# Part 4J: Reducing Effects of Roads On Salmonids under the Oregon Plan
**Oregon Plan Technical Report 1**
**May 6, 2005**

Keith Mills, Liz Dent, Jim Paul, Bobbi Riggers

**This paper is part of a series of PECE criteria and technical papers produced by Oregon Plan Habitat Team Members for the Coastal Coho Assessment.**

**Part 4D PECE Criteria Papers**

Morgan J. 2005. *Certainty that the conservation effort will be implemented: Forest Practices Act. Oregon Plan Assessment Part 4D, ODF A1.* http://nrimp.dfw.state.or.us/OregonPlan/

Lee B. 2005. *Certainty that the conservation effort will be implemented:: State Forests Program Oregon Plan Assessment Part 4D, ODF A2.* http://nrimp.dfw.state.or.us/OregonPlan/

Dent L. 2005. *Certainty that the conservation effort will be effective: Riparian Areas. Oregon Plan Assessment Part 4D ODF B1*http://nrimp.dfw.state.or.us/OregonPlan/

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

**Part 4J Technical Reports**

Mills K., L. Dent L., J. Paul , B. Riggors. 2005. *Reducing Effects of Roads on Salmonids under the Oregon Plan. Oregon Plan Assessment Part 4J, Technical Report 1.* http://nrimp.dfw.state.or.us/OregonPlan/

Dent L., A. Herstrom, E. Gilbert. 2005. *A Spatial Evaluation of Habitat Access Conditions and Oregon Plan Fish Passage Improvement Projects in the Coastal Coho ESU Oregon Plan Assessment Part 4J, OP Technical Report 2.* http://nrimp.dfw.state.or.us/OregonPlan/ 18 pp.

Dent L. and A. Herstrom. 2005. *Land Use and Land Cover Characteristics in the Coastal Coho ESU Oregon Plan Assessment Part 4J OP Technical Report 3.* http://nrimp.dfw.state.or.us/OregonPlan/

# Reducing Effects of Roads on Salmonids under the Oregon Plan

Keith Mills, Liz Dent, Jim Paul, Bobbi Riggers

## INTRODUCTION

One of the goals of the Oregon Plan is to reduce the effects of roads on streams and aquatic habitat. Principal Effects of roads on streams/salmonids include:

1. Restriction of fish passage at stream crossing structures (refer to *Section X* for more detail)
2. Input of sediment in amounts over background (the main focus of this section)
3. Alteration of aquatic habitat from sediment aggradation, increased fines in stream sediment, and, for roads adjacent to streams, directly filling and eliminating habitat;
4. Change in hydrology and stream flow when roads intercept rainfall and groundwater and alter rate of water delivery to streams

This Section deals with roads on State and Private Lands and mostly with issues 2, 3 and 4 above. Fish passage is addressed in a separate technical report: *A Spatial Evaluation of Habitat Access Conditions and Oregon Plan Fish Passage Improvement Projects in the Coastal Coho ESU* (Dent et al. 2005). This report provides minimal information on road managed by the USDI Bureau of Land Management or USDA Forest Service, due to inconsistent reporting as compared with Oregon Watershed Enhancement Board data. Questions on road management on these federal lands must be directed to those federal agencies.

## CURRENT SCIENTIFIC FINDINGS

### Sediment Processes and Effects on Fish

All streams under natural conditions have sediment inputs at varying levels from terrestrial sources (background levels) depending upon soil, topography, vegetation and rainfall. Sediment enters water through various processes that include soil surface erosion, channel erosion and mass movements (landslides, debris flows), and these inputs can be either chronic or episodic. Studies have indicated that high sediment levels can affect fish by increasing mortality, reducing growth rates, causing physiological stress, impairing homing instincts, and reducing feeding rates.

Efforts to relate sediment concentration to fish response had mixed results (Everest et al., 1987). Some studies have found that increased sedimentation reduces egg and alevin survival. However, not all sediment increases have detrimental effects and there are cases where fish have maintained large and viable populations in streams with high chronic loads of fine sediment (Everest et al., 1987). Fish appear to react most negatively when fine sediment concentrations are both high and persistent (Newcombe and MacDonald 1991). Whether effects of increased sediment are adverse depends upon the nature and timing of the delivery, the type of material delivered, and the prior condition of the stream.

Massive levels of fine sediment delivery can produce changes in channel habitat by reducing pool frequency, depth and volume (Coats et al., 1985; Megahan et al., 1980). Streams that have a limited supply of coarse sediments and large woody debris, or minimal ability to retain these materials, can experience reductions in habitat quality through channel degradation, sometimes resulting in channels scoured to bedrock in mountain streams. Habitat can potentially be enhanced if landslides deliver material to streams where coarse sediment and large woody debris are limited (Botkin 1995; Everest et al., 1987). Road-related landslides tend to be larger than in-unit landslides and tend to travel further (Robison et al., 1999). Therefore, road-related landslides typically deliver greater quantities of sediment to streams. Fine sediment from roads can also affect the production of aquatic insects (fish food organisms) (Hicks et al., 1991).

