Watershed Restoration Technical Bulletin
Streamline
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The Watershed Restoration Program (WRP) is a provincial initiative under Forest Renewal BC to restore the productive capacity of forest, fisheries and aquatic resources that have been adversely affected by past forest-harvest practices.

The major goals for WRP in 1999 are to:

- Restore and protect fisheries and aquatic resources in key watersheds throughout the province.
- Increase knowledge, information and tools for restoration and management of watersheds.
- Provide opportunities for community-based employment, training and stewardship.

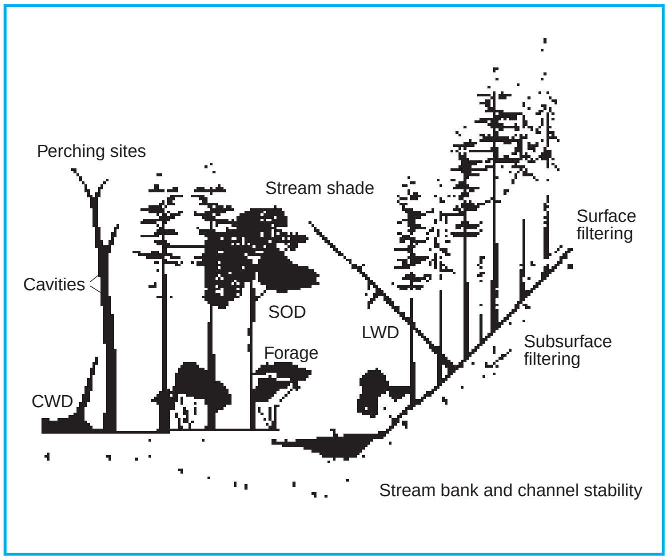

Figure 1. Ecological Functions of Riparian Vegetation (after Koning, W. 1999. Riparian Assessment and Prescription Procedures, Watershed Restoration Technical Circular No. 6).

The Watershed Restoration Program is pleased to announce publication of the final version of the Riparian Assessment and Prescription Procedures (RAPP), Watershed Restoration Technical Circular No. 6, 1999. The new masthead for Streamline is based on Figure 3 from this document depicting "desired future condition" for riparian vegetation. As an introduction to this issue, the figure at left (Figure 1) summarizes the ecological functions of riparian vegetation. Information on ordering Watershed Restoration Technical Circular No. 6, 1999 is available on the last page of Streamline. ▲

Restoration activities funded under the Watershed Restoration Program are based on a natural process-oriented approach, where feasible, that:

- reduces the generation and delivery of sediments from hillslopes to stream channels
- re-establishes natural drainage patterns and water quality
- restores riparian and streambank functions towards pre-logging conditions, and/or
- replaces lost channel-structuring elements and nutrients within streams to restore the amount and quality of fish habitat.

During 1999, Streamline will be featuring articles on riparian restoration, risk assessment and management, road deactivation, effectiveness monitoring (including a close look at some of the projects that have been featured previously in Streamline) and bioengineering. Summaries will be presented about some of the many watershed restoration projects that are ongoing in the province of B.C. If you know of interesting projects, techniques, technical tips, authors or resources, please advise the editor, Donna Underhill, at dbuirinc@axion.net.

This Quarter
Spring 1999

Feature

Getting Ecological Bang for the Buck - Riparian Restoration on the Chehalis River

Tanis Douglas and Donald McLennan

Introduction

This article describes a cost effective and ecologically based approach that Ministry of Environment, Lands and Parks (MELP) has taken to develop riparian restoration prescriptions for the Chehalis River. This watershed is a high priority for WRP riparian restoration as it has high fish values, is of high recreational importance, and has been extensively logged.

The Chehalis watershed is approximately 394 km^2 in area, and encompasses a number of large sub-basins (Scott Resources, 1996). The Chehalis River joins the Harrison River six km upstream from the Harrison River-Fraser River confluence. The Chehalis mainstem can be divided into upper and lower halves, divided by Chehalis Lake. An alluvial reach in the lowest three kilometres is used by pink and chum salmon; coho and an introduced run of summer steelhead move through the upstream, fifteen-kilometre canyon reach to use the tributary streams, the lake, and the upper section of the river. Chinook and sockeye salmon use of the river is currently low, although the low sockeye returns are suspected to be strays from the Harrison River stock. Resident rainbow trout, cutthroat trout, as well as resident and anadromous Dolly Varden char are also known to use the watershed (Scott Resources, 1996). A large spotted owl Special Resource Management Zone (SRMZ) encompasses approximately one-third of the total watershed area (Figure 1), and this special land use was a factor in developing prescriptions within riparian reserve zones.

In 1998, the Ministry of Environment (MELP) commissioned a modified riparian assessment, the goals of which were: to provide an overview of the level of impairment of riparian function; to identify riparian segments where silvicultural approaches could assist in the restoration of riparian function; and to develop ecologically appropriate, conceptual riparian prescriptions using air photo interpretation and a minimum of ground-truthing. By relying on the experience of Oikos Ecological Services Ltd., the full riparian assessment procedure was shortened, so that overall time and expenses were minimized. For a cost of approximately $16,000, the assessment included ninety-seven kilometres of stream. Oikos then developed conceptual prescriptions for approximately 3.5 kilometres (16.5 ha).

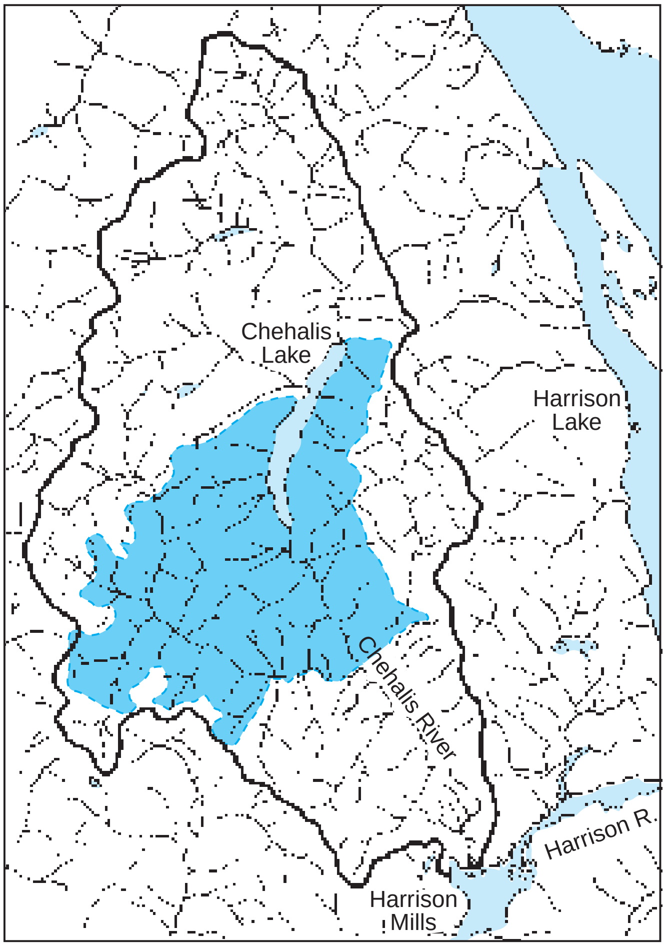

Figure 1. Map showing the location of the spotted owl Special Resource Management Zone (SRMZ) within the Chehalis watershed.

Methods

In order to reduce the costs and timeline of the assessment process, lower priority areas of the watershed were not assessed. MELP staff decided to exclude a 15 km canyon reach below the lake, as that section of the river is not as influenced by the vegetation on its stream banks. Also excluded were small first and second-order tributaries, and the riparian area around the lake. All remaining stream reaches, including fourteen tributaries and the upper reaches of the mainstem, were assessed at an overview level. High quality (1:5,000 scale colour) air photos with stereo coverage provided the basis for an accurate assessment of riparian impacts.

Ninety-seven kilometres of stream were classified into one of fourteen Riparian Vegetation Types (RVTs) based on stand structure and species composition, using interpretation of air photos and forest cover maps. The RVT classes are uniform in vegetation structure so that riparian functions are similar, and each has similar opportunities for riparian restoration. These preliminary RVTs were assessed in order of priority, using a helicopter overflight and brief ground visits. The major priorities for ground visitation were to assess sub-canopy conifer stocking in deciduous stands, and densities in young conifer stands.

Based on this overflight and quick ground evaluations of the different RVTs, Level 1 sampling was completed on those stands considered to have a high restoration opportunity. Basic ecological information was gathered at each high priority site to determine ecological characteristics, to summarize important stand attributes, and to estimate relevant geomorphologic features such as flooding frequency or slope stability.

