

Instream and Channel Restoration Projects

used in constrained reaches of small- to moderate-sized streams (fourth order and smaller) and placed with a connection or connections to the stream bank.

- Instream structures are most appropriate when used as short-term tools to improve degraded stream conditions while activities that caused the habitat degradation are simultaneously modified.
- When instream structures are part of a properly sequenced watershed restoration strategy, they can improve habitat conditions through a range of flow conditions, including large floods. The relationship between instream structure durability and upslope variables indicates the importance of a watershed perspective when implementing stream restoration. ▲

Based on: Brett B. Roper, D. Konnof, D. Heller and K. Wieman, 1998. Durability of Pacific Northwest Instream Structures Following Floods. *American Journal of Fisheries Management*, 8:686-693. American Fisheries Society.

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Intensive Monitoring of Instream Works: Methodology and Year 1 Results

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Project Description

The prime objective for the intensive monitoring of restoration sites on Vancouver Island was to determine the “effectiveness” of instream structures based on site-specific biological and geomorphological targets, or “effectiveness standards.” A secondary objective was the collection of several biological and physical variables at both reach and site scales, to allow detailed inspection of relations between physical parameters (e.g., cover) and responses (e.g., fish abundance). The four geomorphic and two biological objectives associated with the restoration techniques are to:

- improve gravel accumulation or reduce percent fine sediment in bed,
- increase LWD cover,
- increase depth/reduce width (bank protection, bar stabilization),
- improve pool characteristics,
- increase fish production, and
- improve fish access to habitat.

Seven streams in five Vancouver Island watersheds underwent intensive monitoring in 1998. The *San Juan River watershed* contains Halliday, Five Mile and Renfrew Creeks, and is located 10-15 km east of Port Renfrew. The *Kootowis Creek watershed* contains Indian Bay tributary (test) and Staghorn Creek

(control), and is located 15 km south of Tofino. The *Nimkish River watershed* contains Lukwa Creek, the *Eve River watershed* contains Montague Creek, and the *Salmon River watershed* contains Big Tree Creek.

In the *San Juan watershed*, a culvert washout on a forestry road crossing adversely affected Halliday Creek. The road failure caused a large amount of sediment to enter the channel and fill pool habitat. The objective of the restoration work was to increase fish production and accessibility by excavating excess bedload and reconstructing riffle-pool sequences. Most of the LWD was removed from the reach at Five Mile Creek during stream cleaning practices during the 1980's. This resulted in a limited cover for fish during high flows and a lack of residual pool depth. The biological objective was to increase fish production by restoring cover and habitat complexity with the re-introduction of LWD. The lower reaches of Renfrew Creek have been affected by the loss of LWD cover and associated habitat complexity. Increased sediment inputs have resulted in infilling of pools. In 1997, restoration objectives were to increase LWD cover and habitat complexity by stabilizing LWD and introducing more LWD. Scouring during high flows will help to maintain residual pool depths.

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Logging in the *Kootowis Creek watershed* began in 1960; within 20 years, 42% of the watershed had been logged. Cross-stream yarding and wood waste left in the floodplain left a high density of wood debris in the streams. This degraded fish habitat affected adult fish accessibility and stranded adult and juvenile fish in flooded areas. Habitat restoration work involved extensive removal of woody debris from the stream channel. Stable wood was left in the channel and cabled in place to promote scour and provide cover for fish. The objective was to increase fish production by restoring stream channel to pre-logging conditions.

At Lukwa Creek, in the *Nimkish River watershed*, sediment and debris inputs from the headwater reach, torrented tributaries, and two slides from the north valley wall have contributed to channel instability, bank erosion and infilling of fish habitat. The 1997 restoration work objectives were to re-establish the main channel through LWD re-alignment, removal of accumulated coarse sediment, and protection of eroding banks. Improvements to the channel stability would also benefit fish through reducing sediment input and scoured pool habitat.

Most of the lower reach of Montague Creek, in the *Eve River watershed*, was harvested with a minimal leave strip. It now has minimal instream cover and limited hydraulic diversity in the form of deep pools. The 1997 restoration work was conducted on the lowest section of Montague Creek. The biological objective was to increase fish production through increased habitat complexity. LWD structures were constructed along the channel margin, and boulder clusters were placed in the middle of the channel.

Big Tree Creek, in the *Salmon River watershed*, flows through a wide, irregular, and laterally unstable channel. Restoration activities in 1997 were confined to the lower 1300 meters of the creek. The biological objective was to provide stable rearing habitat for both adult and juvenile salmonids. LWD structures were placed in a natural pattern of clusters and individual logs to provide increased thalweg depth, increased habitat complexity and cover.

Fifteen test reaches were selected for the study, three from each of the five watersheds. All but one watershed had at least a single reference reach: a very short alluvial channel length at Montague Creek did not allow identification of a reference reach, and no surrogate reference reaches in adjacent watersheds were identified.

