Integrated Watershed Restoration Projects

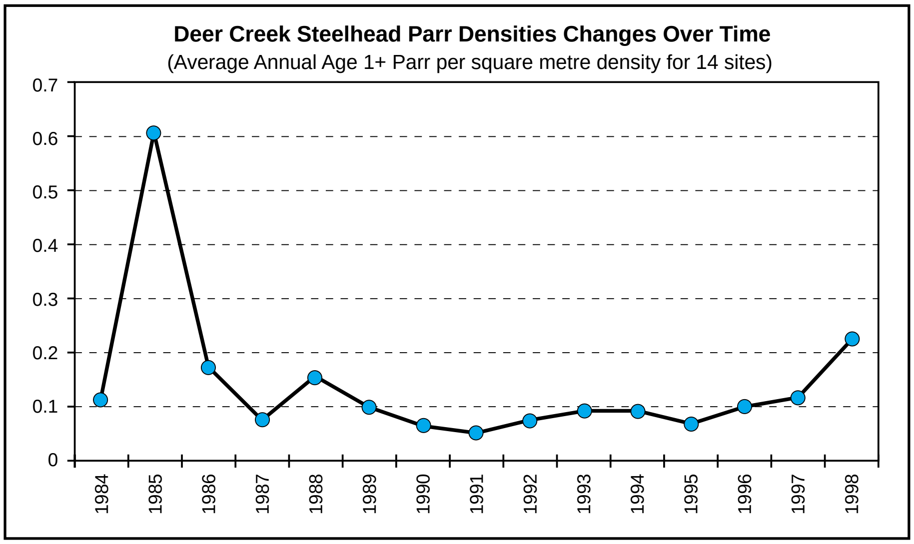

Figure 4. Deer Creek steelhead parr densities.

This increase was mainly due to the increase in freshwater survival of 1-year-old steelhead juveniles (parr). By the late 1990s it was estimated that stocks had recovered to 50 – 70% of historical abundance (J.Doyle, Jan. 2000).

Lessons Learned

The increase in steelhead production from essentially the same parr densities can only be explained by the combination of two factors: increased overwintering survival from parr to smolt and increased survival from smolt to adult. In view of the general poor smolt-to-adult survival of steelhead in the Puget Sound area for the past few years, and the apparent improvement in the freshwater habitat, it seems likely that the improved capability of the habitat in Deer Creek to produce juveniles accounts for most of the increase in adult production.

Fish populations in Deer Creek have increased significantly in the last two years. The observed increase in juvenile fish densities is a reversal of a decade-long decline. In part, this is attributable to the improvement of habitat during the past five years.

Stabilization efforts on the hillslopes, together with the large floods in 1990, were effective in removing sediment deposits from coarse boulder substrates, thus restoring the fish habitat. The reductions in sediment inputs from roads, gullies, and channels are inferred as the primary causes of coho and steelhead stock recoveries. ▲

Based on two documents: 1) Doyle, J.E., G. Movassaghi, M.Fisher, and R. Nichols. 1999. Watershed Restoration in Deer Creek – A Ten Year Review. *Sustainable Fisheries Management – Pacific Salmon.* 1999. E.E. Knudson, C.R. Steward, D.D. MacDonald, J.E. Williams, and D.W. Reiser (eds.). Lewis Publishers, New York and on: 2) Kraemer, C. 1999. Management Brief: 1999 Update on the Status of the Deer Creek Summer Steelhead. Draft. Washington Dept. of Fish and Wildlife.

Upper Willow Watershed Effectiveness Evaluation Strategy

Shannon Sterling

Project Description

The upper portion of the Willow River Watershed covers approximately 880 km^2 in the Quesnel Forest District (Cariboo Forest Region) and is located 55 km northeast of Quesnel, B.C. An Effectiveness Monitoring Strategy (EMS) – also referred to as an Effectiveness Evaluation Strategy – was designed and implemented to allow evaluation of rehabilitative works that were, or will be, prescribed and constructed. An EMS is designed to detect changes in the early stages following rehabilitation activities, as well as longer-term changes as a result of periodic events (e.g., large rainstorm). Monitoring continues until an apparent state of equilibrium has been reached.

The EMS was designed to monitor the large area economically (for less than 5% of the construction

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budget). A hierarchical chain of restoration objectives was developed so that site-level monitoring results obtained through a randomized sampling design could be extrapolated to the watershed scale.

An Integrated Watershed Restoration Plan (IWRP) was completed and a high value of fish habitat in the watershed was established. Restoration was necessary because of the many potential sediment sources caused by a high density of roads, and a peak flow risk resulting from a large clear-cut area (Figure 1).