**Road Effects on Sediment**

Roads are not a natural landscape feature. Road associated changes in sediment delivery have no correlation to a natural process, so sediment from roads represents an increase over background. Exceptions can occur when sediment is stored behind road fills. The effects of increased sediment delivery from roads depend upon numerous factors. Most fine sediment from surface erosion processes is delivered during common rainfall events and is relatively chronic. 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.

Roads have been the primary source of sediment from forest management activities in the western United States (Megahan and Ketcheson, 1996). The greater the disturbance area 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 effects of roads on fish passage are covered in detail in the Oregon Plan technical report (Dent et al. 2005).

**Road Location:** Roads located on steep slopes or next to streams pose the greatest risk of sediment delivery and direct alteration of aquatic habitat. And while road density has been used as an index of road effects in the past, it is not a reliable indicator of the effects of roads on aquatic resources unless all roads are in similar locations and built with similar practices. Road-related landslides that enter stream channels are uncommon if hillslope steepness is less than 50 percent (Robison et al., 1999). Chronic delivery of sediment to stream channels is rare on ridge top roads. Conversely, most stream adjacent roads have a high potential for chronic sediment delivery (ODF, 1996). Washouts are more common on roads with undersized drainage structures, high fills and long steady grades (Weaver and Hagans, 1994; ODF, 1997). All of these factors can be independent of road density.

The greatest road densities identified by Robison et al. (1999) were found in the Vernonia and Estacada study areas (4.6 and 3.3 miles per square mile). Nevertheless, these areas had the fewest road washouts, and the lowest volume of road-associated sediment delivery to streams as compared to the other six study areas (Robison et al. 1999). Therefore, the road area disturbed in "critical locations" is probably a much better indicator of cumulative effects than is road density (ODF, 2003). This supports the IMST conclusion that "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)

**Road Use and Turbidity:** During periods of wet weather, road surfaces that are not constructed with adequate surface materials and spacing of drainage structures are a potential source of fine sediment delivery by allowing sediment-laden waters to enter stream channels directly. Hauling operations conducted on roads with poor drainage can further increase the risk of sediment delivery (Bilby et al., 1989; Reid and Dunne, 1984, Mills and others, 2003). Road segments that are close to streams and stream crossings also have an increased risk of sediment delivery. The likelihood of road surface runoff, fill failure, and washouts delivering sediment to the stream channel increases the closer a road segment is located to a stream.

**Landslides:** Fill failure is also a risk, especially for those roads not constructed to current standards. Sidecast roads, roads built on old railroad crossings with relatively deep fills, and stream crossings with inadequately designed and located culverts are examples of forest road features with increased landslide or washout risk. Landslides are typically the dominant erosion mechanism in areas with steep slopes. Landslide frequency can be greatly accelerated by road management practices (Sidle et al., 1985). For example, Megahan and Kidd (1972) found that 70 percent of accelerated sediment production in an Idaho batholith study site was associated with road-related landslides. Piehl et al., (1988) found only two landslides at culvert outlets, yet they comprised 72 percent of the total outlet erosion associated with 515 cross drainage culverts.

Again, the location of landslide initiation in relation to the road prism has a significant influence on potential sediment delivery to streams. Landslides affecting the cutslope portion of the road are typically deposited in the road. Road surface runoff may erode the deposits of cutslope landslides. These landslide deposits may divert surface waters away from designed drainage structures or divert water onto fillslopes. Fillslope failures are more likely to become debris flows, increasing in size and then entering intermittent and perennial channels.

For slopes that are considered at high risk for landslide potential, a technique known as end-hauling can be used to transport excess excavated materials to more stable waste area locations (this is required in Oregon). Using steeper grades to keep roads on ridgetops can be a significantly less expensive road system design as compared to having to end-haul for steep slopes. Relocating roads in lower-risk areas is also an effective means of landslide prevention. However, where these practices are not possible, end-hauling may be an effective, albeit expensive, technique for reducing landslides (Sessions et al., 1987).

**Exposed Soils:** Research has shown that newly constructed or reconstructed roads may have ten times more surface erosion the first winter after construction as compared to subsequent years (Megahan and Kidd, 1972; Megahan, 1974; Luce and Black, 1999). This results from increased erodibility because of soil disturbance during construction, and the lack of both coarse soil particles (result of erosion) and vegetation to protect the soil surface.

**Road effects on hydrologic change**

**Passing Floods, debris and sediment:** Stream crossing culverts and bridges are subject to plugging by woody debris and sediment and/or their capacity being exceeded by high flows. If water backs up and flows over the surface, a washout-type failure similar to a dam breaching may occur until the crossing fails. When a road grade climbs through the stream crossing, there may be a high potential for channel diversion down the road (Weaver and Hagans, 1994). Such diversions can cause large gullies running long distances down the road and can cause additional landslides and washouts *(similar to a small dam break flood)* as well. The concentration of road drainage can also be associated with interactions between road systems and channels in steep terrain, causing gullies or increasing the risk of landslide occurrence below the culvert (Montgomery, 1994).

