Erosion and Sedimentation in the Pacific Rim (Proceedings of the Corvallis Symposium, August, 1987). IAHS Publ. no. 165.

Effects of woody debris removal on sediment storage in a northwest California stream

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Bridge Creek, a fourth-order tributary to Redwood Creek, drains 30 km^2 of forested, mountainous terrain in the Coast Range of northern California. Prior to disturbance by humans, numerous accumulations of woody debris dominated channel morphology by providing local base levels and sediment storage compartments, creating a stepped profile and a diverse habitat conducive to anadromous fish reproduction. In 1954, and again in 1971, debris accumulations were removed from the lower main channel of Bridge Creek to salvage merchantable logs and eliminate perceived barriers to fish migration. Removal of the larger debris resulted in a loss of the channel structures which stored smaller woody debris and sediment. Following debris removal, the physical effects of floods have been to decrease the volumes and centralize the locations of both woody debris and stored sediment.

This study, utilizing over 30 cross sections and detailed thalweg and fill terrace surveys through the lower 2.4 km of Bridge Creek combined with historical information, estimates pre- and post-disturbance stored sediment volumes, as well as annual sediment fluxes since 1984. A major lithologic knickpoint in the middle of the study reach has retarded stream incision in the upper half (Reach A, Fig.1), causing alluviation in this gentlest (S=0.009) segment of Bridge Creek. Downstream of the knickpoint (Reach B, Fig.1), the channel is narrower and steeper (S=0.017) and the effects of debris removal appear to have been most profound in this reach. Four large debris accumulations were removed from Reach B in 1971, causing stored sediment to decrease from 69 000 m^3 to 21 000 m^3 (a 70% reduction) by 1984.

Presently, only one significant woody debris accumulation exists in the study reach. This "log jam", which formed in 1975 at the channel constriction associated with the lithologic knickpoint, stored 24 800 m^3 of sediment by 1984 and intermittently formed a barrier to anadromous fish migration. To improve the chances of fish passage, debris was removed from the top of the log jam (effectively lowering the local base level) in the summer of 1984. Not until February, 1986, did stormflows of sufficient magnitude (peak Q=37 $m^3 s^{-1}$) occur to cause the channel to adjust to the lowered base level.

Headward cutting through the stored sediments progressed to 370 m upstream of the log jam, and caused a net scour of 930 m^3. Cross sections farther upstream, however, indicated a strong trend of aggradation increasing in a downstream direction (Fig.1). It is likely that this trend would have continued downstream to the log jam had the 1984 partial debris removal not occurred.

To estimate sediment loss caused by debris removal from the log jam, a hypothetical volume of aggradation was calculated by

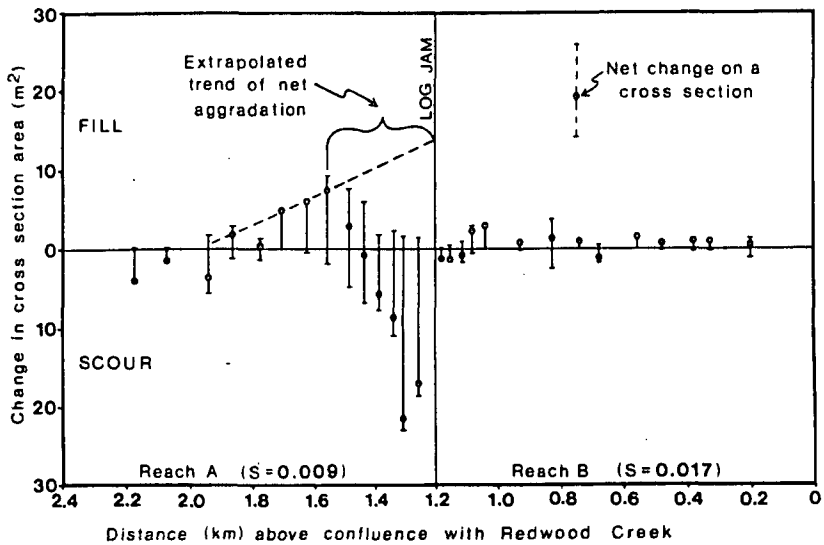

FIG.1 Scour and fill from 1985-1986 on cross sections in the Bridge Creek study reach.

extrapolating the trend of net aggradation downstream through the reach which experienced headward cutting (Fig.1). By summing the hypothetical volume of net aggradation (3850 m^3) and the actual volume of scour (930 m^3), a total of 4780 m^3 of scour was estimated as the net change in log jam-stored sediment caused by partial debris removal. In contrast, sediment storage capacity remains low in Reach B due to debris clearance work in 1971, and only about 890 m^3 of fill occurred during the same period (1985-1986).

Channel processes documented by this study parallel those observed by Beschta (1979) and Bilby (1984). Removal of woody debris from streams draining forested steeplands may have significant and long lasting effects on channel morphology and subsequent biological productivity, emphasizing the need to approach management of woody debris with caution. Because inputs of new woody debris through blowdown and landsliding are infrequent, especially if streamside supply is reduced by logging, channel systems are slow to recover from complete debris removal. A more conservative approach of partial barrier removal warrants consideration, as the loss of an adquate supply and even distribution of large woody debris in a channel system may require decades or centuries to be regained through natural processes.

REFERENCES

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