Restoration activities included:

- reduction of peak flow through installation of cross-ditches to restore the groundwater flows;
- reduction of mass wasting through soil bioengineering, water dispersion (cross-ditches, culvert removal) for return to original water pathways, and pullback of oversteepened eroding slopes for hillslope and gully stabilization;
- reduction of surface erosion through hydroseeding, installation of cross-ditches or water bars, insloping or outsloping of road, establishment of armour cover, removal of structures which are non-functioning or pose a risk of non-functioning in the future, and removal of road fill from channels to control surface erosion;
- reduction of sediment delivery through installation of cross-ditches to deliver sediment away from channels, and installation of live silt fences and sumps to control sediment generation;
- reduction of the potential for debris flows through removal of road fill from channels and gullies for debris flow control; and
- improvement of trout habitat through instream installation of LWD, riffles, and pool excavation.

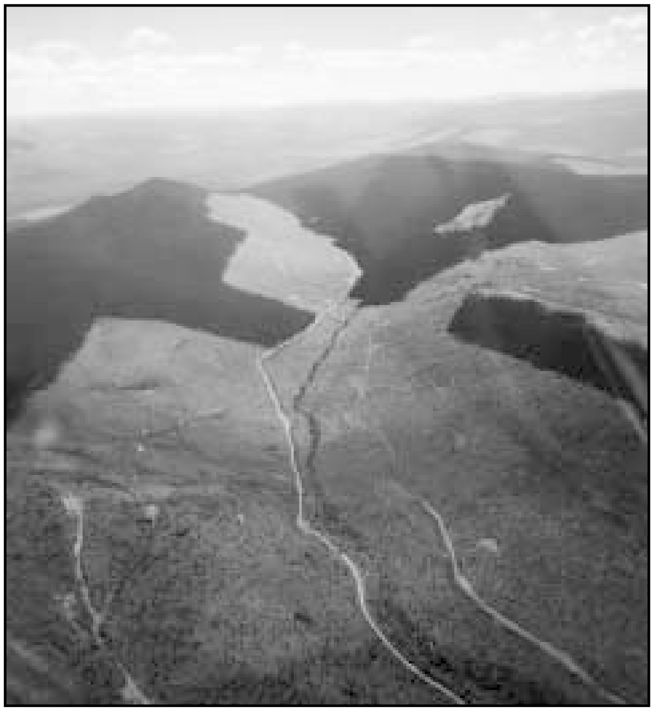

Figure 1. This photograph shows the Rebman Creek watershed, one of the areas with peak flow concerns.

One other area of the Willow Watershed, the 150 m long Demonstration Site BVS50, was used as an operational test site for soil bioengineering to determine the most effective restoration technique for the local soil conditions. Construction of a Forest Service Road (24A) had accelerated three erosion processes at this site: surficial erosion (overland flow, rainsplash and rilling), mass movement, and sediment delivery. Restoration was needed to stop the cutslope from eroding and delivering fine sands and silts to a fish-bearing stream (Big Valley Creek). Treatments, completed in 1998, included willow staking, wattle fences, live silt fences, live pole drains, modified brush layers and hydroseeding. Planting materials included willow, cottonwood and pine trees. Treated and untreated sections, treatment types, and tree species were compared.

The same site (BVS50) was used to test the root growth rate and zone of influence of willow trees over time in the local soil conditions. Root growth test stakes were planted and areal and depth zone of influence is being measured against time. This study will provide information on how long it takes soil bioengineering sites to be effective, and what the spacing of the soil bioengineering structures should be.

Restoration work completed during 1998-1999 involved 76.3 km of road deactivation and rehabilitation, bioengineering of 5 landslides, and 2 km of stream restoration. A semi-annual (late June and October) monitoring frequency will be used for the first 2-3 years, followed by yearly monitoring.

Criteria for Restoration Evaluation: Pool/riffle composition, peak flows, vegetative cover, length of road surface erosion, and plantings survival.

The following monitoring variables are measured for each objective:
Peak Flow Control: effective watershed drainage density (the post-deactivation reduction in channel length is determined by measuring the length of cutslope with groundwater seepage that has been re-introduced to groundwater through the installation of frequent cross-drainages).

Instream Restoration: frequency of pools with functional depth and cover, length of channel with bank erosion, and presence/absence of fish in pools.

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Hillslope Stabilization: percent vegetative cover, number of new slope failures, volume of material beyond its angle of repose, and percent of bio-engineering structures with growth.

Surface Erosion Control: length of road with water running down it, presence of erosion in cross-ditches and road ditches, percent vegetative cover, and length of road with surface erosion.

At the demonstration site, the variables monitored include: percent vegetative cover, percent conifer cover, percent deciduous cover, number of new slumps, area of new slumps, whether sediment is reaching a stream below a culvert (connectivity), trapping of material behind live silt fences, percent survival of the bioengineering structures, and functionality of the culvert.

Restoration Responses

Success is characterized by a significant change or trend (defined for each monitoring variable) from initial conditions towards the desired watershed objectives, or by comparison with established levels (e.g. a bio-standard).

While the construction phase of the Willow Watershed Restoration began in November 1998, most work done so far was completed in 1999. Therefore, most sites have only two monitoring variable measurements (pre- and immediately post-work). Sites with work done in 1998 have three or four measurements. At this stage, the small number of measurements are only the beginning of monitoring, and these "results" are expected to change with time.