Road systems may have the potential to block the downstream movement of large wood (LW). Where a stream crossing blocks the passage of LW there is the potential for a dam-break flood to occur as debris and water back up behind the crossing. Dam-break floods can result in a debris torrent causing significant impacts to the downstream reach in the form of scour and deposition. While debris torrents are a naturally occurring phenomenon that can add needed wood and sediment to a stream reach, an increase in the frequency and magnitude of debris torrents caused by human activity can have negative effects on aquatic habitat and riparian functions. The blockage of LW can also have downstream effects even if a dam-break flood does not occur. Where a downstream reach depends on a supply of large wood delivered during peak flows, road crossings not designed to pass LW can reduce upstream sources of wood and have a negative effect on riparian functions and aquatic habitat conditions.

**Altering streamflows:** King et al. (1984), examined a number of streamflow variables following forest road construction (maximum streamflow, date of maximum streamflow, annual minimum streamflow, annual water yield, and the 5 percent, 25 percent, and 75 percent exceedance flows). No significant changes in the above parameters were detected, with the exception that an increase occurred in the 25 percent exceedance flow in one watershed and a decrease in the 5 percent exceedance flow in another watershed.

Jones and Grant (1996), Beschta et al. ( 2000), and Thomas and Megahan (1998) all found increases in "peak" flows associated with clear-cut harvesting and road building on small watersheds when the "peak" flow was defined within 0.4 - 5 year return intervals.

However, Beschta et al (2000) and Thomas and Megahan (1998) concluded there were no differences in peak discharges for flows with greater than 5 year return intervals and that the trend was not evident in larger basins. This differed from Jones and Grant (1996) who concluded that "the entire population of peak discharges shifted upward" and that there was "no reason to expect the biggest storms to behave differently from the rest of the population." Beschta et al. argue that the Jones and Grant conclusions are not in agreement with either their own analysis or the Beschta et al. conclusions.

**Road Connectivity to Streams:** Drainage from forest roads may or may not flow into streams. Older road design standards considered streams as part of the road drainage system, and directed much of the drainage waters to streams. However, forest soils are extremely porous, and more recently design standards have changed to direct as much drainage onto these porous soils and out of streams as possible. It is possible to measure road connection to streams during on-site road inspections. For roads in the Willamette National Forest, a connectivity of 57 percent was reported by Wemple et al. (1997) in a study of channel network extension by forest roads in the western Cascades of Oregon. Reid and Dunne (1984) reported an even higher value of 75 percent stream connectivity in the Clearwater basin of Washington. For more recently designed or improved roads, connectivity of 25 to 35 percent was identified (Bilby et al., 1989, ODF, 1996b).

**Non Forest Roads:** Forest roads should be viewed within the context of all roads. Historical settlement patterns and ease of construction (relative to mountainous slopes) have resulted in many miles of roads built in valley bottoms near streams to access agricultural, rural and urban areas. These roads often parallel low gradient streams (which historically tended to have very productive salmonid habitat) and cross numerous tributaries. Culverts in these areas that are barriers to fish passage may block many miles of stream habitat on these low gradient streams. In a recent survey of county and state highways in western Oregon, over 1,200 culverts were found to be barriers to fish passage (Office of the Governor, 1999). These highways are typically located downstream of forestlands and therefore may limit or block access to upstream fish habitat. Many of the same road construction practices that occurred historically on forestland also occurred on other lands, and thus will have similar potential watershed-scale effects. The relatively large network of nonforest roads in close proximity to streams that are currently providing, or have the potential to provide, quality fish habitat are likely to have significant impact on the maintenance and recovery of salmonids.

## INDEPENDENT MULTIDISCIPLINARY SCIENCE TEAM (IMST) POLICY ADVICE AND ROADS RECOMMENDATIONS

*The IMST report stated that there were three areas where forest policy shifts were needed. One of this is as follows " Develop policy that brings roads not constructed to current standards, and other hazardous settings in critical locations into compliance with current standards. This means having the current OFPA Rules applied to actions taken before the current Rules were in force. In many cases, the operator acted in good faith and within the rules of the day, but the outcome is not scientifically consistent with the* *mission of the Oregon Plan; thus, a provision by which remediation is accomplished is needed."*

The IMST made a total of 19 recommendations in its forestry project report of September 14, 1999. Eight of their recommendations are directly or indirectly related to the effects of forest roads on the sediment regime or on aquatic habitat. These eight recommendations are listed below, followed by the applicable issue paper options.

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 very supportive of Oregon's current Best Management Practices for roads. Most of the IMST recommendations apply mostly 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) and also clarifying drainage standards (modification of an existing rule or guidance). The IMST also recognized that additional monitoring and research (especially on movement of sediment and large wood past stream crossings) are both critical.

## REGULATORY MEASURES - OREGON FOREST PRACTICES RULES

Since most new road construction or improvement occurs on state and private forestlands, and there is minimal or no new construction on Federal lands, this discussion is limited to the Oregon's forest practices standards. 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. Specific practices cover road location, design, construction, maintenance, vacating and use during wet periods. These rules are enforceable best management practices (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.

These 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 voluntary road hazard identification and risk reduction (voluntary) 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. These regulatory changes address IMST Recommendations 8, 9 and 12.