Results and Discussion

Overview of Riparian Vegetation

In the Chehalis watershed about 60% of the riparian forest has been harvested. Figure 2 shows the frequency of RVTs in the watershed, and Figure 3 describes the different RVTs, summarizes their level of riparian function, and provides a general assessment of restoration opportunity. Young conifer and mixed deciduous-conifer stands (that have regenerated after harvesting) prevail, while pure deciduous stands make up less than five percent of riparian vegetation. In this, the Chehalis watershed is unlike many other coastal watersheds with a similar harvesting history. Deciduous representation is low in the Chehalis because streams are generally incised and floodplains are rare, so that wet, nutrient rich valley bottom sites are not as prevalent as they are in many other areas.

Most harvested riparian areas in the Chehalis watershed at this time are mesic to subhygric, stocked conifer and mixed pole sapling and young forest stands that have regenerated following clearcut harvesting to the stream bank. The harvesting has had a severe impact on riparian function in the watershed, and function has been recovering slowly as stands have developed up to the present time. At present, riparian function is still impaired, especially for contribution of LWD. Forest harvesting has severely affected wildlife habitat values, especially for those species requiring "Old Forest" structures, such as the spotted owl.

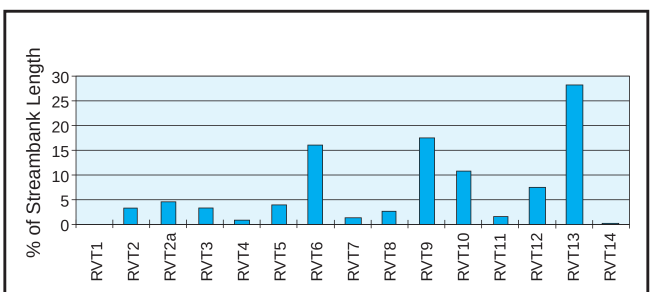

Figure 2. Frequency of Riparian Vegetation Types (RVTs) in the Chehalis watershed.

The restoration opportunity for each RVT is shown in Figure 3 and describes, for a given RVT, the potential for silvicultural interventions to accelerate the recovery of riparian function. These restoration opportunity assignments are general guidelines that will need to be interpreted for each site to include site-specific factors, such as floodplain bench height and stream size. For example, the recovery of LWD function will be a more important priority in small LWD-dependent stream segments than in riparian zones along large rivers where local LWD supply is less critical to stream function. Restoration opportunity decreases with increasing RVT age because riparian function recovers naturally with time, and restoration interventions are less effective in shortening this recovery. For this reason the coniferous Pole Sapling and Young Forest RVTs that dominate the Chehalis sub-basins have a moderate restoration opportunity, compared to deciduous RVTs of the same age. Restoration opportunity in deciduous RVTs is higher than coniferous RVTs of the same age because the deciduous shrubs and trees often suppress conifer growth and significantly reduce conifer stocking. In logged coastal watersheds riparian function is commonly delayed for long periods due to these young deciduous riparian vegetation types.

Site Descriptions and Conceptual Prescriptions

After the classification of RVTs, the next step in the prioritization process was to select sites to visit on the ground, based on observations from the air photo interpretation, and from the helicopter overflight and quick ground checks. Using this information, riparian segments were selected that were considered to have a high restoration opportunity due to stand structural characteristics, fish values, operational feasibility, watershed context, and potential to also manage for spotted owl habitat.

The three site descriptions below show the type of information collected during site visits, and the conceptual prescriptions developed for each. These include a deciduous-dominated alluvial reach in the Upper Chehalis River, and a scoured alluvial fan at the head of Chehalis Lake. The third site is a coniferous young forest of the type being considered for treatments related to spotted owl.

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RVT Class	Description	Overall Impairment	Restoration Opportunity
1. **INIT**	**Initial:** recently scoured gravel bars, vegetation cover < 5%	**High**	**High**
2. **SHb**	**Shrub-herb (broadleaf):** post-harvesting brushfields dominated by alder, may be stocked with conifers in the understory	**High**	**High**
2a. **SHb**	**Shrub-herb (broadleaf):** disclimax brush stands on avalanche tracks	**No Change**	**N/A**
3. **SHc**	**Shrub-herb (conifer)**: post-harvesting conifer plantations < 20 years, < 10 m tall	**High**	**Low**
4. **PSb**	**Pole-Sapling (broadleaf):** post-harvesting hardwood stands 5-25 years old, may be stocked with conifers in the understory	**High**	**High**
5. **PSm**	**Pole-Sapling (mixed):** post-harvesting mixed stands 5-25 years when > 50% alder; 20-40 years when > 50% conifer	**High**	**Moderate**
6. **PSc**	**Pole-Sapling (conifer):** post-harvesting conifer stands; 20-40 years, > 75% conifer	**High**	**Moderate**
7. **PSct**	**Pole-Sapling (thinned conifer)**: thinned post-harvesting conifer stands; 20-40 years, > 75% conifers	**High**	**Low**
8. **Yfb**	**Young Forest (broadleaf):** post-harvesting or post-fire hardwood stands 25-40 years, > 75% red alder, may be stocked with conifer in the understory	**Moderate**	**High**
9. **Yfm**	**Young Forest (mixed):** mixed post-harvesting or post-fire stands; 25-40 years when > 50% alder, 40-80 years when > 50% conifer	**Moderate**	**Moderate**
10. **Yfc**	**Young Forest (conifer)**: post-harvesting or post-fire conifer stands 40-80 years, > 75% conifer	**Moderate**	**Low**
11. **MFb**	**Mature Forest (broadleaf):** mature red alder stands > 40 years,may be stocked with conifers in the understory	**Low**	**High**
12. **MFc**	**Mature Forest (conifer):** conifer stands 80-250 years, > 75% conifer	**Low**	**Low**
13. **OF**	**Old Forest:** stands > 250 years	**No Change**	**N/A**
14. **Road**	non-vegetated or < 50% shrub/herb	**High**	**High**

Figure 3. Description of RVT classes, summary of riparian function, impairment and assessment of restoration opportunity.

Site 1 - Upper Chehalis River (18 ha)

A 3 km section of the Upper Chehalis River is dominated by deciduous Pole Sapling stands and was the only deciduous-dominated area that had low conifer stocking, and thus a relatively high restoration opportunity. This section is a braided floodplain, and currently consists of a mosaic of young deciduous and mixed stands resulting from fluvial activity in the last fifteen to twenty years; small conifer stands are also present. The deciduous stands have variable conifer stocking in the understory, while the conifer stands are generally very dense. Sites were mostly classified as CWHvm1/09 and were different-aged stands of red alder or black cottonwood. Humus form is Leptomoder, and soils are sorted sandy loams and loamy sands, and were classified as Orthic Dystric Brunisols.

Conceptual Prescription:

There are about four stand types and each would require its own restoration prescription based on more detailed estimates of conifer stocking. The main management objective for the whole area is to accelerate the rate at which large conifers are produced in order to stabilize the fluvial landforms, and to accelerate the recovery of other riparian functions such as LWD production, stream shading and filtering. Prescriptions would be of two general types: conifer release in the deciduous stands, and thinning of conifers in overstocked conifer stands. Conifer release would be achieved by selectively falling or girdling deciduous canopy dominants to increase the growth and survival of sub-canopy conifers. The numbers of deciduous overstory trees removed would have to be managed so that increased light would not promote understory shrubs over the understory conifers. In addition, enough deciduous trees must be retained to maintain stability of the landform.

For the overstocked conifer stand, thinning would reduce inter-tree competition and release those conifers that remain. The released trees would then grow more rapidly to provide LWD sooner, stabilize the landform better, and provide more shade and small organic debris (SOD). Wider spacing of stand dominants also allows light penetration to the forest floor and permits development of subcanopy vegetation.

Site 2 - Chehalis Lake Fan (2 ha)

This alluvial reach above Chehalis Lake has widened and aggraded in the post-logging period (Babakaiff, 1999). About one and a half kilometres above the lake a recent scouring event removed trees from a previously logged stand that had regenerated into a conifer-deciduous mix (Figure 4). Similar stands remain in adjacent areas that missed the scouring event. In the scoured area, most of the fine fraction of the soils has been removed, and the area is sparsely vegetated with red alder, shrubs, Douglas fir seedlings and grasses. Other stands that are regenerating from similar scour events provide a template for riparian restoration.

Conceptual Prescription:

The objective of the restoration prescription is to accelerate the rate of ecosystem succession so that full riparian function is restored earlier than would occur by natural succession. The prescription involves planting the site with suitable trees, shrubs, and possibly herbs. Species to be planted will be determined by adjacent template sites. One major concern is a period of drought during the summer as indicated by droughty moss species present, and the poor growth of red alder and Douglas-fir seedlings. This can be addressed with potted stock and/or some form of irrigation. The project geomorphologist has also identified this area for placement of log jams at two adjacent bars (Babakaiff, 1999). The gravel bars would experience lower water velocities due to the proposed log jams, increasing the probability that the planting program would meet with success.

Figure 4. Scoured high bench floodplain with remnant western red cedar stumps.