Peak Flow Control: The cross-ditch spacing for one part of the watershed was not frequent enough to achieve the peak flow objective in areas with fine soils (new channels were created below the cross-ditches, as opposed to the water returning back into groundwater). As a result, more cross-ditches will be added in 2000. Other areas show a reduction in effective channel length in the watershed, and therefore a reduction in the peak flow of the watershed is presumed (immediately post-work data only).

Instream Restoration: The frequency of pools greater than 0.3, 0.5 and 0.6 m residual depth increased to the bio-standard (the prescribed) frequency for rainbow trout (1 year of data).

Hillslope Stabilization: The soil bioengineering was very successful so far (Figure 2). At the Demonstration Site there have been no new slope failures in the treated area, while there was one in the untreated control, and the percent of structures in place and

Figure 2. Hillslope stabilization along this roadway involved wattle fencing, brush layers, live silt fences, willow staking, and hydroseeding. Willow and cottonwood were the species used.

growing is near 100% (1 year of data). Areas with pullback have not had any new failures (immediately post-work data only).

Surface Erosion Control: The length of road with water running down it had mixed results; some areas will be reconstructed in 2000. Erosion was present in many cross-ditches; armouring will be increased in 2000. Percent vegetative cover results are awaiting analysis. In fine soils, cross-ditches constructed to ATV templates all survived the fall rains; many of the 4WD cross-ditches had already failed after the fall rains (Figure 3). The length of road with surface erosion (including ditch) has been reduced, but some results are still forthcoming (immediately post-work data only).

Figure 3. Post-work photo of 4WD Template cross-ditch breached since repairs.

Lessons Learned

Initial results revealed:

- Live Pole Drains collect water when properly located; however, some drains showed no evidence of water flow, suggesting that placement of drains is sensitive (1 year data).

- Cross-ditches should be closely spaced to return the cutslope seepage water to groundwater: spacing depends on site characteristics, and is particular to the conditions encountered in the Willow Watershed.
- Cross-ditches constructed in fine soils to ATV template had no breaches after the fall rains and hunting traffic; several constructed to 4WD template had been breached in the same conditions.
- The effective channel length was reduced to 44% of its pre-deactivation state in one watershed. This should reduce the peak flow in the streams and reduce destabilizing forces on landslides below.
- Riffles constructed by hand using compressed air withstood the large flood of spring 1999 (estimated to be greater than the average flood). ▲

S. Sterling, 2000. Upper Willow Watershed Effectiveness Evaluation Strategy, Northwest Hydraulics Consultants, North Vancouver, B.C. Progress Report.

The Keogh and Waukwaas Rivers Paired Watershed Study for British Columbia's Watershed Restoration Program: Juvenile Salmonid Abundance and Growth

D.J.F. McCubbing and B.R.Ward.

Project Description

The study assesses the effectiveness of WRP stream habitat rehabilitation techniques through in-stream sampling (electrofishing and seine netting) in representative treated and untreated reaches, and through comparison of results with population dynamics data gathered from 25 years of salmonid juvenile abundance in-stream, smolt enumeration, and adult steelhead run size estimates. In-river treatments include stream habitat structures and slow-release nutrient applications, in the Keogh watershed. These have been incrementally increased over the five-year period (Figure 1), along with earlier road deactivation and on-going construction of off-channel ponds and channels. Juvenile salmonid density, growth, smolt yield, and adult escapement data will be collated and analyzed for change, in a staircase-type experimental design. To strengthen the analysis, a neighbouring watershed (Waukwaas River) is being monitored, but without WRP stream rehabilitation treatments. Data on the escapement enumeration of pink and coho salmon in the Keogh River will be added to the adult steelhead data. This will assist in evaluating the effectiveness of WRP techniques, and in calibrating coho and steelhead smolt yield to adult escapement (i.e., smolts per spawner as a function of spawners pre- and post-treatment).

The Keogh and Waukwaas Rivers, two fourth-order streams, are situated at the northern end of Vancouver Island, B.C., in the coastal western hemlock bio-geoclimatic zone. The logging histories of both watersheds are similar. A summary of Keogh watershed logging history indicates that approx. 53% of the basin had been logged since 1940, including 55% of the floodplain and up to 70% of the sub-basins. Past

Unit	1994 - 96	1997	1998	1999	2000	Reach
1		S	S	Fs	Fs	Zt
2		S	Fs	Fs	Fs	Yt
3		F	F	Fs	Fs	X
4		F	F	F	Fs	W
5			F	NS	NS	Yu
6				NS	NS	Zu
7						Waukwaas

Figure 1. Treatment plan and reaches used for fish density, growth, survival, and smolt yield assessment in the Keogh and Waukwaas Rivers for evaluation of WRP stream habitat rehabilitation techniques. See Figure 1 for definition of reaches; t= treated, u=untreated, blank = no treatment, F = fertilizer, S = structures, and Fs = fertilizer and structures, NS = not sampled.