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:** Operators (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. By Statute (HB 3264 in 2003) ODF no longer approves written plans. ODF now comments on whether following the plan would likely result in rule compliance, would likely result in non compliance, or if there insufficient information to make this determination. Enforcement action is taken on actual compliance with the rules, not the content of plans.

**Road Location:** Roads must be located away from streams and steep slopes to the extent possible, crossing streams is only allowed for essential access. The Board of Forestry approved a new 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 (ODF 2003a and 2003b), slopes over 60 percent with decomposed granite-type soils, within RMAs or within 50 feet of stream channels or lakes, or within wetlands.*** They 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. This policy also includes certain cases where roads will not be approved (based on road length in critical locations, proximity to streams, wetlands, or inability to effectively mitigate risk to resources

**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.

**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 width, with a total disturbed area of 16 to 30 feet wide.

**Stream crossing design:** Rules require minimizing the number of stream crossings, and where crossings are necessary, ensure the structure allows passage of adult and juvenile fish (see Dent et al. 2005: Oregon Plan Fish Passage report) and very large flood flows. Rules also require keeping construction equipment and debris out of streams, except as essential for construction.

**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, including specific criteria for locating and spacing culverts.

**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. Most forest landowners now use these techniques routinely, so the department's emphasis has shifted to public safety since 1996.

**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 and surface road drainage and adequate filtering of fine sediment must be maintained. 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. Abandoned roads constructed prior to 1972 and not used for forest management since that time are not subject to Forest Practices regulatory authority.

**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.

**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 streams; and
2) Require operators to cease heavy truck traffic on roads when the road surface is breaking down on segments that can deliver sediment to streams.

Prior to 2003, wet weather road use had not been directly addressed in the forest practice rules, although maintenance of a stable surface has been required for a long time. Research and monitoring show that wet weather road use can influence water quality, especially turbidity. Monitoring also indicates that the effects of wet weather road use can be reduced through the use of durable surfacing. Durable surfacing also allows much greater flexibility for use of forest roads (much longer periods of active use). In addition, effective road drainage can reduce road maintenance costs, and also reduce surfacing needs for roads. Finally, a gravel surface also reduces erosion potential for roads that are not currently being used for heavy truck traffic.

**Rule Enforcement:** All rules are subject to Civil Penalties of $5,000, and for serious intentional violations, criminal enforcement. This penalty is in addition to the cost of damage repair. Written statements are issued to repair situations, if possible, prior to damage.

**Old Roads Versus New Roads under constructed and maintained under current Best Management Practices**

Old road construction practices often included created high risks to riparian and aquatic habitat and are contrasted with new road practices as shown in Table 1. 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. The department estimates that the majority of existing forest roads were constructed prior to 1983 (in other words, prior to rule changes which improved construction practices on steep slopes).

## NON-REGULATORY MEASURES - ROAD HAZARD IDENTIFICATION AND RISK REDUCTION PROJECT, STATE FORESTS ROAD MANAGEMENT

Roads built prior to the Oregon Forest Practices Act and current rules pose increased risk to fish habitat. The Road Hazard Identification and Risk Reduction Project is being voluntarily implemented on State and Private Forest Roads to address this issue. Roads assessed by this project include ***all roads*** on non-federal forest land used as part of an industrial or state forest operation ***since 1972, regardless of when they were constructed***. Emphasis is given to road systems constructed prior to current forest practice standards and road systems in areas near coho streams. This project includes:
1) A systematic process to identify road-related risks to salmon and steelhead recovery.
2) Priorities for problem solution,
3) Implementing actions over time to reduce road-related risks.

The two major field elements of this project are (1) surveying roads using the Forest Road Hazard Inventory Protocol (ODF, 1997), and (2) repairing problem sites identified through the protocol. Road repairs conducted as a result of this project include improving fish passage, reducing washout potential, reducing landslide potential, and reducing the delivery of increased and or turbid drainage water entering streams. Priority areas were for roads near coho streams and in areas with old roads on steep slopes. All voluntary actions are implemented on existing roads. For new roads, all stream crossings must pass adult and juvenile fish and pass the 50-year peak flow with a significant safety factor (no water above the culvert).

***Table 1. Comparison between old and new road practices.***

| Past "high risk" Practice | Current "low risk" Practices |
|---|---|
| 1. Sidecast construction on steep slopes. | 1. Full-bench design, end-haul construction on steep slopes. |
| 2. “High” fills. | 2. “Low” fills. |
| 3. Stream crossing culverts sized to pass *Q25 or whatever fit. | 3. Steam-crossing culverts sized to pass *Q50. |
| 4. Downstream side of stream crossing fills not armored with rip-rap. | 4. Downstream side of stream crossing fills armored with rip-rap. |
| 5. Fills not designed to allow for overtopping by high stream flow. | 5. Stream crossing fills designed to allow overtopping by stream flow. |
| 6. Passage of sediment and large wood hindered by stream crossings. | 6. Facilitate passage of sediment and some wood at stream crossings. |
| 7. Passage of gravel hindered by stream crossings. | 7. Facilitate passage of gravel over/through stream crossings. |
| 8. Fish passage through culverts may be problematic for adults and juveniles. | 8. Adult and juvenile fish passage through culverts and maintenance of passage required. |
| 9. Road cross drain spacing may not meet standard spacing criterion:<br>a. ditch erosion<br>b. discharge onto steep slopes<br>c. ditch water drains directly into streams | 9. Cross drain spacing is such that ditch erosion is minimized, drain water not directed onto steep slopes, ditch water not directed into streams. |
| 10. Unneeded roads abandoned “as is.” | 10. Unneeded roads stabilized and vacated. |

* Q25 and Q50 refer to streamflows with a 25-and 50-year return interval, respectively. Culverts are now required to pass the 50-year flow.