Site 3 - Statlu River Spotted Owl Special Resource Management Zone (SRMZ)

The Statlu River is a major tributary to the Lower Chehalis River, and it is along the Statlu and part of the Lower Chehalis River and Chehalis Lake that the spotted owl SRMZ is located (Figure 1). As previously described, the majority of stands in the Chehalis watershed are mixed and conifer-dominated Pole Sapling and Young Forest stands that have regenerated following harvesting. It is these stands that are proposed for treatment in the spotted owl SRMZ. Riparian function is restored more quickly in treated stands than under natural succession, by manipulating stand structural characteristics to provide old growth characteristics sooner. Old growth characteristics that benefit spotted owl will also benefit a multitude of other species, including those that live in streams.

A number of conifer-dominated young forest stands along Statlu Creek were visited where stand manipulations could be effective, and where roads were available to facilitate yarding and other harvesting concerns. In one representative stand a series of fixed area plots were established to provide data based on tree species, densities and diameter classes. In the sampled stand, harvesting was completed 50 years ago, and the area is now stocked by advanced and natural conifer regeneration ranging in age from 48 to 73 years. The dominant tree species were western hemlock and amabilis fir. Harvested stumps provided an estimate of approximately 110 stems/ha for pre-harvest tree densities. The stand was classified as CWHvm1/01 with moist depressions that were classified as CWHvm1/06. The landform is morainal blanket, humus form is Hemimor, and the soils have a sandy loam texture and are classified as Orthic Humo-ferric Podzols.

Conceptual Prescription:

The conceptual prescription for this and other stands on Statlu Creek will be further developed as an additional project that follows this overview assessment. Spotted owls require a multi-storied canopy with enough room to fly between trees and branches to catch their favoured prey, the flying squirrel. Of course,

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they also require that the habitat of the flying squirrel be present. In the target area biogeoclimatic zone (CWHvm1), the general objectives for a spotted owl prescription are to achieve the following stand characteristics (SOMIT 1997):

- 60-80% crown closure with two or more tree species
- well-defined vertical structure with limbs to within three metres of the ground
- 37-185 overstory stems/ha that are >75 cm dbh
- five trees/ha with broken tops and five snags/ha >76 cm dbh
- 268 m^3/ha coarse woody debris > 10 cm diameter,
- 40% understory vegetation patches with >25% ground cover

The above SOMIT stand characteristics are taken from research in Washington and Oregon and describe areas that the spotted owl is known to use. The goal for stands in the spotted owl SRMZ is to create suitable or superior habitat for spotted owls sooner than would develop by natural succession alone. These prescriptions will benefit aquatic species by restoring full riparian function sooner, and benefit other wildlife species requiring Old Forest structure as a habitat component.

Stand management prescriptions will be developed using a combination of computer modeling (TASS, Mitchell 1975 and Greenough and Kurz 1996), consultations with researchers, and our own approaches including creating canopy gaps, creating snags, and uneven thinning regimes. Figure 5 shows the natural thinning curve for stands of similar species composition as those in the Statlu Creek area. As stands age, stand density is reduced by inter-tree competition for light and nutrients and this 'self-thinning' process occurs over a period of about 100 years. Conceptual prescriptions will include stand thinning treatments to accelerate the rate at which this natural thinning occurs, so that light, moisture and nutrient resources are concentrated into fewer stems. In this way Old Forest characteristics such as larger stems, lower densities, CWD, and snags may be produced more rapidly than they would be in a natural succession. A number of important questions must still be answered before these prescriptions are finalized, including: how much time is saved by treating the stands compared to how long it will take to reach Old Forest stage without intervention? What and how many treatments should be used? What is the optimal time to carry out the treatments?

Data from the sampled stand will be used for the computer modeling component, and 'dummy' data will also be used to model how other stands might react to the treatments. Treated stands will be run against untreated stands to estimate the benefits of the

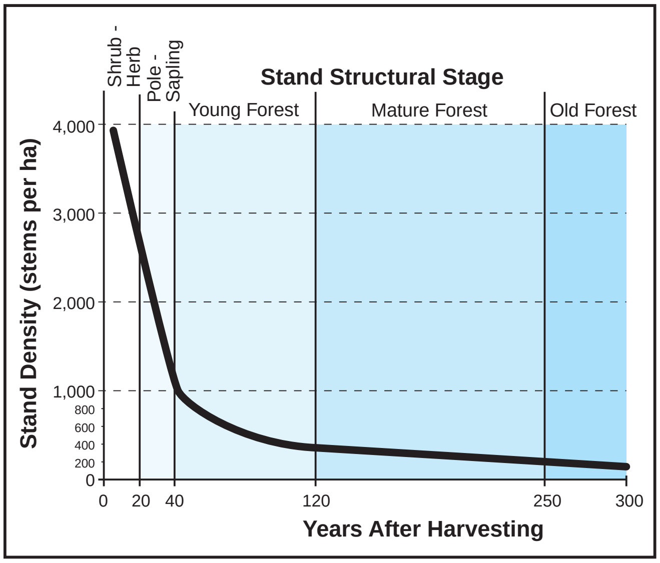

Figure 5. Natural thinning curve for stands similar to those in Statlu Creek.

treatments. The forest cover database for target stands within the Riparian Reserve Zone along Statlu Creek will be queried to help identify and prioritize the most suitable stands for treatment. The prescriptions developed will be circulated for comment and then refined based on reviewers' input.

Prioritization of Riparian Prescriptions

Of the three sites described above, the Statlu site is considered the highest priority. Although the conceptual riparian prescriptions developed for Sites 1 and 2 will help re-establish riparian function, these riparian segments make up a very small proportion of the watershed and the impact of the treatments at the watershed level would be small. Restoration prescriptions for the Statlu stands address the condition of the dominant post-harvesting vegetation types, as well as managing for both aquatic and terrestrial species' use. The dual objectives of acceleration and restoration of full riparian function and providing owl habitat, increase the overall priority of developing and implementing the prescriptions, compared to other coastal watersheds where only riparian objectives would be served.

Future Work

At the request of MELP, Oikos is presently initiating computer modeling and other steps to develop stand management prescriptions for selected riparian stands along Statlu Creek within the spotted owl SRMZ. As an additional component of that study, the most suitable stands in the spotted owl SRMZ will be identified for restoration work (Figure 6). In fiscal year 1999/2000 it is hoped that all selected sites will have detailed stand management prescriptions identified

Figure 6. Candidate stand for evaluating treatments to encourage old forest characteristics.

and initiated. Future activities depend on funding provided to Canfor, as MELP is no longer receiving FRBC funding to continue this work.

Conclusions

The project successfully provided an assessment of the present condition and level of function of riparian vegetation in the Chehalis watershed. Riparian segments that would benefit from restoration activities were identified and described, conceptual prescriptions were developed, and potential restoration work was prioritized. Based on these analyses, it was decided that stand management prescriptions that would accelerate the restoration of full riparian function and create desirable stand characteristics for spotted owl habitat within the Statlu River spotted owl SRMZ were the highest priority for riparian restoration activities in the Chehalis watershed.

Increasingly tight budgets emphasize the need for more economical approaches to riparian assessment and prescription development. In this project, standard assessment methods could be abbreviated due to the experience of the consultant. Tighter budgets also increase the desirability of multi-dimensional management (as in this case), where riparian restoration will benefit several managed species with a minimum of extra effort.

References:

Babakaiff and Associates Geoscience. 1999. Upper Chehalis Watershed: Channel Condition and Prescription Assessment. Report for Ministry of Environment, Lands and Parks, Surrey, B.C.

Greenough, J.A., and W.A. Kurz. 1996. Stand tending impacts on environmental indicators. Canadian Forest Service - B.C. Ministry of Forests, Victoria, B.C.

Oikos Ecological Services Ltd. 1999a. Ecosystem Classification. Chapter 11 in Acres International Ltd., B. Thompson, B.A. Blackwell and Associates Ltd., J.M. Ryder and Associates Terrain Analysis, Northwest Hydraulic Consultants Ltd., Oikos Ecological Services Ltd., Phero Tech Inc., and Timberline Forest Inventory Consultants. 1999. GVRD Watershed Ecological Inventory Program. Annex to the Analysis Report. Watershed Management Plan #5. Prepared for the Greater Vancouver Regional District. Burnaby, B.C.

Oikos Ecological Services Ltd. 1999b. Riparian Overview and Conceptual Restoration Prescriptions for Selected Sub-drainages of the Chehalis River, south-western British Columbia. Report for Ministry of Environment, Lands and Parks, Surrey, B.C.

Oikos Ecological Services Ltd., and Bill Thompson. 1999. Modeling and Management Scenarios. Chapter 15 in Acres International Ltd., B. Thompson, B.A. Blackwell and Associates Ltd., J.M. Ryder and Associates Terrain Analysis, Northwest Hydraulic Consultants Ltd., Oikos Ecological Services Ltd., Phero Tech Inc., and Timberline Forest Inventory Consultants. 1999. GVRD Watershed Ecological Inventory Program. Annex to the Analysis Report. Watershed Management Plan #5. Prepared for the Greater Vancouver Regional District. Burnaby, B.C.

