Feature

the concerns of the local Delta residents, and minimized both the impact to fish and wildlife and the cost to stakeholders.

The success of this project can be attributed to the commitment of the qualified, skilled and competent individuals who contributed to the project.

Acknowledgments

Slope stabilization and creek rehabilitation works were carried out under the direction of the Corporation of Delta. Valuable input provided by Mr. Don Moore and Mr. Rob Rithaler at the Corporation, and permission to publish this article is acknowledged and appreciated. Special thanks go to Mark Kennedy at Golder Associates Ltd. for his assistance in the preparation of the article and for his participation in on-site environmental monitoring.

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Technical Tips

Habitat Rehabilitation: How Much Off-Channel Coho Habitat?

Pat Slaney and Matt Foy

In aquatic watershed restoration projects, the objective may be to develop fish habitat prescriptions for a coho stream and implement habitat rehabilitation within a logged watershed. If, for example, a prospective project area's timber had been logged to both banks >50 years ago along a 10 km fish-bearing stream (assuming hillslopes are intact or restoration is largely completed) there is likely to be several opportunities for restoring off-channel habitats cut off by old roads, and also some potential on the floodplain for developing cost-effective mitigative off-channel habitats. Instream work may appear too risky in most or all of the stream channel because of excessive channel instability on a wide alluvial floodplain. The questions that then arise are: 1. How much off-channel habitat is reasonably needed given the historical impacts to coho salmon habitat? 2. Will two ponds and two channels do the job or is the requirement for several times this to restore coho production capability?

Earlier research in S. E Alaska, Washington's Olympic Peninsula and at B.C's Carnation Creek showed that coho are very dependent on overwinter refuges. Hence pools with complex LWD and suitable off-channel habitats are needed to obtain high survival rates from the fry to the parr or smolt stage (Figure 1). Carnation Creek research, in particular, showed: that overwinter survival of juvenile coho is positively correlated with the size of fingerlings reached upon entering the fall freshet period, and coho juveniles that had moved into or remained in off-channel habitats had up to three times the overwinter survival to the smolt and parr stage of those that remained in the mainstem of this "flashy" west coast stream (75% vs. 25%). [A key reason coho have been somewhat resilient to date is that no roads were built on the floodplain, thus preserving all off-channel habitats plus LWD still exists in the mainstem.] Evidence that coho are dependent on off-channel wetlands, ponds, lakes and small nursery tributaries can also be inferred from whole river fertilization of the mainstem Keogh River, which only resulted in about a 20 % increase (peak, 30 %) in coho smolt output compared to 65 % (peak, 150 %) for steelhead smolts. Also, at the Clearwater River in Washington, the number of coho

Technical Tips

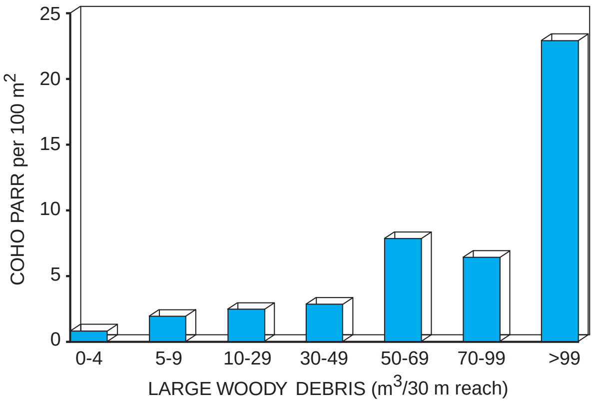

Figure 2. The relationship between surface area of off-channel ponds and estimated number of salmonid fish present. Equation of the line is Log_{10} fish number equals 0.51 log_{10} pond area (ha) plus 3.47, n=19, r^2=0.64, P<0.001. (see data sources, p. 3-9 in Slaney and Zaldokas, 1997).

in ponds was highly correlated with spawner escapement in the mainstem upstream of the ponds; thus, lower river ponds are of greatest benefit to coho. Further, a recent mark-recapture study at the Coquitlam River indicated that 50 % of the smolts emigrating from the river in the spring originated from a set of five off-channel projects. Clearly, the freshet season is the "bottle neck" for young coho in streams, with exceptions being spring-fed and probably slow moving slough-like streams where freshets are readily accomodated within the floodplain.

Estimating how much off-channel habitat should be constructed:

- Estimate how many sq m or ha of off-channel habitat is closely associated with the stream. In our example of a 10 km coho stream, we will assume it is near zero.
- Estimate about how many juvenile coho will require winter habitat refuges. A common mid-summer density in most streams with 5-10 m wetted width is 0.3 to 0.5 juveniles per m^2, on average. Our 10 km stream averages 8 m in wetted width and thus has 80,000 m^2 in total; at 0.5 coho per m^2 the total number of coho to accommodate overwinter is about 40,000.
- Next, what percentage of the stream, weighted to pools and glides, have complex instream LWD? In our example, this is negligible because this is the worst case scenario of an average of >50 years since logging to both banks. If, however, about half the pools and glides had dense LWD cover, then the numbers to accommodate off-channel could be reduced by 50 %.

Constructed off-channel habitats as ponds and/or channels with ample cover and adequate depth (2 m) produce about 0.5 to 1 smolt per sq m (WRP Tech. Circ 9; chapter 3 and 7) if ponds are optimally sized at about 0.2 ha (Figure 2). Therefore, with the example outlined above, a minimum of 40,000 sq m, or 4 ha (equivalent to 20 ponds sized at 0.2 ha) would be required. Three small ponds can be efficiently excavated at one site and can be connected by short channels. Thus, in this example where overwintering habitat was near zero, **seven sites are needed**.

Finally, should adjustments for mortality be made because there is competition from fry that colonized

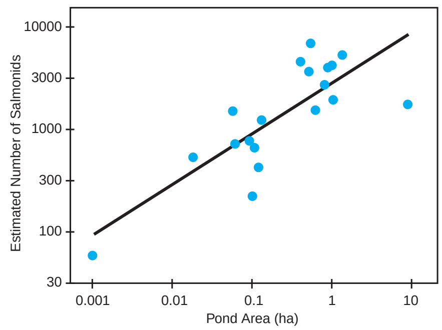

Figure 1. Relationship between volume of large woody debris (LWD) in streams and the density of coho parr in winter (from Koski 1992).

the pond early (residents) plus losses to predation from fall-to spring? Research results at Carnation Creek indicate higher mortality in the old-growth-lined mainstem than off-channel, which means we would need significantly less off-channel habitat to offset logging-induced habitat losses in the mainstem. Our advice is that unless the constructed ponds and channels are productive and there is some certainty they are optimally designed, a safety factor is advised to achieve a net habitat gain (and regardless, habitat has been lost or declining for several years). Thus, no adjustment is needed until we can accurately predict off-channel production of smolts via effectiveness monitoring.

An equation can therefore be formulated as:

$$\mathbf{A_o = A_{st} (D_f) (1.0) - A_{no} - A_{is}/10{,}000}$$

where:

A_o = area in hectares required in off-channel ponds and/or channels to offset mainstem logging impacts;

A_{st} = the total wetted stream area in sq m in summer;

D_f = the average density (no./sq m) of coho at capacity in mid-late summer;

1.0 = no. of m^2 of pond or channel (with ample woody cover) yielding one smolt

A_{no} = the estimated area in sq m of accessible natural off-channel in fall - spring in the floodplain;

A_{is} = the estimated area in sq m in mainstem pool and glides of dense instream LWD cover ;

10,000 = a conversion factor to obtain hectares of ponds or channels or both.

[for ponds A_o /0.2 ha = the optimum number] ▲