Roads assessed by this project include all roads on Oregon Forest Industry Council (OFIC) member and State forestlands, regardless of when these roads were constructed. At the beginning of this project (in 1997) industrial forest landowners estimated spending approximately $13 million a year on voluntary and regulated road improvement work over the life of this project, for the coastal ESUs. The State Forests program continues to spend about $1.5-2.5 million per year for road improvement that increases resource protection.

The Oregon Small Woodlands Association (OSWA) indicated they also wanted to be a part of the project. However, they did not make specific commitments to a timeframe, and indicated that financial and/or technical assistance is generally necessary for non-industrial landowners to accomplish the goals of the project.

In summary, the road hazard identification and risk reduction project includes a detailed survey to identify hazards and risks to streams, and specific repairs that above and beyond FPA road maintenance minimums and towards new road standards. This project has been applied extensively on Private Industrial (32 percent of the ESU) and State (9 percent of the ESU) forestlands, for a total of 41 percent of the ESU. These activities have been applied on limited non-industrial forestlands (20 percent 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 are not discussed in detail in this paper.

The following section describes road surveys, repairs, and priorities as implemented and identified through the Road Hazard Identification and Risk Reduction Project (RH&RR).

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

**Fish passage improvement - A**llow 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.

**State Forests Road System Management:** The State Forests program implements all forest practices road construction and maintenance rules, 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.

The State Forests program is beginning to conduct transportation planning on all State Forests. Currently, a proposed *Road Information Management System* is under review. This system included development of indices of risk from roads, including consistent ways to measure, should be suitable for monitoring use on any forest roads.

This pilot study has developed indices for evaluating road risk to resources as follow:
1. Fish passage barriers - **Number of adult and juvenile per square mile**
2. Roads in critical locations - **Percent of road system in these locations**
3. Diversion/washout potential of structure **- Rated as low, moderate, or high. Counts on a per area basis**
4. Road drainage connectivity to streams **- Percent of road system draining to streams and not filtered through forest floor**
5. Risk of chronic erosion during wet season use - **Percent of rocked roads with connectivity (# 4 above) that have durable surfacing**
6. Land in non forest condition - P**ercent of land-base in road surface, cut or landing**

These data will be collected during watershed analysis, by ODF employees or contractors.

## TIMELINES

The following timelines were established in 1997 when the Oregon Plan for Salmon and Watersheds became official. There are timelines for the three principal road strategies: Forest Practices Regulation, the Road Hazard Identification and Risk Reduction project, and State Forests Transportation management practices.

**Forest Practices Rule and Policy Changes**

| **Completed Actions** | **Date Completed** |
|---|---|
| Report of the Forest Practices Advisory Committee | August, 2000 |
| Critical Road Locations Policy | March, 2002 |
| *(technical note)* | *June, 2003* |
| Wet Season Road Use Rule | January, 2003 |
| *(technical note)* | *June, 2003* |
| Road Drainage Rule modification | January, 2003 |

| | |
|---|---|
| *(technical note)* | *June, 2003* |
| HB 3264 - modified written plan requirements | July, 2003 |

| **Planned Actions** | **Target Date** |
|---|---|
| Rule modifications for HB 3264 | July, 2005 |

**Road Hazard and Risk Reduction Project Implementation**

| **Completed Actions** | **Date Completed** |
|---|---|
| Road inventory protocol written | 1997 |
| Assessment plan priorities | 1997 |
| Road Management Guidebook | 2000 |
| Assessment work *completed by (planned)* | *2002* |

| **Planned or Agreed-to Actions** | **Target Date** |
|---|---|
| Road work in priority areas | January 1, 2007 |
| Monitoring for substantive progress made | 2007 |
| *(priority areas - next to coho streams in coho ESU)* | |
| Project Completion | January 1, 2012. |

**State Forests - Road Management**

| **Completed Action** | **Date Completed** |
|---|---|
| Forest Roads Manual Completed | 2000 |
| Northwest Oregon Forest Management Plan | 2001 |
| Road information management System Pilot Study | 2004 |

| **Planned or Agreed-to Actions** | **Target Date** |
|---|---|
| Harvest and Habit model outputs | 2005 |
| (*preliminary transportation planning layer*) | |
| Transportation Planning Complete | 2011 |

## IMPLEMENTATION AND EFFECTIVENESS

Actions reported under the Oregon Plan, and also monitoring of forest practices rule compliance and effectiveness, are discussed here. As summarized in this paper *under Current Scientific Findings*, there is a very large difference in the effects of roads depending on whether built to current standards or not.

