related administrative rules have continually evolved in response to changes in scientific knowledge. Since the first adoption of forest practices administrative rules in 1972, major revisions to the road rules occurred in 1978, 1983, 1994, and 2002. The most recent changes (in 2002) occurred about 5 years after the non-regulatory road hazard identification and risk reduction (non-regulatory) project began. These changes were to adopt new rules for wet weather road use, to revise the rules for road drainage, and to implement a policy for not locating roads in critical locations.

Findings from Robben and Dent (2002) resulted in changes to the road drainage rules and a technical note on road drainage was written to further reduce the threats to aquatic habitat.

Findings from Robison et al. were used to define critical areas with regard to potential landslide hazards.

Table 14. Forest Practices Monitoring Program desired outcomes, strategies, tools, and approaches.

Outcome	Strategies	Tools and Approaches
The monitoring program provides timely, pertinent, and sound information at multiple scales regarding the forest practice rule implementation, effectiveness, and assumptions.	✓ Monitor the effectiveness and implementation of the forest practices rules on sites that have been harvested under current forest practices at both the landscape scale and watershed scales ✓ Coordinate and communicate priorities, approaches, and findings with research institutes.	✓ Data collection before and after harvest on volunteered sites ✓ Random selection through the FACTS database ✓ Pilot studies with active watershed councils. ✓ Formalize peer review process, submit findings to referred journals, communicate priorities with the OSU forest research lab.
Monitoring efforts are coordinated so as to maximize state resources and increase understanding with other state's efforts.	✓ Participate on the Oregon Plan for Salmon and Watersheds Monitoring Team ✓ Lead and participate on the internal ODF Monitoring Team ✓ Coordinate and communicate with monitoring and research efforts in other states.	✓ Develop agreed upon protocols ✓ Coordinate strategic plans ✓ Implement studies with sample designs that overlap with other state and federal agency's efforts.
The implementation and effectiveness of the Oregon Plan for Salmon and Watersheds (OPSW) is evaluated and communicated.	✓ Monitor the effectiveness and implementation of restoration, non-regulatory, and regulatory activities designed to protect/restore salmon populations and habitat. ✓ Monitor temporal and spatial trends in forest and stream conditions	✓ Monitor volunteered sites with OPSW projects and randomly selected sites from the OWEB database. ✓ Monitor conditions on sites randomly selected throughout the state on a long-term basis.
Monitoring results provide information to adapt and improve policies governing the management and protection of forest resources on non-federal forest land.	✓ Prioritize projects to address critical issues and communicate findings to policy makers.	✓ Report to board of forestry annually. ✓ Provide information to review committees.
There is understanding, acceptance and support for strategies, approaches and findings.	✓ Develop and implement a plan to receive input and communicate strategies, approaches and findings to internal and external stakeholders, conservation communities, and the public.	✓ Printed reports, articles, and newsletters. ✓ Updated Web Page with reports and data. ✓ Media tours, editorials, press releases. ✓ Presentations at existing forums and meetings,

7. SUMMARY: Certainty and Uncertainty of Effectiveness

Fish Passage

Oregon has incorporated state of the art science on fish passage into guidelines for complying with the laws and non-regulatory measures. Limited monitoring, research, and literature reviews suggest strategies within Oregon guidance have a high degree of certainty to pass fish (Dent and Allen 2000, Paul et al. 2002, Kahler and Quinn 1998), but more field validation is needed. Dent et al. (2005b) estimate that Oregon Plan projects are estimated to have increased access to 6 – 11% of coho stream miles. The certainty of these conclusions is high in part because of the availability of monitoring data specifically targeted to evaluate current strategies. Furthermore, the state tested the sensitivity of access improvement estimates to modeled thresholds and determined the results were relatively insensitive to shifting thresholds of modeled coho habitat potential.

The uncertainty of effectiveness of fish passage strategies is driven by tools used to evaluate fish passage in the field, data completeness, and some of the assumptions used to model coho habitat. Two approaches to evaluate effectiveness are to (a) compare the physical attributes of a crossing with those estimated to pass fish or to (b) monitor actual fish movement through crossings. In some cases the crossing may have been a complete barrier to fish passage so success can be measured simply by establishing if fish are present upstream of the crossing after it has been upgraded. The data presented in the coho reports relied on the first (a) approach. More research is needed to further validate if the fish passage strategies are effective both over time and based on actual fish movement.