Scott Resource Services Ltd. 1996. Overview assessment of Chehalis River watershed. Contract report to Watershed Restoration Program, B.C. Ministry of Environment, Lands and Parks, Surrey, B.C.

SOMIT. 1997. Spotted Owl Management Plan. Strategic Component. Report prepared by the Spotted Owl Interagency Team. BCMELP - BCMOF, Surrey, B.C.

Mitchell, R. 1975. TASS. The Tree and Stand Simulator Model. Research Branch, B.C. Ministry of Forests, Victoria, B.C.

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Feature

Nulki-Tachick Watershed Restoration Project

Scott McIntosh and Cam Irvine

Objectives

The Nulki-Tachick Watershed Restoration Project (NTWRP) began in the fall of 1995 as a multi-year project under Forest Renewal BC. The project initially sought to answer such broad questions as, "What is the present state of health of this watershed?" and "Why are the wild rainbow trout (Oncorhynchus mykiss) stocks of this once flourishing fishery in such decline?" This watershed is a natural resource that provides an important sport fishery to residents of the Vanderhoof and Prince George regions, and that contributes to a sustenance fishery for the people of the Saik'uz First Nation. Directing development of the 1998 NTWRP objectives were a series of studies that contributed necessary data, including an IWAP (1996), a Level II Fish Population and Riverine Habitat Assessment (1996), a Water Quality Study (1996/97) and a Fisheries Investigation (1995-1997). During 1998 the three main objectives were to:

- clarify stock status by enumerating rainbow trout through mark and recapture in Stoney Creek between Nulki Lake and Tachick Lake;
- replant in logged-off riparian zones throughout the watershed a mixture of hybrid spruce (White/ Engleman), low level willow and black cottonwood; and,
- aid the natural recovery of the local rainbow trout fishery by restoring altered riparian and stream habitat within selected sections.

Background

The Nulki-Tachick lakes watershed is located in the central interior of British Columbia, 100 km west of the City of Prince George, and 20 km southwest of the District of Vanderhoof (Figure 1). Corkscrew Creek is a 4th order inlet stream on the south side of Nulki Lake, approximately eight km southwest of Vanderhoof. Stoney Creek is both the principle outlet stream for Nulki Lake and the principal inlet stream for Tachick Lake. The creek flows north for 6.4 km to connect the two lakes.

This 47,000 ha watershed lies within the sub-boreal spruce biogeoclimatic zone, a montaine region that dominates the central interior of British Columbia. Elevation in the watershed ranges from ~730 m (above sea level) at the surface of Nulki and Tachick Lakes to ~1340 m at Corkscrew Creek's headwaters in the Nulki Hills (southern portion of the watershed). Although the southernmost edge of the watershed has steep gradients (hilly to mountainous), most of the watershed is flat or gently sloping. White spruce and subalpine fir are the dominant upland climax tree species. Lodgepole pine and trembling aspen are common seral species, with paper birch occasionally a pioneer species at disturbed sites. Douglas fir are common at dry, nutrient-rich sites. Black spruce are common in the wet, swampy areas. Extensive wetlands (sedge marshes, shrub fens, treed fens, and moss bogs) occur in poorly drained postglacial depressions. Black cottonwood are common along the shores of streams.

Soils in the Nulki-Tachick watershed, being derived from glaciofluvial processes, are dominated by sandy to gravely textures (moderate to well drained). Luvisolic, Podzolic and Brunisolic soils are common on morainal deposits. Poorly drained organic soils are associated with damp depressional areas. Total precipitation in this 47,000 ha watershed averages

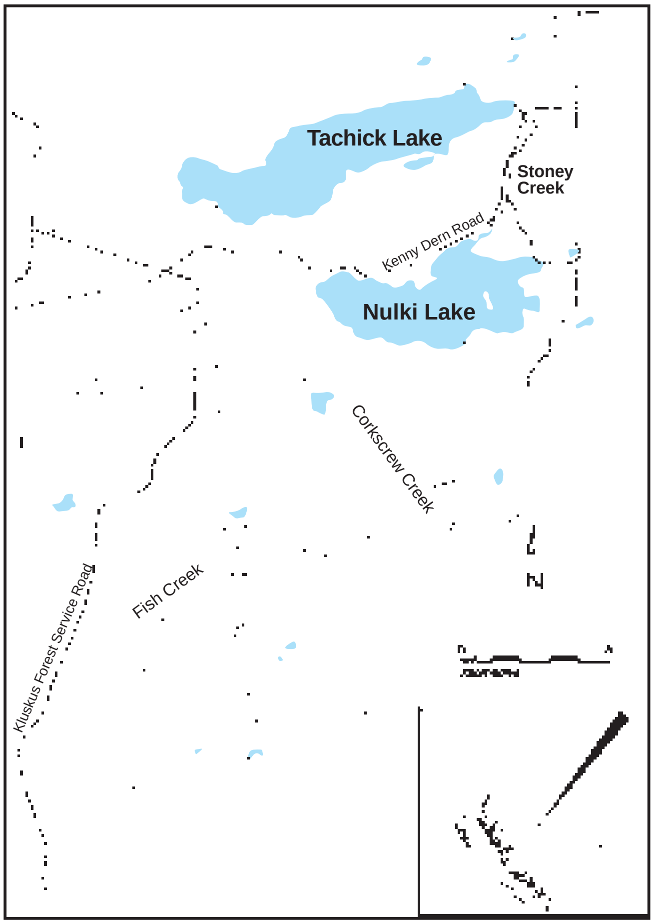

Figure 1. Map of Nulki-Tachick watershed, showing general location in inset.

26.5 cm annually, with 75% of all rainfall occurring between the beginning of May and the end of October.

The Nulki-Tachick watershed hosts a list of diverse fish species, including mountain whitefish, burbot, northern pike minnow (northern squawfish), peamouth chub, lake chub, redside shiner, longnose sucker, largescale sucker and prickly sculpin. Many of these are included in the sustenance fishery of the Saik'uz First Nations people. However, the focus over the four year duration of this project has specifically been rainbow trout. A unique feature of the Nulki-Tachick system is in Corkscrew Creek, the principle stream used by rainbow trout for spawning and rearing purposes. This 60 km monoculture network of streams is created by a two m waterfall located two km from its confluence with Nulki Lake. Only rainbow trout are able to negotiate these falls and gain access to the extensive habitat above.

Approximately 35-50% of the watershed has been cleared by agricultural and forest industries since the 1950's. There were major developments in the head-waters prior to implementation of the Forest Practices Code. A network of logging roads, culverts, bridge crossings and timber staging areas exists within the watershed. As much of the Corkscrew Creek mainstem and tributary riparian zone forest (~35 km) has been harvested, recruitment sources for large woody debris (LWD) have been removed in this drainage area. Subsequent loss of instream LWD and pool habitat has been detrimental to juvenile rearing habitat.

The NTWRP is within the Omineca-Peace and Vanderhoof MELP and MOF regions. The proponent is the Saik'uz First Nation. Fisheries investigations in 1995 to 1997 and population assessments in Corkscrew Creek offered an accumulation of aging data that indicate rainbow parr over-winter in this system for one to three years before taking up residence in the lakes downstream. Large woody debris and complex habitats that increase stream productivity are rare in Corkscrew Creek. Furthermore, unstable banks void of riparian vegetation are eroding and embedding spawning gravel in the lower reaches of Corkscrew Creek. Stoney Creek also lacks habitat that can provide predation refuges for young fish. These factors are likely contributing to poor juvenile survival and low rainbow trout recruitment to Nulki Lake and Tachick Lake. In 1998, the NTWRP focused on restoring those high priority habitats which have the greatest probability of increasing juvenile survival. The aim is to increase recruitment to rainbow trout populations.

Rehabilitation Work

An integrated watershed scale approach to restoration of critical areas included:

- revegetation of riparian habitat and placement of instream debris structures along Stoney Creek;
- bank stabilization, riparian revegetation, and instream LWD structures in the Johnson's Meadow area of Corkscrew Creek; and
- bank stabilization, riparian revegetation, and instream LWD structures near the Fish Creek - Corkscrew Creek confluence area.

In 1998, fish habitat structures were placed as follows: 13 in a 300 m portion of reach 5 of Corkscrew Creek; six in a 200 m portion of reach 4 of Corkscrew Creek; and five in a 300 m portion of reach 2 of Stoney Creek. LWD structures were designed after Cederholm et al (1997) and natural templates. These required 107 LWD pieces, 31 rootwads, and 154 boulders (Figures 2, 3 and 4).

LWD structure designs were based on natural templates found in the watershed. Planning and construction was a group effort involving many people from Saik'uz and the help of experienced mentors. Watershed restoration specialists, Andrew Wilson (MELP), Mark Potyrala (Keogh River WRP), and Pat Slaney (WRP co-ordinator) provided valuable insights and suggestions for the design and construction of structures.

The majority of work placing wood and boulders for the LWD structures was completed using draft horses (Figure 2). Horses were used in Corkscrew Creek where access along the creek was restricted and because they have less impact on the bank and stream than would heavy machinery. Nechako Valley Horse Logging, a locally owned business based in Fort Fraser since 1984, was contracted for this work.