**Road Hazard Identification and Risk Reduction Project Reporting**

Work reported to OWEB from 1997 through current (2003) is summarized in Table 2 (state forests), Table 3 (private industrial forests) and Table 4 (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 that work that also meets 50-year flow requirements, and does not summarize treatments such as weirs or outlet pools. For a complete discussion on fish passage see Dent et al. 2005.

**State Forests Discussion:** There are **988** square miles State Forests land in the Coastal Coho ESU, approximately 9 percent of the ESU. Table 2 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, as this ESU includes most of the Oregon's state forest lands, yet only reports 570 miles of road surveyed. This despite the fact the Tillamook District alone (about 1/3 of this area) surveyed 1323.52 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 a reporting issue). Other common activities include adding durable surfacing (491 miles), and vacating roads (50 miles). Actual completed road work is consistent with project objectives and work done on private industrial forest lands.

***Table 2. State Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003).***

| | 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** |

**Private industrial Forests Discussion:** There are **3534** square miles of private industrial forestland in the Coastal Coho ESU, approximately 32 percent of the ESU. As with State Forests, 6973.4 miles of roads were reported surveyed, most before 2000 (Table 3). Based on a 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 this survey represents about 70 percent of industrial forest roads in the ESU.

There were many fish passage structures replaced (598) and peak flow improvement structures replaced (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 forest lands. Except for sidecast pullback, most work tapered off by 2003. This may be because the steeper lands, where side cast pull back is important, tend to be further from the most important Coho habitat which was a priority in the early days of the plan.

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 the monitoring called for under this project.

**Non industrial lands discussion:** There are **2240** square miles of private non-industrial lands in the Coastal Coho ESU, approximately 20 percent of the ESU.  Most of these are at least partially forested, with some lands principally in agriculture. Overall, much less work occurred on these lands (Table 4 lists only the forested portions of these lands). In part as a response to the small road survey mileage and repair activity, short courses sponsored by OSU, ODF and OFRI were conducted in 2003. 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.

**Other Lands and Land Uses:**  There are **4195** square miles of Federal forestland in the Coastal Coho ESU, approximately, 38 percent of the ESU. Federal reports on road activities are shown in Table 5.  The federal data available for this report provide two categories: maintenance and decommissioning. 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 evaluate road activities under the Oregon Plan.

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 forest lands 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 3. Private Industrial Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003).***

| | 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 | 461.4 | 24.45 | 13.15 | 27.08 | 8.01 | **151.58** |

***Table 4. Private Non-industrial Forests Summary of Road Improvements for Oregon Coastal Coho ESU (1997-2003).***

| | 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 5. 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.

**Forest Practices Road Related monitoring**

Evaluation of current rules is 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. Wet Season road use and turbidity - final report in 2003.

**1. Forest Road Drainage Practices**

The objective of this project was to determine - how effective were the current BMPs at minimizing the delivery of sediment to channels? The 1996 ODF monitoring report 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 (ODF, 1996). This project also found a general lack of filtering of drainage waters near streams, and that steep-gradient roads tend to have cross drainage structures at wider spacing than lower-gradient roads. There were also inconsistencies in drainage practices between georegions, with special concerns in the Siskiyou georegion.

**2. Storm Impacts and Landslides of 1996 - final report in 1999**

The following are conclusions from Robison et al. (1999). These findings include the most current information addressing the adequacy of the forest practice rules related to landslides and forest roads.

- Landslides associated with forest roads made up a smaller percent of the total landslides in the ODF study than road-associated landslides did in most previous studies.
- The road-associated landslides were smaller, on average, than road-associated landslides in past studies. However, these road-associated landslides were four-times larger on average than non-road landslides.
- 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, and to a lesser extent in Vida study areas. 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.

**3. BMP Compliance Monitoring - final report in 2002**

In total, 148.4 miles of existing road and 38.5 miles of new road randomly selected and 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.

The following Table (6) shows the location of roads surveyed. Most (over 95 percent) of these roads were **not** located in ***critical locations.*** This is the case for both new and old roads. However, of roads in critical locations, old roads were more commonly in RMAs while new roads in critical locations have a greater occurrence on steep slopes. This likely reflects a shift in policy and practice that calls for building ridge top roads and minimizing road construction in midslope areas and along streams.

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). Since this monitoring, the road drainage rules were modified, and a technical note on road drainage was written.

***Table 6. Percent of New and Existing Road Lengths from monitoring study 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<br>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% |

**4. Wet Season road use and turbidity - final report in 2003.**

Wet season road use can be the most significant forest practice-associated source of chronic turbidity and fine sediment in 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 department completed a study of turbidity associated with wet season road use. 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 all can affect turbidity increases associated with wet season road use (Mills and others, 2003). This study was used to design the recent changes to the forest practices rules (addition of a new rule for wet weather road use).

