The Influence of Timber Harvest on Sediment Transport in the Western Cascades

Jacob H. Higgins, Department of Biology, Western Oregon University, email: jhiggins13@wou.edu

Abstract

As timber harvest continues to be one of our primary land uses in the Pacific Northwest, it is important to understand the potential affects it can have on the environment. One important way that timber harvest can affect the environment is by increasing runoff and sediment load in headwater landscapes. Increased sediment transport can have serious effects on water quality, channel stability, and riparian ecosystems. Previous studies have shown that sediment yields are much higher in areas that have experienced recent clear cutting events and that have access roads associated with them. If timber harvest does cause increased sediment transport and degrade water quality, it is imperative to find new methods of timber production that will minimize these effects and enhance ecosystem services. This paper provides an overview of forest practice and its effect on sediment transport in the Western Cascades.

Introduction

Before the Oregon Forestry Protection Act came into effect in 1972 clear cutting with slash and burn methods were the primary ways that timber was harvested in Oregon. Clear cutting is a forestry/logging practice in which most or all trees in an area are uniformly cut down. The change in the appearance of the landscape is so dramatic that it can have serious affects on the local and distant environments. The major effects of clear cutting, and timber harvest are sedimentation which; greatly reduces water quality (for humans and wildlife), decreases channel stability, and cause mass wasting events to occur more readily.

How does sedimentation reduces water quality (Brown, 1971):

➢Excessive concentrations of suspended sediment can cause gill injury or alteration of behavior patterns in salmon, and steelhead.

➢Mineral and organic sediments in water or deposited in spawning gravels may cause mortality, delayed development, or poor living conditions for salmon and steelhead.

➢Sedimentation at excessive concentrations can cause an alteration and destruction of habitat for organisms at the bottom of the food chain.

➢Sediment deposition can have Indirect influences on gravel flow and aeration.
- ✓ Gravel size has been related to the interchange of dissolved oxygen in a river.

How sedimentation and timber harvest practices reduces watershed ecosystems:

➢Clear cutting increases the ability for sediments to wash into watershed streams/rivers and settle to the bottom of the channels.

➢Clear cutting also causes excessive erosion which can reduce the soil's inherent productivity and reduce riparian vegetation ability to grow and cool the watershed's waters.

How timber practices can increase the chances of mass wasting events:

➢Removal of large trees and vegetation has a had a drastic increase on the probability of landslides occurring.
- ✓ Large trees provide strong root structures that penetrate, and anchor the soil.
- ✓ Trees also draw up water from the soil and increase the stability of the slope by removing the over saturation in the soil.

➢Heavy logging machinery damages precious topsoil and decreases its ability to absorb water (because a little bit of water helps hold the soil together with its cohesive properties).

Figure 1: Example of sedimentation due to clear cutting.

Key Experimental Studies

Experiment 1:
Long-Term Patterns of Sediment Transport After Timber Harvest, Western Cascade Mountains, Oregon, USA by G.E. Grant and A.L. Wolff. (1991)

➢This paper describes a 30-year history of sediment production (1958-1988), both bedload and suspended load, from three small watersheds (each ~ 2-3 acres in area) with different road and cutting treatments.

➢The study site was in H.J. Andrews Experimental Forest located in the Willamette National Forest on the western cascades. Dominated by 400-500 year old Douglas fir trees.

➢**The Experimental Design:**
- ✓ Watershed 1 was clear cut in 1962, using skyline suspension system to minimize surface soil disturbance and all residual logging debris were burned in 1966.
- ✓ Watershed 2 was the control, and was left undisturbed.
- ✓ Watershed 3 had three discontinuous clear cuts in 1962-63 (that totaled 25% of the watershed area), the Watershed also had a road constructed in it during 1959. logging debris were also burned in 1963.

➢**Key Figure:**

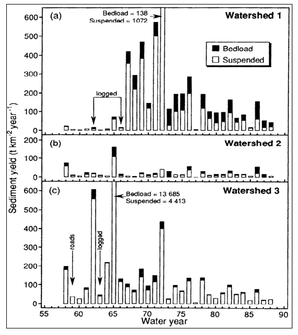

Figure 2: Annual sediment yields for watersheds 1, 2, 3 for water years 1958-1988

Experiment 2:
Clear-Cut Logging and Sediment Production in the Oregon Coast Range
by George W. Brown, and James T. Krygier (1971)

➢The crucial question asked by the authors in of this paper is "how does clear cut logging affect erosion and sedimentation in headwater streams?" The study began is 1958.

➢The study site is located in the Alsea basin (three different watersheds) 8 miles south of Toledo, Oregon, and 10 miles from the pacific Ocean. The watershed is forested by Douglas fir and alder trees.

