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Participants at the BC - US Technical Exchange visiting a recent rip-rap and LWD treatment of an eroding bank at the West Kettle River near Beaverdell. (Work completed by Attrill Woodworking Services.)

## INTEGRATED WATERSHED PROJECTS

### Upper Grande Ronde River Watershed Restoration: Past, Present, And Future

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#### **Purpose**

This paper examines a case example of a watershed planning effort in the upper Grande Ronde River drainage, and describes how it can be used as insight for current large scale efforts. Having been both criticized and acclaimed, the plan is worthy of review; more important, it has survived to become an active restoration vehicle. More than 10 years of continuous effort have been put into the plan, and it served as a blueprint for several million dollars in restoration effort on public and private lands.

Wallowa-Whitman National Forest experienced a series of drought years in the late 1980's and early 1990's. The loss of two year classes of spring/summer chinook salmon and steelhead that belong to the Snake River stock was caused by the Tanner fire in the watershed, which burned 3,900 acres (1580 hectares) and adversely affecting the majority of the main-stem anadromous fish habitat. There was a period of controversy (1989 to 1995) between the multi-discipline, multi-stakeholder agencies that sponsored the development of a plan, and the Forest Service group. In 1992, the Upper Grande Ronde River Anadromous Habitat Protection, Restoration and Monitoring Plan (UGRR Plan) was presented. Over an eight year period, the US Forest Service gave various reasons why the UGRR Plan could not be officially implemented. This was a classic example of unsatisfactory linkages between scientific, social, political, and management levels. Certain stakeholders were disappointed that the plan that they had spent time and effort to develop, was not implemented officially.

In 1995, the UGRR Plan was converted into a working paper called the Upper Grande Conservation Strategy for Endangered Snake River Spring Chinook Salmon. It covered the strategy until October 1, 1999. Although it had not been implemented officially, the personnel of the La Grande Ranger District used personal initiative to conduct an extensive watershed restoration based on the working paper. Several million dollars have been spent to close roads, change grazing practices, work

with landowners, conduct timber salvage, reduce fire hazard, restore streams, and change recreation sites and practices, in an effort to improve the watershed. Much of the funding was acquired through partnership funds, and the plan enabled partners to understand the need and priorities for projects proposed by the district. Extensive road, forest, fire hazard and stream inventories have also been conducted to design new projects to improve baseline conditions.

Based on what we have learned from the UGRR Plan, a model for watershed restoration implementation has emerged. It is necessary first to develop a plan with clear purpose and objectives. Second, a description of the watershed needs must be written in enough detail to provide understanding of its relationship to the natural resources and their uses. Projection of desired future conditions can be developed based on baseline resource condition inventories and the best scientific information available. The plan should be officially supported and endorsed by the forest leadership, and shared with tribal, state, and public participants whose input, support, and matching dollars can greatly enhance the project's success. The period following the end of Fiscal Year 1999 may bring substantial changes in the way funds are allocated to the US Forest Service to do its work. The national directions for management emphasize watershed and water quality restoration instead of only traditional commodity values including timber. ▲

### San Juan Integrated Restoration

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The San Juan Watershed Agreement establishes a cooperative and jointly managed program with the objectives of protecting, improving, and replacing fish habitat and fisheries-related recreational opportunities. This agreement concerns the 665 km<sup>2</sup> drainage of the San Juan River, located on the southwest coast of Vancouver Island approximately 80 km west of Victoria. The main valley lies east-west and has been eroded along a major fault line with different terrain and geology to the north and south. The south side of the drainage is composed of easily erodible sedimentary rock, while the north side is composed of more stable intrusive and volcanic rock. The length of the San Juan River is just over 50 km and is composed of two

distinct types of stream channel morphology. Most of the streams, particularly the headwater reaches, are steep bedrock/boulder-controlled channels. The other channel morphology type is a 1-2 km wide floodplain found in the lower 10 km of the San Juan mainstem.

The agreement for the San Juan Watershed recognizes both the economic and social values provided by forest management, and also that fulfillment of private property rights includes protection of publicly-owned environmental values such as fisheries, water quality, and water quantity. It was signed on August 1, 1995, and will terminate on December 31, 2001.

The parties to the agreement recognize that there has been significant improvement in forest practices, especially during the last three years. The agreement builds on this positive change by developing a comprehensive fisheries restoration and enhancement plan for the entire San Juan watershed. The plan has been adequately funded, professionally implemented, and cooperatively managed by the parties.