## DISCUSSION AND SUMMARY

BMPs for new forest roads are effective, and are implemented with a high compliance rate (over 95 percent). Oregon's forest practices rules for new roads and road use are as good as any land use in Oregon or any other region, as based on both research and monitoring. Oregon's rules require maintenance of older roads, and require new rule standards for any road reconstruction. For other old roads, industrial private and state forest lands have applied the road hazard identification and risk reduction project to improve resource protection over time. Since the Oregon plan was approved, there has been significant work on old roads, both by rule when reopened, and under the volunteer road hazard identification and risk reduction project (e.g. estimate 70% of industrial forest roads).

Old roads make up the majority of roads, and where there have been many improvements reported, we have little data on road conditions at a landscape or watershed scale. To date, monitoring has not been conducted at this larger scale, so it is not possible to determine risks posed by forest roads, other than to conclude that they are very likely lower than in 1997. This data gap was anticipated by the RHIRR project, with a plan for monitoring in 2007.

### Monitoring need

There are several reasons to plan for on-the-ground monitoring activity now. First, the Road hazard identification and Risk Reduction Project calls for monitoring in 2007. It will take some time to develop methods and work with stakeholders to develop understanding, acceptance and support for monitoring protocols and property access. We have learned a great deal from the successful ODF road monitoring projects and have a good idea of the data needed. And while we have many thorough reports of progress submitted to OWEB, these are provided on a volunteer basis, so there is no independent verification of project completion or success. The State Forests pilot study has developed standard indices of road condition that should be applicable to all forest roads. Finally, the lack of consistent federal reporting leaves many questions on the relative risks posed by roads on federal lands, and if these risks have been increasing or lowering over time.

Therefore, it is critical to monitor across all forest ownership, with methods that will consistently evaluate the very different road systems. To do this, it will be necessary to review indices with stakeholders, such as landowners, environmental, and research communities. Ultimately, the monitoring must look over the landscape, and measure road conditions against accepted indices of hazard and aquatic risk. Monitoring should include state and federal funding, consistent methods, overseen by roads engineer with expertise in risk to aquatic resources. Ideally the approach would rely on a random sample adequate to represent all landowners, georegions, and "critical" road locations.

**REFERENCES**

Bilby, R. E., K. Sullivan, and S. H. Duncan. 1989. *The Generation and Fate of Road-Surface Sediment in Forested Watersheds in Southwestern Washington.* Forest Science. Vol. 35, No.2: 453-468.

Botkin, D., K. Cummins, T. Dunne, H. Reiger, M. Sobel, and L. Talbot. 1995. *Status and Future of Salmon of Western Oregon and Northern California: Findings and Options.* The Center for the Study of the Environment, Santa Barbara, California.

Coats, R. L., L. Collins, J. Forsheim, and D. Kaufman. 1985. *Channel Changes, Sediment Transport, and Fish Habitat in a Coastal Stream.* Environmental Management 9(1):35-48.

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

Dent L., A. Herstrom, E. Gilbert. 2005. *A Spatial Evaluation of Habitat Access Conditions and Oregon Plan Fish Passage Improvement Projects in the Coastal Coho ESU Oregon Plan Assessment Part 4J, OP Technical Report 2.* http://nrimp.dfw.state.or.us/OregonPlan/ 18 pp.

Everest, F. H., R. L. Beschta, J. C. Scrivener, K. V. Koski, J. R. Sedell, and C. J. Cederholm. 1987. *Fine Sediment and Salmonid Production: A Paradox. In: Salo, E. O., editor, Streamside Management, Forestry and Fishery Interactions.* College of Forest Resources, Univ. of Washington. pp 98-142.

Folz, R.B. 1996. *Traffic and No-traffic on an Aggregate Surfaced Road: Sediment Production Differences.* Paper presented at FAO seminar on Environmentally Sound Forest Road and Wood Transport, Sinaia, Romania.

Hicks, B. J., J. D. Hall, P. A. Bisson, and J. R. Sedell. 1991. *Response of Salmonids to Habitat Changes.* American Fisheries Society Special Publication 10:483-518.

IMST. 1999. Independent Multidisciplinary Science team. *Recovery of wild salmonids in Western Oregon forests: Oregon Forest Practices Act Rules and the measure in the Oregon Plan for Salmon and Watersheds.* Technical Report 1999-1 to the Oregon Plan for Salmon and Watersheds Governor's Natural Resource Office, Salem, Oregon. 85 p.

Jones, J.A. and G.E. Grant. *1996 Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon.* Water Resources Research Vol. 32 No. 4 pp.959-974

King, J.G. and L.C. Tennyson. 1984. *Alteration of streamflow characteristics following road construction in north central Idaho.* Water Resources Research 20(8):1159-1163.

Luce, C., and T. Black. 1999. *Sediment Production from Forest Roads in Western Oregon.* Water Resources Research 35(8): 2561-2570.

Megahan, W. F. 1974. *Erosion Over Time on Severely Disturbed Granitic Soils; A Model*. USDA Forest Service, Intermountain Forest and Range Experiment Station, Research Paper INT-156.