While the data presented by the state represents the most complete data set available across ownerships, missing data is sure to influence the certainty of the results. For this project, which focused on coho habitat, missing data does not substantially reduce certainty. The authors estimate that the majority of stream crossings are represented for low elevation, high intrinsic potential (High IP) stream reaches. These crossings tend to be on state and county roads and that data set is considered a complete census. State and county roads tend to be the most commonly occurring along lower gradient coho streams. In addition, if landowners could not provide a complete data set, the state asked landowners to focus on coho stream crossings. Even so, the state estimates that nearly 1/3 of stream crossings have unknown access status. This suggests a strong need for further fish passage inventory.

The state tested sensitivity of results to thresholds for upper extent of coho distribution and High IP. The sensitivity analysis suggests that estimates of accessible stream miles are somewhat sensitive to a shift in the gradient used to define the upper extent of coho. For example, the estimated percent of stream miles accessible would reduce by about 3% if the upper extent of coho habitat were defined as less than 5% rather than 7%. However, estimates of percent of stream miles with limited access were relatively insensitive to shifting gradient thresholds. None of the results were sensitive to shifting thresholds that define High IP.

Roads: Chronic Sediment and Road-Related Landslides

The vast majority (70%) of the ESU is comprised of private industrial and federal forest ownership. An estimated 32% of the ESU is in private industrial forest ownership and 38% is in Federal ownership. Information on the effectiveness of road construction and maintenance practices suggests that existing forestry-related regulatory programs for road construction, management, and restoration are effective at minimizing sediment delivery to streams, minimizing the size and occurrence of road-related landslides, and improving fish passage (Mills et al. 2005, Dent 2005b). The certainty of this conclusion is high in part because ODF has a strong regulatory program that requires notification of road construction. Furthermore, rules and strategies restrict road construction in and around critical locations such as streams and landslide-prone areas. The regulations are an enforceable BMP program designed to minimize effects on water quality and aquatic habitat.

ODF has undertaken a number of monitoring projects specifically designed to address uncertainties with regard to road construction and maintenance practices. These projects have informed rule revision processes that have improved resource protection. Monitoring suggests that the numbers of road-related landslides has decreased although they remain larger than non-road related landslides. Current ODF regulatory and management programs decrease sediment input to streams by:

- ✓ decreasing the proximity of roads to streams and landslide-prone areas
- ✓ decreasing disturbance area associated with roads
- ✓ reducing hydrologic connectivity to streams
- ✓ controlling traffic during wet periods when hauling is contributing to erosion and delivery of sediment to streams
- ✓ requiring the use of high-quality rock surface on roads- Monitoring and research demonstrate that durable surfacing can reduce sediment delivery by 75 to 90 percent or more
- ✓ requiring maintenance or proper vacating practices for roads no longer in use

The greatest uncertainties are with regard to the treatment of old roads. Old roads make up the majority of roads, and while there have been many activities reported through the Oregon Plan, we have little data on road conditions neither at a landscape scale nor across ownership boundaries as to the effectiveness of the non-regulatory actions. This data gap was anticipated by the Oregon Plan Road Hazard Identification and Risk Reduction project, with a plan for monitoring in 2007.

Debris Flows

Harvest restrictions around landslide prone areas and along debris flow paths vary across forest ownerships. However, all forest ownerships have recently increased regulatory leave-tree requirements as compared with early forest-management practices. Debris-flow-delivery of wood to streams is addressed in detail in Part 4D, ODF Chapter B1 Riparian Report (Dent 2005). In general current research establishes that landslides and debris torrents can provide major contribution of wood to streams (10-60%). However, there is no scientific or monitoring data on if the High Landslide Hazard requirements to leave trees on headwalls (described for state forests) are reducing the threats to coho associated with debris flows. Nor is there data on effectiveness of forest practice rules that are geared towards public safety. However, it stands to reason that in the event of a debris torrent, a landslide that contributes wood as well as sediment and boulders could better mimic historic processes. This assertion is supported by preliminary results from CLAMS suggest that potential for wood recruitment is likely to vary across the forest ownerships, with the highest potentials on public lands and lower potentials on private lands. Whether these projections are adequate to improve coho habitat is uncertain, but the likelihood is low that habitat will be worse in 100 years under current policies than it is today.

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