Mat and Josh Jonke, with horses George and Red (Figure 2), were able to transport the large boulders and logs needed to construct LWD structures with

Figure 2. Nechako Valley Horse Logging's draft horses place large woody debris and boulder structures in Corkscrew Creek with precision and little environmental disturbance.

Feature

minimal stream disturbance. Once the material was transported to the stream site, the horses were unhooked from the cart and used to move the logs and boulders into position for anchoring. A block and tackle system was used to position logs when stream conditions confined horse movement. The use of these draft horses allowed a high degree of precision during log and boulder placement. It was safe to work near them, and they caused minimal stream and riparian impacts. It was a pleasure working with horses rather than heavy machines because the loudest noises were their gentle splashing and munching of grass.

A Hitachi excavator, made available through ongoing construction in the village of Saik'uz, was used to place logs and very large boulders used in LWD structures in Stoney Creek. The excavator was also required to position a log-boulder reef that was built off site and later lifted into the creek. Pullbacks and re-contouring unstable banks in one reach where silt was washing into the Corkscrew Creek was accomplished using a backhoe and operators from the Saik'uz First Nation.

Figure 3. Student technicians from the Saik'uz First Nation prepare LWD structures for cable-ballasting.

Figure 4. The site of a LWD root revetment during construction.

All structures incorporated boulders to which logs were attached using the Hilti-epoxy method (Slaney et al. 1997) to ensure that structures would withstand the force of water during large rain events and spring freshet (Figure 3). Student technicians from the Saik'uz First Nation and Nayun Contracting, a locally owned silviculture business, were employed to anchor large structures (Figure 4). Nayun Contracting has operated since 1992 and has been involved in other watershed restoration projects with the Vanderhoof District Ministry of Forests.

Riparian Restoration and Bank Stabilization

In the same reaches of Corkscrew Creek, 200 linear metres of stream bank were stabilized, covering an area of 0.42 hectares. Bio-engineered slope stabilization strategies were designed after Babakaiff et al (1997) to re-establish willow and cottonwood on riparian banks and to stop further erosion. Willow wattles, brush layers, live stakes and willow mattresses were assembled and put in place by a crew of six Saik'uz First Nation technicians through August and part of September 1998 (Figures 5 and 6). The technicians cut and bound willows in wattles then placed them at bank stabilization locations along Corkscrew Creek. These were made of organic materials (willow, cottonwood, hemp rope) wherever possible, and rebar stakes were used on only a few occasions at the Fish Creek confluence where the ground was too solid for willow or cottonwood stakes to hold. Both willow and cottonwood are capable of vegetative propagation and so will take root and grow. This plant growth enhances slope stability and facilitates colonization by other plants.

Following typical slope stabilization site procedures, wattles, which are tied bundles of live willow stems, were placed horizontally across unstable banks in layers to form a retaining wall. These structures hold back soil and give the slope a terraced appearance. Woody stakes of live willow or cottonwood, placed vertically in rows, are known as brush layers. These

Continued on page 11.

Figure 5. Student technicians from Saik'uz First Nation prepare willow wattles for bank stabilization.

Figure 6. Brush mattress and willow wattles stabilize a streambank that was recontoured to reduce active erosion.

were hammered perpendicular to the ground above each wattle to physically stop material eroding from the slope. As the brush layers root and grow they will form a wall of vegetation along the slope.

To reduce erosion in one reach of Corkscrew Creek we used a 426 Ford/New Holland backhoe and operators from the Saik'uz First Nation to pullback and re-contour unstable banks. These areas were revegetated and stabilized with riparian structures. Bank stabilization structures were often used in conjunction with LWD structures to increase the stability of several areas where actively eroding banks were contributing fine silts to the creek and smothering spawning gravel.

In addition, a riparian planting program was carried out by nine Saik'uz First Nation students, who planted 20,000 spruce and 88 alder seedlings, as well as 16,185 willow and 15,519 cottonwood whips. These were planted in areas where past logging practices had deforested riparian areas. In the long term, these shrubs and trees will help stabilize streambanks and will contribute to instream LWD recruitment.

Summary of work accomplished to date

Employment for 1998 NTWRP restoration:

Heavy equipment operators	16 days
Draft horse operators	22 days
Project manager	260 days
Project biologist	125 days
Habitat technicians	559 days
Tree planters	267 days
First Nations workers	826 days
Displaced forest workers	277 days

(days of labour are based on 8-hr working days)

Equipment

Equipment required for project completion included:

- an excavator (Hitachi EX200),
- a backhoe (426 Ford/New Holland),
- a dump truck,
- a team of draft horses,
- a logging cart,
- rock and wood drills,
- a power saw,
- cable cutters,
- 9 drill bits,
- 200 metres of 9/16" wire rope cable,
- 35 tubes of epoxy glue,
- 36 duckbilled earth anchors.

Restoration Cost Summary

Salaries	$55,034
Heavy equipment	$ 8,633
Draft horses and operator	$ 6,050
Materials	$ 7,910
Surveying	$ 9,688
Rentals	$ 6,298
Total	**$93,613**

The strategic introduction of large wood and boulder structures is likely to restore fish habitat and thereby increase rainbow trout productivity in Corkscrew Creek. This strategy provides more refuges and over-wintering habitat for rainbow parr. In Stoney Creek, the addition of LWD structures will provide refuges and velocity breaks for migrating adult and juvenile rainbow trout, thereby reducing predation pressure.

Monitoring

The growth and stability of bank stabilization projects that made use of bioengineering techniques will be assessed in 1999. In addition, the 1998 LWD placements

Continued from page 10.

Feature

will be monitored to determine rainbow trout use and pool depth in relation to pre-restoration conditions. Minor modifications to improve the function of several structures will be conducted in 1999.

A permanent hydrometric station (WSC Station 08JC017) collected flow and temperature data from the mainstem of Corkscrew Creek, while water temperatures in Stoney Creek and the main spawning tributary of Corkscrew Creek were monitored using Starlog (data loggers).

Preliminary notes on 1999

Initial observations in 1999 indicate that structures were holding in place through average freshet conditions. Structures were collecting debris, scouring, and deflecting, as proposed, at almost all sites.

Figure 7. During "plant-a-tree day" a student technician from Saik'uz First Nation mentors a local youth.

Looking Ahead

Last year the Nulki-Tachick Watershed Restoration Project was a great success, thanks to much hard work by dedicated staff. In 1999 the Saik'uz Nation plans to plant more trees along Stoney and Corkscrew creeks to provide shade. In looking ahead, we include education and involvement of the community (Figure 7). The Saik'uz Nation also plans to build more log structures to improve fish habitat and stabilize creek banks, and help local landowners construct fences to keep cattle out of the creek. Fisheries managers still have many questions about the trout here, and we will try to answer a few of them with a small fisheries program.

References

Babakaiff, S., D. Hay, and C. Fromuth. 1997. Rehabilitating stream banks. Ch. 6. In Fish Habitat Rehabilitation Procedures (Slaney, P.A. and D. Zaldokas, Editors). Watershed Restoration Technical Circular 9. Ministry of Environment, Lands and Parks. Vancouver, B.C.

Cederholm, C.J., L.G. Dominguez, and T.W. Bumstead. 1997. Rehabilitating stream channels and fish habitat using large woody debris. Ch. 8. In Fish Habitat Rehabilitation Procedures (Slaney, P.A. and D. Zaldokas, Editors). Watershed Restoration Technical Circular 9. Ministry of Environment, Lands and Parks. Vancouver, B.C.

Fontaine, B.L. and T.D. Merritt. 1988. An anchoring system for fish habitat structures: field technique, evaluation, and application. U.S. Department of Agriculture, Forest Service Research Note PNW-RN-481.

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SPRING 1999 SAN JUAN RIVER RIPARIAN FOLLOW-UP AND ADDITIONAL WORK

Reinhard Muller and Eric Muller

Introduction

In the previous issue of Streamline (Volume 3, Number 4) the San Juan Watershed Agreement and resulting cooperative watershed restoration program was detailed by Bud Iverson and Deb Epps. This article provides further information, focusing on riparian work and adaptive management to enhance the previous project work.

The operational work during the spring of 1998 had completed the following: falling and planting of approximately 7.0 ha along Harris and Lens Creeks; girdling of several alder patches (6.9 ha) along Harris Creek, Renfrew (Granite) Creek (Figures 1 and 2) and the San Juan River to release understory conifers and to spot under-plant additional conifers; and the planting of a number of San Juan River sand and gravel bars with 191,170 willow cuttings and other shrubs and herbs to stabilize the movement of fines in the system.

While the 1998 work had been done by a Pacheedaht First Nations forestry crew from Port Renfrew, all the 1999 work was done by Timber West Forest Limited workers from the Honeymoon Bay Division. All work was funded by Forest Renewal BC. The work areas were coordinated by Eric Muller of Fulcrum Forest Consultants, based on previous prescriptions and changes recommended by R. Muller of Fen Forest Consulting. All 1999 work started February 22, 1999 with a training session regarding riparian treatments and ended March 31, 1999. The spring 1999 operational work was designed as a follow-up on treatments done during 1998, as well as to complete additional areas previously prescribed for bar stabilization and alder girdling. The bulk of the work concentrated on river bar stabilization with willow cuttings.

