Response of Juvenile Coho Salmon and Steelhead to Placement of Large Woody Debris in a Coastal Washington Stream

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Project Description

Large woody debris (LWD) was added to North Fork Porter Creek, a small tributary of the Chehalis River, located west of Olympia, Washington. This project was part of an effectiveness and cost comparison study between two techniques. Additions began in late summer 1990 and ended in late summer 1991. More than half the wood and all the cover structures were added in autumn 1991 so habitat restoration from LWD addition was not expressed fully until winter of 1991-1992. Three 500-metre study sections contained one Reference site, one Engineered site, and one Logger's Choice site. The Engineered method involved placing conifer logs in the channel using heavy equipment and securing the wood in place. Five different configurations were used: full crossing structures, partially crossing, parallel, pyramid, and logjam structures. The inexpensive Logger's Choice method involved cutting and felling red alder trees from the stream bank into the channel and cabling the logs to their stumps (Figure 1). Structures included full crossing, partial crossing, and parallel logs.

Figure 1. An example of felled and cabled red alder trees at the Logger's Choice site. This less-expensive restoration has now approached the pre-treatment condition, only five years after treatment.

Criteria for Restoration Evaluation: Pool/riffle composition, fish population, and LWD.

Changes in habitat and response of juvenile coho salmon *Oncorhynchus kisutch* and steelhead *O. mykiss* were monitored to determine effectiveness of the two LWD restoration techniques. The three stream sections were evaluated seasonally beginning in June 1988 through spring 1994, for three years before and three years after LWD additions in 1991. Salmonid populations from representative habitat types were surveyed by electrofishing. Fishes collected were identified to species, and fork length was measured for each individual. Fish population estimates and habitat surveys were conducted in March, June and late September, allowing for low-flow and high discharge information. Habitat units consisted of 4 types of pools (scour, plunge, dam and backwaters), and 3 types of fast water (riffles, cascades and glides). Coho salmon smolts were collected in traps each year from early April through mid-June, identified, measured, transported below the lower study site, and released.

Restoration Responses

Physical Habitat

LWD

Winter storms brought additional LWD from the red-alder dominated riparian stand to all 3 study sites, however, LWD pieces added were much smaller than those placed at the treated sites. In 1994, the number of pieces/total wood volume of LWD in the Engineered site was 8.9/11.5 times the pretreatment level, 3.6/3.0 times in the Logger's Choice site, and 2.3/1.3 times in the Reference site. Average length of each piece at the Engineered and Logger's Choice sites increased significantly following restoration.

Pools

Pool surface area increased significantly in both modified sites and decreased slightly in the reference site. The Engineered site displayed the most dramatic increases in pools, with the proportion of the water surface composed of pools increasing from 33%, 38%

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and 38% in spring, autumn and winter, respectively, to 59%, 74% and 56%. Most of the increase was due to the creation of dam and plunge pools associated with the full-crossing LWD structures placed in the stream. The Logger's Choice site exhibited increases of 7% to 12% in proportion of pool areas, due almost entirely to creation of additional scour pools.

Fast-waters
Fast-water habitats decreased at both rehabilitated sites. In the Engineered site, riffles decreased and cascades were eliminated after completion of restoration. In the Logger's Choice site, riffles increased during spring and winter, but stayed relatively constant during autumn before and after restoration. The proportion of cascades decreased by more than 10% during all three seasons in the treated sites. Fast-water habitats increased at the reference site.

Substrate
Large amounts of gravel accumulated at the structures added to the two treated sites.

Spawning activity
Coho salmon and steelhead were frequently observed spawning in the treated sites after restoration. Prior to restoration, few coho salmon and steelhead were observed spawning throughout the entire study area.

Coho salmon and steelhead populations

After restoration, winter juvenile coho salmon abundance increased twenty-fold in the Engineered site and six-fold at the Logger's Choice site; the reference or control site exhibited no change. There were no significant differences in the coho salmon populations during spring and autumn at any of the sites. The coho smolt yield tripled after the rehabilitation project in the engineered site, and nearly tripled in the Logger's Choice site, but decreased slightly in the reference site. Age-0 steelhead abundance declined significantly at the Logger's Choice site in spring, and remained the same in fall and winter for all sites. However, the populations at the reference and engineered sites both increased in winter. There was no difference in age-1 steelhead abundance among sites, nor pre- and post-restoration during any season. Winter populations of juvenile coho salmon and age-0 steelhead were inversely related to maximum and mean winter discharges; however, both species declined at extremely high winter discharges.

Lessons Learned

- It was estimated that the habitat in the Logger's Choice site would approach the pre-treatment condition within 5 years of treatment as a result of wood decay, breakage and displacement during high flow periods.
- The Engineered site was designed to persist for 25 years or more; no evidence of decay was observed in the coniferous LWD and very little damage to structures was experienced by repeated exposures to elevated flows.
- The greater longevity of structures added to the Engineered site offsets the higher initial cost relative to the Logger's Choice method, when considered in terms of cost per additional coho salmon smolt produced.
- The Logger's Choice approach for adding LWD may be most appropriate where conifer trees can be felled into the channel.
- Habitat restoration efforts were most effective during winters of low or moderate flow (< 1.5 m^3/s), but were of little benefit during winters with extremely high flows. The pools created by LWD placement in the two treated sections did not offer sufficient protection from periods of extremely high discharge.
- The availability of suitable winter habitat was likely a major factor limiting coho salmon production in the study area.

Six Year Retrospective

Jeff Cederholm shared the following observations in January 2000, about recent happenings:

- Alders within the Logger's Choice site have decayed as predicted and the habitat has responded by declining to its previous state. Therefore the lesson learned is that alder provides a relatively short-term benefit.
- The Engineered site continues to provide highly desirable habitat because most large woody debris remain relatively intact except for some logs that have been scoured and been degraded in their effectiveness.
- Logs continue to be contributed from the streamside area due to blowdown in all three sites, Reference, Logger's Choice and Engineered.
- Adult steelhead and coho are using the experimental area for spawning. ▲

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