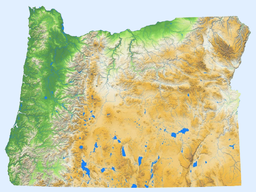
Effects of Forest Roads on Hillslope Hydrology and Sedimentation in the Western Cascades



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ABSTRACT

Improper construction and maintenance of roads on both public and private timberland contribute to clogging river channels with sediments, thus impeding migration of local fish species, as well as making the hillslopes unstable. In western Oregon, legacy forest roads were constructed in ways that over-steepened slopes and removed nearly all of the natural barriers protecting against these hazards. Misplaced road alignments in steep forested terrain disrupt the natural flow of groundwater and render hillslopes unstable during wet weather conditions. If ditches and culverts are not properly constructed, they concentrate a majority of the surface flow into narrow channels which dramatically increases erosion and sedimentation into valleys below. Improper maintenance of the logged land and ditches can also contribute to this problem when the supporting groundcover is completely removed, which decreases root strength, allowing loose sediment to runoff directly into eroding channels. These matters can pose a serious threat to local communities and native fish species, however, through applying erosion-control techniques, many of these concerns can be mitigated. This study examines the effects of forest road construction on hillslope hydrology and sedimentation in forested timberlands of the Western Cascades, Oregon.

INTRODUCTION

Oregon has been commercially harvesting timber for well over 100 years. Though many forms of transportation have been used to facilitate product to market, the most prevalent today is the roadway. These are not simple create and forget roadways; scientific study of how these affect the surrounding environment has prompted conservation efforts to redefine what is desired in how the road impacts its surroundings. The Pacific Northwest is a natural habitat for salmon spawning, in which the salmon swim up small streams and tributaries to lay their eggs within the loose gravel along the bottom of the channels. It was discovered that when improperly constructed logging roads were present in a drainage basin, there was a statistically significant increase in fine sediment transportation and consequent deposition in these stream channels. An increase in fine sediment introduced into a stream would clog the pore space in the gravel bottom, decreasing the survival rate of the salmon eggs. Poorly engineered forest roads can also lead to a decrease in the strength of a hillslope, posing a danger not only to the people working on or near the slope, but the ability to transport the product to market on schedule. Constructing and properly maintaining forest roads represents an economic, environmental, and safety incentive to both the public and private sectors.

Figure 1. An example of what occurs when the discharge overwhelms an undersized culvert, resulting in a road that washes away.

PROJECT OVERVIEW

This project covers the problems caused by numerous mass wasting events deriving from the existence of forest roads, and how they alter the hillslope hydrology and sedimentation of a forest slope.

- Cutting into a hillside to build a forest road has the potential to increase the likelihood of slope failure by 25 – 340 times more than when compared to an undisturbed hillslope, (Beschta, 1978).
- Improperly sized or placed culverts have the potential to become clogged, which leads to the surrounding ground becoming oversaturated and may wash away the road.
- Completely stripping a hillslope of vegetative groundcover removes all root strength, weakening the hillside and allowing rainwater to erode the surface directly. This can increase sediment production by up to 95% compared to an undisturbed hillside, (Beschta, 1978). It can take up to twenty-two years for sediment production to return to its pre-cut levels (Grant and Jones, 1996).
- Scraping ditches to remove all vegetation allows sediment to wash away unhindered, increasing the sediment deposited in streams by up to 700%, (Luce and Black, 1999).

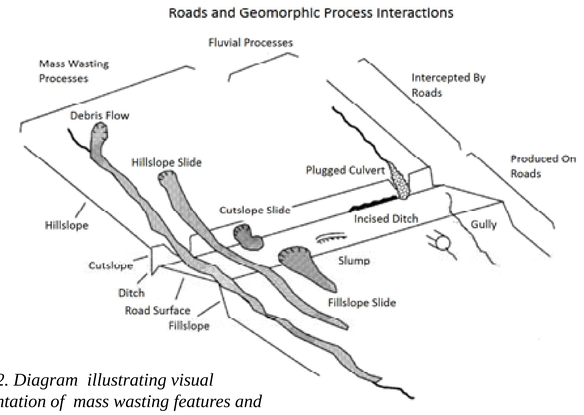

Figure 2. Diagram illustrating visual representation of mass wasting features and events, and how they spatially relate to a hillslope with a forest road.

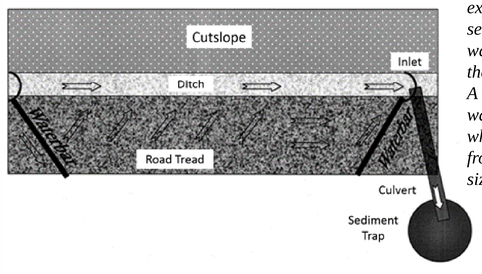

Figure 3. Many of the experiments to measure sediment discharge of a watershed are set up like the diagram to the right. A sediment trap allows water to flow through while capturing sediment from an area of specific size.

RESULTS AND DISCUSSION

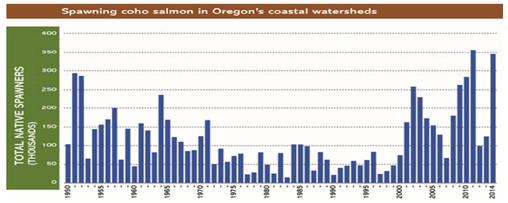

Figure 4. Chart showing the decreasing salmon spawn population, partially due to stream channels clogging with sediment.

• Replacing ageing culverts with larger, appropriately sized culverts increase the ability to drain water from the slope in a timely manner and decrease the likelihood of a clog occurring.

• Removing culverts and filling in ditches on unused or abandoned roads allows the natural hydrologic patterns to resume which reduces sediment transport by allowing surface runoff to filter back into the ground instead being run through narrow surface level channels.

• Placing new culverts in a location that allows the discharge to drain into the forest floor 15'-200' from the stream channel (dependent on road grade and culvert distance from stream) would allow the sediment being carried in the runoff to be deposited in fan-shaped deposits on the surface. The water would absorb into the ground and reach the stream as clean groundwater.

• Oregon's Forest Practices Act of 1972 requires that within two seasons of timber harvest of a unit, new trees must be planted in densities specified by the particular circumstances of the harvest. This does not completely mitigate the reduction in strength from root loss, but within a few years the benefit gained from the root strength of vegetation will begin to return.

• Mowing down vegetation growing in drainage ditches along the road side instead of scraping them clean will allow the foliage to strain out sediment and greatly reduce the speed and quantity of sediment reaching the stream in a given time.

CONCLUSION

Through studies conducted in the last 40 years, various techniques have been devised to mitigate many of the issues regarding sediment deposition into streams. While there is an abundance of forest roads scattered throughout the Pacific Northwest, we can see there is only a small portion of them account for a majority of sediment transport, (Luce and Black, 1999). With this in mind it is possible to treat only the greatest offenders and maximize the effect of road alteration processes, decreasing the impact that both new and legacy forest roads have on the hydrology and sedimentation patterns in the Pacific Northwest.

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