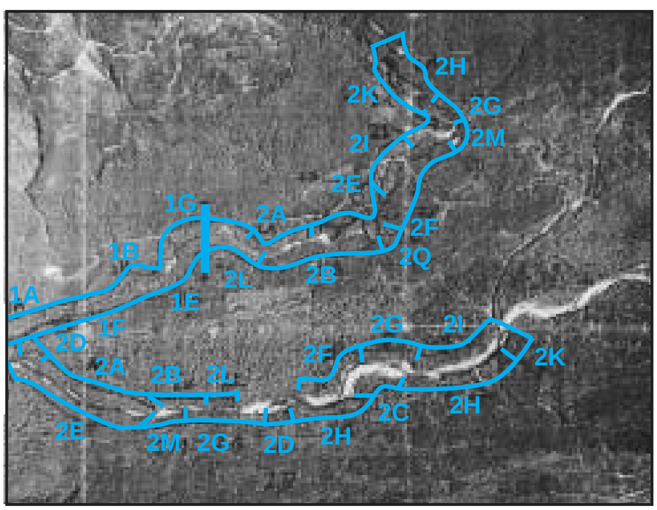

Figure 1. Air photo of treated segments of Harris and Lens Creeks.

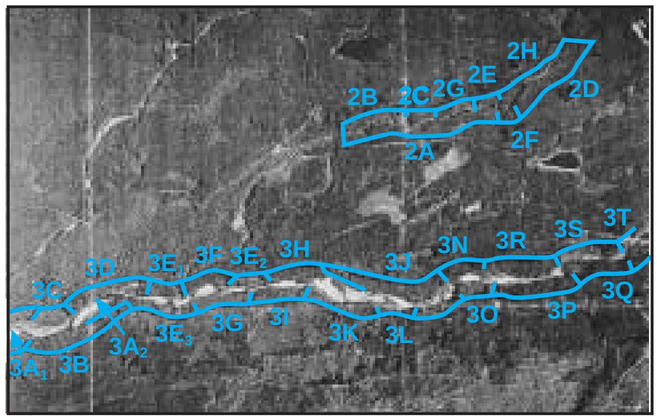

Figure 2. Air photo of treated areas of Renfrew (Granite) Creek.

ANALYSIS AND STATE OF 1998 WORK ONE YEAR LATER:

Alder Falling, Planting of Conifers, Understory Conifer Release and Brush Release:

- Most understory conifers released in 1998 were either Sitka spruce or western hemlock of various heights and age classes, which had been suppressed by big overstory alder for many years. Growth habit was therefore often spindly, with mostly shade foliage produced at very low light intensities. From past experience with release of long suppressed understory conifers, there was a danger that many suddenly exposed understory hemlock and Sitka spruce would light burn and die from the shock. Fortunately, this has not been found to be the case to date, and the danger is expected to decrease with each subsequent growing season. A few very suppressed trees, however, were bent over by last winter's snow loads. Actual visible growth release is not expected to happen for a few more years until trees have built up a better root and foliage systems.
- Planted seedlings of Sitka spruce (Figure 3), grand fir and western red cedar did very well and in some cases grew new leaders of up to 80 cm in height.

Feature

Figure 3. Sitka spruce planted on San Juan River bar just below Harris Creek. This photo was taken after one growing season and two winter flood events. Note the protection offered by broom from sand aggradation.

Grand fir was browsed early in the season (1998) by both deer and elk, while cedar appeared to be browsed only later during the winter and early spring 1999. Sitka spruce was left untouched, as expected, and therefore grew best. Sitka spruce is, however, expected to become infected with leader weevil within the next 5 years or so.

- Felled alder had been bucked in some areas to provide better planting access. As expected, browsing on red cedar and grand fir was heavier in the areas bucked out well, compared to those with heavy slash remaining. Furthermore, well-bucked alder chunks, branches and boles tended to have shifted more easily during high water events and in some places had settled on planted seedlings or released understory conifers (Figure 4). Thus, felled hardwoods should be bucked as little as possible in the future to reduce both browsing and debris shifting by floods. It may also be beneficial to anchor some felled trees which in turn will serve to block shifting of others. Understory shrubs and herbs on the felled areas were found to have released, but not yet to the extent expected. Most understory brush release was observed on vine maple along Lens Creek.

Figure 4. Spruce planted seedling and residual partly covered by shifted felled alder. Photo taken after first growing season and winter flood events.

- Conifer release and spot underplanting under large girdled alder was as slow as the planted areas, since it usually takes two growing seasons after girdling to kill the overstory. Understory salmonberry under the girdled patch at Renfrew creek grew vigorously and appeared to be suppressing some of the planted Sitka spruce.

1998 Planting and Stabilizing of River Bars:
About 191,170 willow cuttings had been planted in 1998 with a small percentage of cottonwood, red osier dogwood, spirea, stink currant and a few herbs. Survival of willow and cottonwood cuttings appeared to be well over 95%. Similar high survival was observed with rooted shrub stock from Madrone Nursery. Most red osier dogwood cuttings died before being able to generate roots. Stink current cuttings rooted very slowly, but many appeared to have survived. Stachys coolyei and Petasites palmatus rhizome cuttings and plants did very well in spite of being browsed by Elk. During the summer of 1998 it became apparent that the larger willow (that is, willow greater both in length and diameter with wood sometimes several years old) showed more vigorous growth than the smaller, less deeply planted cuttings placed by hand.

Eroding River Bank Stabilization:
Most stecklings experimentally nailed into vertical eroding banks survived, and grew during last summer, but were later washed out or were lost when the banks collapsed during some of the high water erosion. One notable exception was a less than vertical eroding bank along the lower portion of the San Juan River above Fairy Lake, where planted cuttings are still growing (Figure 5). Modified brush layers installed along a steep eroding bank (outside bend) on Renfrew Creek grew well and maintained the slope. However, another series of modified brush layers along a very steep eroding shale bank at Bavis Creek failed because the bank further collapsed and initial establishment and survival apparently had been low.

Flood events during the winter of 1998/99:
At least two large flood events occurred at the San Juan River and tributaries in 1998/99. During late fall of 1998, the largest one created some new side channels,

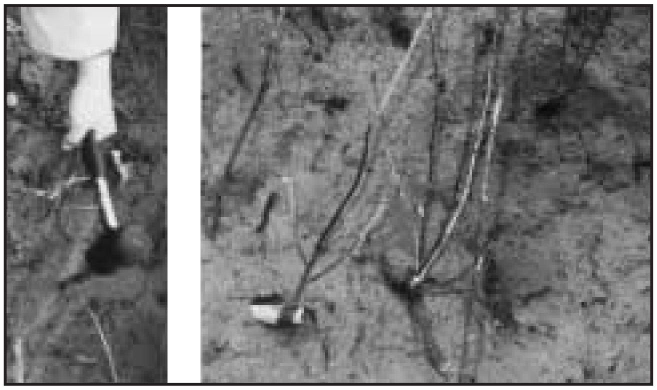

Figure 5. Willow stecklings nailed into near vertical eroding silt/ sand banks and results after first winter floods. This only worked in one area and was unsuccessful elsewhere.

heavily eroded streambanks of meanders, degraded a few sand and gravel bars that had been stable for many years, and removed large logs and roots which had not shifted for several years. These same events are believed to have shifted much of the low-bench felled alder, which then settled on some of the newly-planted seedlings, as shown in Figure 4. One partly planted sandbar on the San Juan River, near Harris Creek, was decreased in height by approximately 20 to 60 cm. This removed most planted and, by then, well-rooted willow stecklings (Figure 6) as well as a few experimentally planted conifers. Some older patches of naturally established willows remained, because they were more deeply rooted. Gravel bars containing mostly gravel and cobble sizes with little sand were found still to have living, well rooted willow cuttings. Tops and upstream cutting portions, however, were often severely ground off or damaged by gravel and cobble movement. Judging by similar natural willow occurrence, however, it is likely that cuttings will slowly grow and establish themselves in spite of specific mechanical grinding damage.

Figure 6. Willow stecklings well-rooted during first growing season but washed out by bar degradation in late 1998 flood events. They are all still attached by their longest roots.