Megahan, W. F., and G. L. Ketcheson. 1996. *Predicting Downslope Travel of Granitic Sediments from Forest Roads in Idaho.* Water Resources Bulletin. Vol. 32, No. 2. pp. 371-381.

*Megahan, W. F., and J. W. Kidd. 1972. Effect of Logging Roads on Sediment Production Rates in the Idaho Batholith. USDA Forest Service Research Paper. INT-123, Intermountain Forest and Range Experiment Station, Ogden, Utah. 14 pp.*

Megahan, W. F., W. S. Platts, and B. Kulesza. 1980. *Riverbed Improves Over Time: South Fork Salmon.* In: Symposium on Watershed Management, New York, NY; American Society of Civil Engineers; 1980: 380-395.

Mills, K. L. Dent. And J. Robben,, 2003. *Wet Season Road Use Monitoring Project: Final Report.* Oregon Department of Forestry.

Montgomery, D. R. 1994. *Road Surface Drainage, Channel Initiation, and Slope Instability.* Water Resources Research, Vol. 30, No. 6. pp 1925-1932.

Newcombe, C. P., and D. D. McDonald. 1991. *Effects of Suspended Sediments on Aquatic Systems.* North American Journal of Fisheries Management. 11:72-82.

ODF Forest Practices Monitoring Program. 1996. *Road Sediment Monitoring Project Report: Survey of Road Drainage in Western Oregon*. ODF Technical Report, pp. 11.

Oregon Department of Forestry. 1996a. *Road sediment monitoring project report: Survey of road drainage in Western Oregon.* Report for the Department of Environmental Quality.

Oregon Department of Forestry. 2000. Forest *Road Management Guidebook*. J. Cornell and K. Mills, Editors.

Oregon Department of Forestry. 2003a. *Forest Practices Technical Note Number 2: High Landslide Hazard Locations, Shallow, Rapidly Moving Landslides and Public Safety: Screening and Practices.* Oregon Department of Forestry, Salem Oregon.

Oregon Department of Forestry. 2003b. *Forest Practices Technical Note Number 4: Fish Passage Guidelines for New and Replacement Stream Crossing Structures.* Oregon Department of Forestry, Salem Oregon.

Oregon Department of Forestry. 2003. *Forest Practices Technical Note Number 5:*

*Determining the 50-Year Peak Flow and Stream Crossing Structure Size for New and Replacement Crossings.* Oregon Department of Forestry, Salem Oregon.

Oregon Department of Forestry. 2003. *Forest Practices Technical Note Number 7: Avoiding Roads in Critical Locations.* Oregon Department of Forestry, Salem Oregon.

Oregon Department of Forestry. 2003. *Forest Practices Technical Note Number 8: Installation and Maintenance of Cross-Drainage Systems on Forest Roads.* Oregon Department of Forestry, Salem Oregon.

Oregon Department of Forestry. 2003. *Forest Practices Technical Note Number 9: Wet Weather Road Use.* Oregon Department of Forestry, Salem Oregon.

Oregon Forest Resources Institute. 2002. *Oregon's Forest Protection Laws: An Illustrated Manual.* 160 pp.

Office of the Governor, Executive Order No. EO 99-01, January 8, 1999. *The Oregon Plan for Salmon and Watersheds.* pp. 9.

Piehl, B. T., R. L. Beschta, and M. R. Pyles. 1988. *Ditch Relief Culverts and Low-Volume Forest Roads in the Oregon Coast Range.* Northwest Science: 62(3) 91-98.

Reid, L. M., and T. Dunne. 1984. *Sediment Production from Forest Road Surfaces. Water Resources Research.* Vol. 20, No. 11: 1753-1761.

Robben, J. and L. Dent. 2002. *Best Management Practices Compliance Monitoring Project: Final Report*. Oregon Department of Forestry.

Robison, E. G., K. Mills, J. T. Paul, L. Dent , and A. Skaugset. 1999. *Oregon Department of Forestry 1996 Storm Impacts Monitoring Project: Final Report.* Forest Practices Technical Report #4. Oregon Department of Forestry, Salem, Oregon. 145 pp.

Sessions, J., Balcom, J. C., and Boston, K. 1987. *Road Location and Construction Practices: Effects on Landslide Frequency and Size in the Oregon Coast Range.* Western Journal of Applied Forestry, Vol. 2, No. 4. pp. 119-124.

Sidle, R. C., A. J. Pearce, and C. L. O'Loughlin. 1985. *Hillslope Stability and Land Use*. American Geophysical Union Water Resources Monograph 11.

Thomas, R. B., and W. F. Megahan. 1998. *Peak Flow Responses to Clear-cutting and Roads in Small and Large Basins, Western Cascades, Oregon: A Second Opinion.* Water Resources Research, V.34, No. 12, 3393-3403. December.

Weaver, W. E., and D. K. Hagens. 1994. *Handbook for Forest and Ranch Roads.* Mendocino County Resource Conservation District in Cooperation with the California Department of Forestry and the U.S. NRCS.

Wemple, B. C., J. A. Jones and G. E. Grant. 1997. *Channel network extension by logging roads in two basins, Western Cascades, Oregon.* Water Resources Bulletin 32(6):1195-1207.