➢**The Experimental Design:**
- ✓ The sediment yield characteristics of the watersheds were monitored for 7 years before treatments occurred (1958-1965).
- ✓ Logging roads were constructed into Deer Creek and Needle Branch in 1965.
- ✓ Logging harvest began in 1966.
- ✓ Flynn Creek, a 500-acre watershed served as the control and remained in its natural condition throughout the study.
- ✓ Needle Branch a 175-acre watershed was fully clear cut.
- ✓ Deer Creek is a 700-acre watershed was broken down into three small units, and was measured at four different stations. 138-acres were 30% clear cut, 100-acres were 65% clear cut, and 39-acres were 90% clear cut. Total about 25% of the watershed was clear cut.

➢**Key Figure:**

TABLE 2. Analysis of Simultaneous Sampling of Suspended Sediment Concentration and Streamflow at U.S. Geological Survey Stations during Rising Stages and Discharges Greater than 5 cms

Water Year	Sample Size	Sediment Concentration, ppm Range	Sediment Concentration, ppm Mean	Streamflow, cfs Range	Streamflow, cfs Mean
		Flynn Creek (Control)			
1964–1965	72	1–205	194	4.2–148	32
1966	64	1–718	128	4.2–66	22
1967	28	38–429	148	4.2–69	32
1968	18	32–256	109	11–44	26
1969	17	1–200	97	7–44	20
		Deer Creek (Patch Cut)			
1964–1965	71	1–1610	267	6–204	58
1966	66	1–6960	327*	6–115	32
1967	32	53–670	233	20–105	59
1968	20	35–345	115	10–46	40
1969	49	6–381	90	8–76	37
		Needle Branch (Clear-Cut)			
1964–1965	88	1–969	116	1.6–45	13
1966	68	1–892	179*	1.6–27	9
1967	89	1–6300	589	1.6–25	11
1968	44	20–7070	640†	1.9–32	10
1969	38	70–738	280†	3.1–24	12

* Significant increase at 90% level of probability.
† Significant increase at 95% level of probability.

Figure 3: Suspended sediment concentration and streamflow.

Discussion

Experiment 1 Key Results (Figure 2):

➢ The sediment yields of Watershed 2 (control) were uniformly constant over the study time.
- ✓ Also Watershed 2 did not experience any mass wasting events during the study time.

➢The sediment yields of Watershed 1 (clear cut) were dramatically increased after clear cutting and burning was completed, and did not lower until new plantings and growth had occurred.
- ✓ Watershed 1 had four debris slides that occurred after a small storm in 1965, and smaller episodes of debris sliding between 1968-1972.

➢More than 85% of the total sediment yield for Watershed 3 occurred during a storm in 1964 when a series of debris flows scoured the channel to bedrock (the large peck in 1965 on figure 2).
- ✓ Also a moderately large debris flow occurred during December of 1961 (large peck in 1962).

Experiment 2 Key Results (Figure 3):

➢Sediments sampled during 1965 evaluate the effects of the road building.
➢Sediments sampled during 1966 evaluate the effects of logging and slash burning.

➢Flynn Creek's sediment yields stayed consistent throughout the study time (figure 3), and no major mass wasting events occurred.

➢Deer Creek's sediment yields were significantly higher than normal in 1966 (figure 3) (the year after treatments) and returned to pretreatment levels the following years.
- ✓ 40% of Deer Creek's sediment yield for 1966 occurred during a road slide.

➢Needle Branch's sediment yields increased significantly immediately after logging and burning.
- ✓ The Watershed's sediment yields continued to be higher than normal for the next 3 years following treatment as well.

The Oregon Forestry Protection Act:

➢The Forestry Protection Act (FPA) was passed in 1971 and came into effect in 1972.
- ✓ The FPA sets standards for all commercial activities involving the establishment, management, or harvesting of trees on Oregon's forestlands.

➢**Some major guidelines include:**
- ✓ Clear cuts cannot exceed 120 acres within a single ownership, including the combined acreage of any clear cuts within 300 feet of each other.
- ✓ The location, construction, maintenance, use, and drainage of forest roads must prevent sediment from getting into streams.
- ✓ Trees and other vegetation must be left along streams in which fish live. Stream buffers provide, Shade, slow moving water pools, leaf litter (nutrients).
- ✓ Landowners must complete replanting of harvested ground within two years of a harvest, and within six years of harvest, the young trees must be "free-to-grow", meaning they are vigorous, well-distributed, and ready to grow into successfully into a young forest.

Conclusion

Through responsible forest management and protective laws, Oregon can maintain our forestland for decades, while at the same time, supplying the world with a remarkable product. These experiments have shown that clear cutting forest practices and associated forest roads can cause sediments to end up in watersheds and they can cause mass wasting events to occur. it is imperative that we continue to follow the guidelines of the Oregon Forestry Protection Act, that way our forest and streams stay safe and healthy for many generations. This will benefit humans and wildlife throughout Oregon.

References

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