Sandbars:

Most willows planted on sandbars or sandy portions of gravel bars survived severe flooding well, and with further sand aggradation, as expected and desired. On some areas this sand aggradation was only a few centimeters, partly burying the new shoots. On other areas, aggradation was so heavy that only the tips of last year's growing shoots were visible. By far the heaviest sand aggradation occurred on the machine-planted crossover-bar, where last year's new shoot growth had been the tallest and densest. Up to 80 cm of sand was deposited between the new willow growth and in some cases plants were totally buried. Because of the well established root systems, now buried far below, it is expected that new growth will emerge, more roots will develop along recently buried stem portions and further bar stabilization will occur. It remains to be determined if the much shorter red osier dogwood, stink currant, hardhack and Stachys cooleyi will be able to re-emerge from a covering of sand. Petasites palmatus is expected to emerge, because it appears to be more adapted to such environments, and can generate long, thick underground rhizomes. Planting of the river bars with willows appears therefore to be achieving the intended results of trapping fines and reducing unvegetated channel widths (Figure 7). Small red cedar (PSB 415) planted on one grassy section of a sandbar, survived but are not growing well.

Figure 7. Natural willow patch demonstrating how fines and debris get caught and settle out on a bar.

1999 OPERATIONS:

Initially, additional crew time had to be spent bucking out access roads and trails due to recent windfalls and logs having settled across access roads during major flood events. As in 1998, an aluminum riverboat with Yamaha jet drive was hired for planting access. Because of last year's success with planted willows, and the relative ease of such plantings, most of the

Feature

1999 operations were centred around further river bar stabilization with willows and a few cottonwoods. Since planting and growth success had been greatest with machine planting by a small backhoe, one accessible small bar near the Harris Creek - San Juan confluence was planted, using the same machine and experienced operator as in 1998 (Figure 8). Most of the still unplanted riverboat-accessible bars were hand-planted by the crew. Because of the good 1998 survival rate, the 1999 planting distance for hand-planting was doubled, to about 2 feet. This also achieved more overall area coverage. Most of the cuttings were obtained from adjacent growth, but additional material had to be obtained from the Camper Creek and Airline Road area. To better determine future river bar aggradation or degradation, coloured nails were permanently placed into trees along the two road-accessible river bars. Accurate measurements were then made using a level, so that present bar heights and widths at specific points could be mapped for future reference.

Figure 8. Machine planting in 1999, using large (1m and larger) willow and cottonwood cuttings.

Summary of Work: 1999

Hand-Planted

Willow Stecklings	74,306	
Cottonwood	5,631	
Red Osier Dogwood	300	(rooted plugs)
Spirea Douglasii	200	(rooted plugs)

Machine Planted

1m long Willow Cuttings	5,175
1m long Cottonwood	255

Bank Stabilization at Bavis Creek

Willow cuttings	300
Wattle fences	2
Modified brush layers	2

Total Bar Planted	85,867
Total Hectares	9.15
Stems/ha	8,791
1998 Bar/Bank	191,170
1998 Total Hectares w/o bank	5.3
1998 Stems/ha	36,069

Each bar has also between 6-10 buried waste cutting rings.

Other

3 days cutting willows at Camper Main and Airline Road.

Person-days planting and cutting Willows: 229 (not counting overhead support).

Cost per planted cutting: $ 0.46.

Girdling Alder to Release Conifers

1 ha / 7 man-days.

2 crew days opening access

1 crew day brushing vine maple and other brush at Lens Creek to release planted conifers.

1 crew day removing driftwood from planted conifers and cabling some alder and cottonwood logs at Harris Creek.

River Bar and Bank Planting of Willow, Cottonwood and Shrubs

Combined 1998 and 1999: 277,037, 14.5 ha

Total girdling of alder 1998 and 1999: 7.9 ha

Total felled and planted 1998: 7.0 ha

Acknowledgements

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Technical Tip

RESTORATION OF FISH HABITAT AND WATER QUALITY REQUIRES RIPARIAN SILVICULTURE

V.A. Poulin and B. Simmons

Forest Renewal BC has placed watershed restoration practitioners on notice that watershed restoration efforts in the future will be aimed at high impact watersheds where fish habitat and water quality are at risk. The message is clear: there is less funding available for projects and the funding that is available must be invested wisely and aimed at restoring those conditions that have resulted in loss of fish habitat and degradation in water quality. The key question is, what will benefit water quality and fish habitat most in damaged watersheds? Habitat specialists can re-establish log structures in streams to rehabilitate fish habitat, and willows can be planted on eroding banks to stop sloughing. However, these efforts are temporary. Although they speed the natural recovery of streams, they do not to solve the underlying problem. Restoring water quality and fish habitat means addressing the root of the problem. This means that it is essential to stop sediment supply and to return mature forest characteristics to riparian areas in the fastest possible time.

WHY RESTORE RIPARIAN AREAS?

Few people fully understand either the role of riparian forests in creating and maintaining fish habitat and protecting water quality, or the underlying need for riparian restoration. In the past, it was common practice to log to the edge of streams and rivers. The result of this removal of all merchantable trees from streamside areas was that many of the riparian attributes needed for fish habitat and protection of water quality were lost. For example, large trees that fall into streams create habitat features that are critical to the spawning, rearing and over-wintering requirements of many fish. Trees also influence the geomorphology of streams in so many ways that water quality and channel stability are inextricably linked. Fallen trees stabilize the beds and banks of streams and slow the movement of sediment. Root networks provided by long-lived, deeply rooted tree species are critical for preventing erosion and reducing sedimentation. Such strong roots hold the banks of rivers and streams together, resisting undercutting and bank loss. Vegetation on floodplains dissipates the energy of flood events, reduces erosion and thus lessens the potential for channel alterations. Vegetation also captures sediment and bedload and aids in floodplain development.

TIME IS OF THE ESSENCE

In the absence of vegetation management, many undesirable stand characteristics will persist in riparian corridors. This will either slow or prevent the recovery of important ecological attributes needed for fish habitat replacement and bank and channel stability. On behalf of International Forest Products (Interfor) and the Watershed Restoration Program (WRP), the authors examined portions of four coastal watersheds over the past year to assess the condition of riparian stands and to develop riparian restoration prescriptions. Riparian stands were mapped and broadly classified into one of five riparian vegetation types (RVTs). These were:

- RVT 1. understocked plantations and brush sites
- RVT 2. overstocked conifer plantations
- RVT 3. conifers overtopped by deciduous trees
- RVT 4. deciduous dominated stands lacking conifers
- RVT 5. mature stands or stands not requiring restoration

The results of the assessments are illustrated in Figure 1. Overstocked conifer plantations (RVT 2) and conifers stands overtopped by deciduous trees (RVT 3) were the most frequently encountered riparian stand types. The vast majority of overstocked plantations were commercial plantings of Douglas fir, Sitka spruce and, to a lesser extent, western red cedar. These were heavily infilled by western hemlock or other naturally seeded conifers. Conifer densities in these areas reach 2,000 to 7,000 stems per hectare (sph). The second most common stand type encountered were alder-dominated areas with varying amounts of suppressed conifer understory. Conifer densities varied from sparse (200 sph) to over-stocked (2,000 sph) and growth was stalled due to lack of light and to competition from understory shrubs. Trees in high densities compete for space and nutrients, resulting in smaller trees, high crowns, reduced root mass, and lower structural diversity. Although each stand type provides some level of functionality, stand conditions today will prevent or slow down the development of forest characteristics most needed to achieve restoration of fish habitat and watershed stability such as big trees and strong root systems. Overstocked conifer stands are especially at risk as high densities do not allow the stand to develop windfirm characteristics. Without

Technical Tip

controlling stem density and developing the ability to resist windthrow, many overstocked plantations in reserve zones will experience blowdown. The result will be continued destabilization of streambanks and sediment production – two factors that will seriously impede restoration of fish habitat and water quality. A further concern is the burden these stands will place on resource managers when harvesting takes place in adjacent areas in the future. Keeping high risk reserve zones standing will be costly.

That is the bad news. The good news is that the vast majority of elements needed for successful restoration of riparian areas are presently in place, and riparian silvicultural activities can be highly successful in reversing negative trends in stand composition and stand characteristics. Riparian silviculture can yield large trees in 25 to 50 years; this can be done economically by simply spacing and brushing. These practices can also make it possible to improve many components of biodiversity and wildlife habitat. However, time is not kind. The older the stand, the more difficult and risky it is to evoke change.