There were 56 test sites within this study. They contained only three general types of rehabilitative techniques: boulder clusters (4), constructed rock

riffles (3), and LWD placements (49). To allow for a more discrete inspection of LWD placements, the techniques were further differentiated:

- single LWD piece, cabled to an anchor boulder or stump (2);
- multiple pieces of LWD, oriented dominantly perpendicular to flow (13);
- multiple pieces of LWD, oriented dominantly parallel to flow (21); and
- multiple pieces of LWD left *in situ*, with SWD removed from the channel (7).

Criteria for Restoration Evaluation

The intensive monitoring methodology focuses primarily on effectiveness monitoring: “have desired conditions and restoration objectives been met?” The monitoring variables included:

- Reach-based Fish Habitat Assessment Procedures (FHAP) variables: habitat unit length, gradient, bankfull depth, bankfull and wetted width, pool area, pool residual depth maximum pool depth, total and functional number of LWD pieces, total and functional LWD lengths, substrate type, and percent cover by type.
- Biological data (using Gee traps): fish abundance, life stage, species and length.
- Survey data: cross-sections, longitudinal profile, scaled plan view, structure descriptions.
- Supplemental data: bed surface sampling, stream discharge.

Both biological and geomorphic parameters were monitored and results were given a 1 to 4 class ranking. Class 4 fully meets or exceeds effectiveness standards, Class 3 adequately meets effectiveness standards, Class 2 poorly meets standards, and Class 1 is defined as not meeting effectiveness standards.

Impacts of Restoration

The mean biological and geomorphic effectiveness ratings for the structures are listed in Figure 1.

Restoration Technique	Mean Effectiveness Rating	
	Biological	Geomorphic
Boulder Cluster	3.0	3.0
Riffle-pool construction	1.7	4.0
LWD: single piece	3.0	2.0
LWD: multiple pieces, dominantly \perp to flow	3.2	2.2
LWD: multiple pieces, dominantly parallel to flow	2.7	2.0
LWD: multiple pieces, both \perp and parallel to flow	3.2	1.7
LWD: multiple pieces left <i>in situ</i> , but SWD removed	2.7	2.4

Figure 1. Comparison of watershed restoration structures based on geomorphic and biological effectiveness scales.

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The riffle-pool sites have low biological effectiveness ratings, but the mean biological effectiveness ratings of the other six structures are all 3.0 ± 0.3 , that is, the six structure types have equal biological effectiveness ratings. Examination of site-specific case studies also did not yield evidence to suggest that particular variations of LWD placements induce greater biological effectiveness. All treated reaches with LWD structures are going through only the second or third year of high flow conditions. Scouring at these structures has the potential to further increase residual pool depth and improve fish habitat.

Geomorphic effectiveness ratings are high in the rock-based structures (boulder clusters and riffle-pool sites) but low at the LWD structures. It is likely that the LWD structures require flood events of a greater return period to induce bed scour compared to the rock structures. It is also possible that residual pool depths measured at rock structures have not been formed naturally, but were anthropogenically excavated during rock placement.

- As with the biological effectiveness ratings, there was little difference in geomorphic effectiveness rating between the six LWD structures; all are 2.0 ± 0.4 . The geomorphic effectiveness ratings were generally lower than the biological effectiveness ratings because of an apparent lack of a significant post-construction flood event to induce bed scour.
- Time dependency is required for high effectiveness class ratings of some geomorphic parameters. For example, when an alteration in the hydraulic

geometry or a reduced width:depth ratio is targeted, it may take several years for the bank erosion rates or width:depth ratios to reflect the impact of the instream prescriptions.

Geomorphic effectiveness ratings will probably show a general increase in the next few years, assuming that the prescriptions perform adequately.

Lessons Learned

- Site selection should be based on the presence of pre-restoration data.
- Summer fish sampling may give the structures a higher class ranking.
- Particular configurations of LWD placements did not induce greater biological effectiveness ratings.
- Location of structures in the channel together with site-specific conditions were responsible for effectiveness, regardless of the structure type, its orientation to thalweg, or channel confinement.
- Selection of class boundaries has a significant effect on ratings.
- This methodology is a useful technique for evaluating projects that may not have a reference site pre-established. ▲

Based on: Aquaterra Environmental Services and Babakaiff and Associates Geoscience Inc. 1999. Intensive Monitoring of Instream Works: Methodology and Year 1 Results. Prepared for Ministry of Environment, Lands, and Parks.

Development of Techniques to Rehabilitate Oregon's Wild Salmonids

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Project Descriptions

Various types of habitat restoration techniques aimed at increasing rearing density of salmonids have been tried in Oregon coastal streams. These techniques have included placing structures made of wood, boulder, or concrete across the stream channel, excavating off-channel alcoves, and placing wood and boulders in various configurations into coastal streams. Most of the instances where habitat improvements were evaluated relied on data collected only during summer months.

During the first phase of the research an extensive sampling program was established on many Oregon coastal streams to evaluate the effectiveness of existing instream restoration projects. The purposes of this sampling were to:

- examine the types of rearing habitat created by habitat improvement techniques
- compare the relative effectiveness of the habitat created by these techniques to support juvenile coho salmon during the summer and winter, and
- compare the density of juvenile coho salmon in