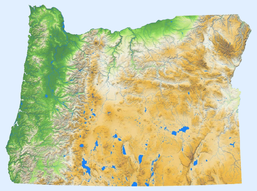
Hydrogeomorphic Response to Forestry Practice in Mountainous Watersheds of Western Oregon



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ABSTRACT

Forestry practices in western Oregon, especially clear cutting and road construction, have had significant, dynamic and occasionally detrimental impacts on watersheds. Increased soil erosion in the form of landslides have been shown to occur far more frequently in heavily logged areas and cause dramatic changes in sediment yields and water quality. Additionally, in the instances of clear cutting, slash-burning, and road construction, the extensive removal of vegetation has caused significant impacts to stream water temperatures, oxygen levels and peak flows. As longer and supplementary studies are conducted on these diverse relationships, the collected reports point toward an increasingly complicated series of influences. Short term studies often come to vastly different conclusions as compared to long term analyses, regardless if the subject is stream flow discharge or sediment transport. At risk are the ecosystem services that are provided to aquatic species, salmonids and related old-growth habitats. If Oregon forests are to be conserved and utilized efficiently, further studies and collaborative efforts are needed so as to quantify the impacts of logging methods in various environments. Ongoing review of forestry practice standards and adaptive management methods form an important part of a statewide forest plan. This paper reviews the relevant literature and provides a framework for understanding complex landscape response to forestry practice in western Oregon.

FORESTRY PRACTICE

The analysis of the impacts on environments caused by logging vary massively depending on pre-existing geologic features, forestry goals, and industry regulations. Between road construction, product movement, machinery, and outright harvesting, areas subjected to timber industry demands face significant changes. Some of the primary alterations to the landscape include the clearcutting or patch-cutting of both inland and riparian trees, the removal of low lying vegetation, and the destruction of subsurface rooting. In addition, left over organic materials from tree tops especially can litter the area of a logging operation. Collectively, the harvesting and disruption of the area can also contribute to destabilization of shallow surface sediments and generally lower soil cohesion.

Stream	Percent Buried	Burial Depth (m)	Percent Covered	Cover Depth (m)	Sum of Buried and (percent)	Survey Length (m)	Length Buried (m)	Length Covered (m)
CLEARCUT STREAMS								
12E*	44	1.8	28	2.3	72	27.7	12.3	7.7
12W	6	1.0	91	0.9	97	27.0	1.5	24.5
17W	64	1.0	36	1.0	100	21.0	13.4	7.6
17M	42	1.6	58	1.4	100	23.0	9.6	13.4
21E	7	0.5	85	0.6	92	27.6	2.0	23.4
13S	90	0.6	8	0.2	98	50.0	44.9	4.2
13M	52	1.0	48	0.4	100	35.0	18.3	16.7
Weighted Averaged for Clearcut Streams								
	48	0.97	46	0.90	94	211.3	102.0	97.5
BUFFERED STREAMS								
17E**	0	–	29	(blowdown)	29	28.3	–	8.3
21M	0	–	0	–	0	35.0	–	–
13E	0	–	0	–	0	25.0	–	–
21W***	0	–	–	–	0	27.3	–	–

Table 1. Burial and Coverage of Streams by Slash After Clear-Cut Harvest.

ENVIRONMENTAL EFFECTS

The wide spread disturbances caused by forest practices in the mountainous watersheds of Western Oregon have tremendously dynamic impacts on the local watersheds and often respond to unique conditions to the area. For instance, the clear-cut removal of riparian vegetation and old growth timber alone commonly leads to at least a few of these watershed disturbances: sediment yield increase in streamflow, stream temperature increases, peak flow yield increases and decreases, stream oxygen content, channel morphology and small stream burial. Not only do these substantial side effects of logging vary by each geologic scenario, but also have discrepancies between short term and long term consequences. In a study that observed the August stream flow yield of a watershed in the western cascades for 25 years after clear-cut logging, they recorded a 159% increase over the control in the first 8 years and a 25% decrease in the following 17 years (Figure 2). It is also worth noting that these water flow yields are heavily influenced by what species of riparian vegetation are removed and what species fill the vacancy in the following years.

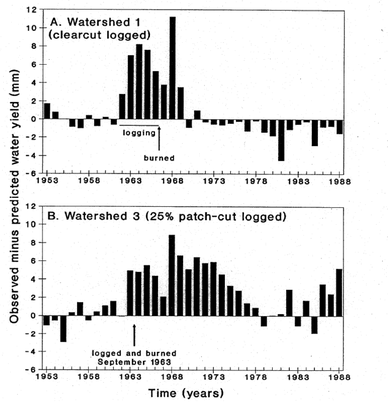

Figure 2. Harvest Effects on Water Yield at HJ Andrews Experimental Forest.

In addition to changing stream conditions, accelerated mass wasting has been frequently recorded after clearcutting and slash burning. The removal of root cohesion, the increased soil saturation from the removal of vegetation, and the disturbance of water transportation routes all contribute to regional instability. The extent of destabilization, however, depends on slope aspect, slope steepness, climate conditions, and soil composition. These variables are especially important in the first year before invasive vegetation can take root in the unoccupied soil. Mass wasting events, which in these conditions are primarily less that 5 meters in depth, have expectably complex impacts on the area and are principally caused by over saturation. Some mass wasting events can contribute to the covering of more productive soil with less productive sediment, leading to a collectively less biologically active landscape. Additionally, such events are credited with increasing sediment yields in streams as landslide activity moves extensive debris downhill.

RIPARIAN HABITATS

The environmental effects that characterize an area after logging can have detrimental impacts on the ecosystem services that are provided to aquatic species, salmonids and old-growth related habitats. Factors such as water temperature, oxygen content (affected by leaf debris from invasive and deciduous vegetation), flow yield and channel morphology can promote the population growth of one species while making the same stream uninhabitable by others. For instance, if the flow yield of a stream inhabited by salmonids is lowered enough, entire populations can perish as streams run dry. Likewise, if the sediment content of a stream rises too dramatically, particles can clog interstitial crevices previously occupied by aquatic life.

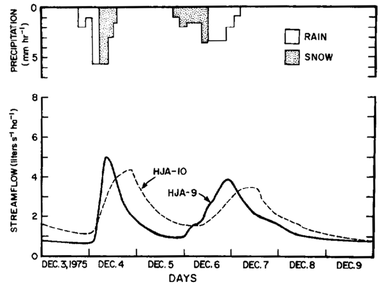

Figure 3. Storm Hydrographs for Post-Logging Period, H.J. Andrews.

CONCLUSION

Forestry practices throughout the mountainous watersheds of Western Oregon have complex hydrogeomorphic influences on environmental conditions and ecological services. The massive array of often complementary effects that change depending on climate, terrain, time and other unique regional factors suggest that a continued and heightened effort to understand and quantify these responses is key to improving forest practices. The relevant literature evaluated in this project collectively comes to no singular concluding statement with exception to the notion that environments subjected to forest practices will inherently demonstrate an often underappreciated complexity. Accepting and understanding this complexity will be key for adopting an improved statewide forestry plan as further field research explores substantial impacts caused by logging.

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