RESTORATION OPTIONS : ONE-ENTRY SYSTEM

Results of our assessments suggest that the most economical and effective way to restore riparian function in coastal watersheds is to focus riparian silvicultural treatments. Specific stand treatments vary with age and stand type, but significant improvements

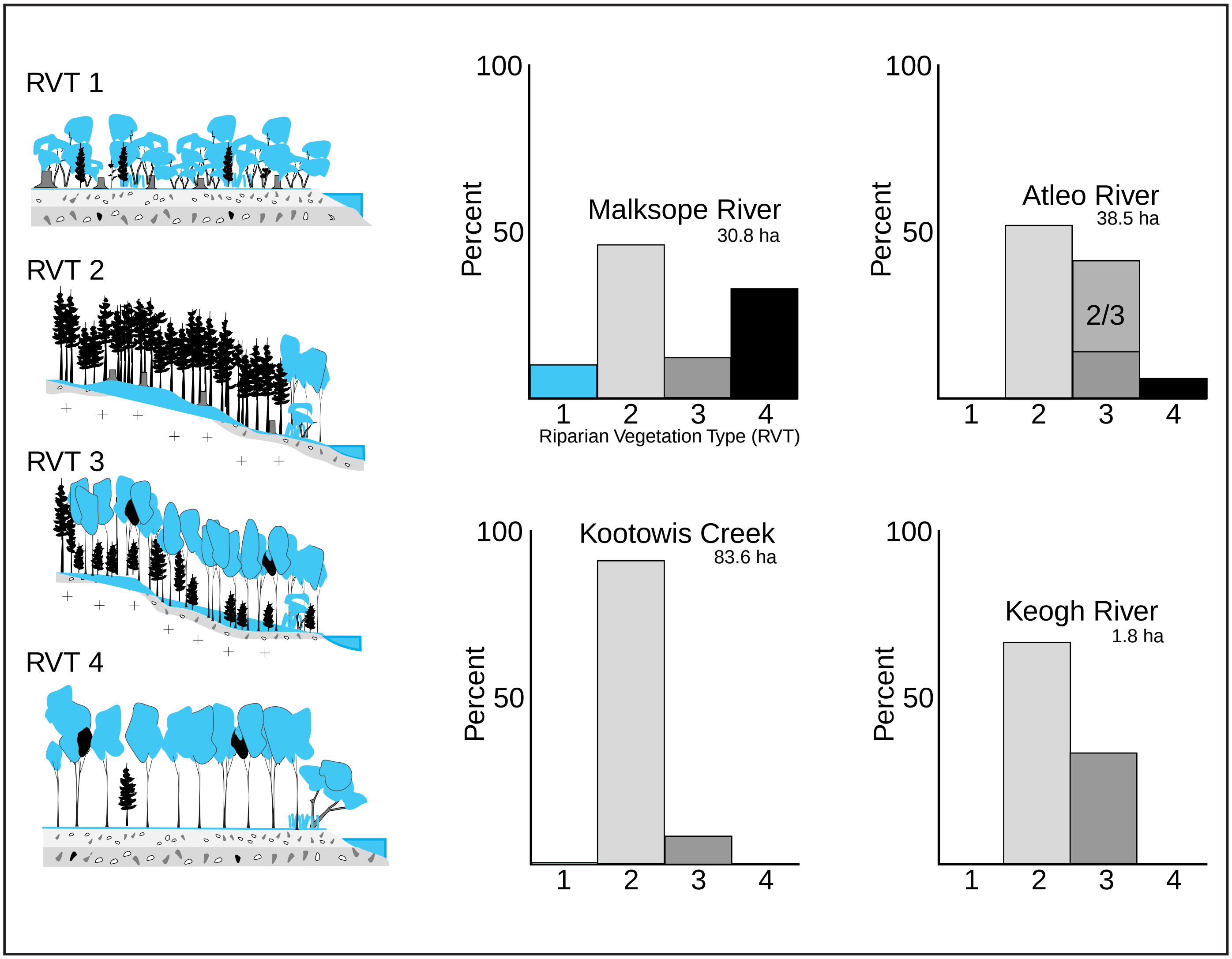

Figure 1. Percent distribution of four riparian stand types (RVT's) used to classify treatment areas in four coastal stream systems.

in the growth of conifer and deciduous trees can be realized by spacing, thinning, and where necessary, fertilizing. This is a one-time entry system that takes advantage of existing conifer and deciduous stocking. Overstocked conifer plantations were the dominant stand types present in our watersheds and improvements in tree height and diameter can be achieved by thinning and brushing. The second most frequent stand types encountered were deciduous-dominated areas that contain varying amounts of conifer understory. Where conifers are present they can be released by felling or girdling the overstory and brushing if necessary Another approach is to manage for large alder while achieving partial conifer release, or to simply manage for large alder where there are no conifers. These are all one-entry treatments.

Although planting is a valid restoration treatment, it should be considered only in special circumstances. It is the most costly and risky of riparian treatments, and it requires monitoring and brushing for several years after treatment. In watersheds where portions of plantations have failed due to high brush competition, it may be preferable to leave these areas as natural openings, which are desirable components of biodiversity. They provide important forage to wild-life and allow sunlight to reach adjacent spaced stands.

BENEFITS CAN RETURN RAPIDLY

Riparian restoration may take longer than quick-fixes, but is it the only fool-proof method for mitigating long-term damage to fish and fish habitat in watersheds that have been destabilized by logging. Since the size of conifer trees can be doubled or tripled in as little as 50 years, the benefit cost of riparian silviculture may be the highest of all watershed restoration treatments. Brushing and spacing costs range from $2,000 - $3,000/ ha, depending on the area. Assuming an average reserve zone width of 30 m (S1), 200 m of reserve zone or 6.7 - 10 km of stream can be treated on one side of a river for under $100,000. This will provide 165 to 240 person-days of rewarding work for a displaced forest worker, or keep a crew of five going for nearly two months.

In the interior the situation can be different. An assessment undertaken on the Little River, near Likely, B.C., required us to modify our classification approach slightly to consider different problems. There, planting was an important riparian prescription. It was needed to rebuild the conifer stocks in the riparian reserve zones where plantations had failed due to forest health problems such as frost, insects, browsing and diseases. We also recommended cottonwood be added to the stand to provide protection to conifer seedlings, improve biodiversity and develop large wood quickly.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to those who made it possible for us to become part of the team working towards restoration of riparian areas. Warren Warttig of International Forest Products Ltd. saw the need for riparian restoration on the Malksope River, Atleo River, Kootowis Creek and Buck Creek. Karen Campbell, of Weldwood of Canada Ltd., gave us the opportunity to apply our coastal experience to an interior situation at Little River. Special thanks to Wendell Koning for welcoming ongoing input to development of the riparian assessment field guide, and to Heather Deal of the Watershed Restoration Program. Heather created opportunities to work on the Squamish River, Slesse Creek and Keogh River. Each and every one of these projects has improved our understanding of forested riparian ecosystems and how they can be modified to restore riparian function.

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Update

Conferences

AFS Annual Meeting. August 29 - September 2,1999. Adams Mark Hotel, Charlotte, N.C. Contact Betsy Fritz: Tel: (301) 897-8616, ext.212; or e-mail: bfritz@fisheries.org

Canadian Water Resources Association, *Confronting Uncertainty: Managing Change in Water Resources and the Environment.* Oct.27-29, 1999 at the Delta Airport Hotel in Richmond. This conference will offer sessions on watershed management, fish stocks and habitat, forestry hydrology, groundwater, regulatory issues, recreation, water supply and quality, and other topics. For registration information, please contact Mr. Brian Hughes: Tel: 604-980-6011; or e-mail to bhughes@nhc-van.com

Strategies: Empowering the Forester, March 1 - 3, 2000. ABCPF 52nd AGM Millenium. General enquiries should be directed to the Team 2000 Host Committee at 1595 Fifth Avenue, Prince George, B.C. V2L 3L9. Tel: 250-962-6160, Fax: 250-962-6614, or e-mail: team2000@indforserv.bc.ca

Workshops

Rehabilitation of Forests in the Okanagan: Sites, Policy and Productivity July 7 - 9, 1999. Okanagan University College in Kelowna. The first day will include a BEC system presentation. The next day, there is a tour of the Vernon area, including a stop at a landslide rehabilitation site that used bioengineering, a visit to a wastewater irrigated hybrid poplar and vegetation site and a winery tour. The third day tours the Okanagan Falls area looking at site and soil classification along BEC transects and visiting landing rehabilitation with wood wastes.

Information

"Riparian Situation Analysis". Ministry of Forests is currently developing and reviewing policies regarding management in the riparian zone. For further information please contact: Brendan.Holden@gems3.gov.bc.ca.

Websites

The following websites may be of interest to Streamline readers:

The Stream Team http://www.stream.fs.fed.us

USDA Forest Service Fish Ecology Unit http://www.zmariner.com/fs/feu/index.html

Watershed Management council http://glinda.cnrs. humboldt.edu/WMChome

Forest Renewal websites:

http:/www.env.gov.bc.ca/fsh/wrp/index.html - digital copies of FHAP, CCPA, RAPP forms and RAPP field instructions and MSACCESS data capture tool for FHAP

http://www.env.gov.bc.ca/fsh/wrp/links.html - links to WRP bookshop, watershed codes, RIC publications, the TRIM program, the Forest Practices Code

http://www.publications.gov.bc.ca - Queens Printer publication information

http://habitat.pac.dfo.ca/heb/content.htm DFP Habitat and Enhancement Branch homepage - directions to DFO's habitat restoration programs, to streamkeepers information and to community involvement and programs.

Streamline

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Streamline's goals are to communicate information on practical approaches to watershed restoration including the rehabilitation of stream channels, riparian zones and hillslopes, and to act as a link between geographically separated WRP proponents and their contractors by facilitating the sharing of information and ideas between the regions of B.C. We rely on our readers' participation. Please send articles and project descriptions (with relevant photos and drawings), as well as information for our "Update" section. We reserve the right to edit submissions for appropriate content, style, and relevance to the Technical Bulletin.

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