The ownership in the San Juan watershed is approximately 44% Crown. The remaining 56% is privately held, of which 11% is managed within a Tree Farm License (TFL) by TimberWest Forest Limited. TimberWest holds 86% ownership interest in the non-Crown watershed lands, and MacMillan Bloedel holds the remaining 14%.

To meet FRBC objectives, it was necessary to obtain input and develop a cooperative planning process that included other interests in the San Juan Watershed. As a result, the FRBC Steering Committee was created to advise and make recommendations regarding the projects to be carried out on the Crown land portions of the watershed.

Representatives on the committee include:

- Pacheedaht Band
- Sooke Renfrew Forestry Society
- San Juan Enhancement Society
- Cowichan Lake Forest Coop
- Renfrew Community Association
- IWA

The San Juan integrated restoration work has involved the preparation of base maps and terrain mapping, stream enhancement activities, slide restoration assessment, road deactivation, gully and slide rehabilitation, riparian plantings, and construction of instream habitat rehabilitation works.

To provide an excellent workforce that was able to work on this and other projects in a safe and productive manner, a training proposal was developed by the FRBC Steering Committee. The training, completed during the fall of 1997, involved native and non-native individuals from the Port Renfrew area. The course had 16 components, covering a variety of subjects such as first aid, basic forestry, vehicle and helicopter

safety, power saw operation, basic mapping, fish habitat assessment, fire suppression, supervisory skills, and other related topics. A total of 26 individuals took part in one or more of the individual course components for a total of approximately 1,832 hours of training. The individuals who participated in the training have been involved in a variety of projects in the San Juan Watershed as employees of the Pacheedaht Development Corporation.

The cooperative and jointly-managed program in the San Juan Watershed is, and has been, successful in protecting, improving, and replacing fish habitat and fisheries-related recreation opportunities. The watershed restoration plan has been adequately funded, professionally implemented and cooperatively managed by the parties. The work-to-date has created employment, and the working partnership has resulted in increased stewardship for fisheries resources throughout the San Juan watershed. ▲

## Windermere Creek Restoration

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The restoration efforts for Windermere Creek owe their success, in part, to area residents and a multitude of vested stakeholders who are dedicated participants in these local initiatives. The various partners remain committed to the successful management of the Windermere Creek Watershed.

Windermere Creek is a fifth order tributary of the Columbia River. The lower reaches of the creek flow directly through the community of Windermere, located in the East Kootenays of southeastern BC. The mainstem flows 27 km from its origin in the Stanford Range of the Columbia Mountains to its confluence with Lake Windermere. Windermere Creek is the largest tributary to the lake, and is a regionally important fish stream. Extensive human land use activity in the Windermere Creek Watershed includes crown land forest harvesting of 16 percent of the total watershed area, access development (highway, secondary and forest roads), two open pit gypsum mines (one active), gravel pits, agriculture, recreational (golf course, camp grounds), and residential development. Windermere Creek is under review for "Community Watershed" status, as it provides water for agricultural use and for local native communities (it incorporates a portion of Columbia Lake Indian Reservation #3).

The watershed is within licensed guide-outfitter and

trapper territories; it provides important wildlife movement corridors for a number of species. (See multiple stakeholders, Figure 1.) Backcountry recreation activities in the Windermere Creek Watershed, such as hiking, fishing and hunting, are popular pursuits for local community members. The area offers berry picking sites close to local communities. Karst topography features provide unique swimming opportunities at a “bottomless” sinkhole. The watershed is of spiritual significance to the native community of the Columbia Lake Band.

Resource extraction and developments have resulted in considerable adverse impacts to the water, habitat, and channel conditions of Windermere Creek. A watershed prioritization completed by Ministry of Environment, Lands and Parks recognized the uniqueness of Windermere Creek due to its importance to a broad range of concerns and interests. The need for restoration was considered high at both the local and regional levels. Restoration strategies were developed to ensure a watershed restoration process that was integrated overall, and which incorporated the interests of multiple stakeholders. Restoration was funded through Forest Renewal BC, in partnership with Slocan Forest Products, Radium Division, and Ministry of Environment, Lands, and Parks.

Overview Interior Watershed and Fish Habitat Assessment Procedures (IWAP and FHAPs) were conducted in 1997 to provide a preliminary assessment of the location, nature, and extent of the effects of human impacts on the watershed and affected habitat. Based on the results of the overview studies, a Level 1 FHAP commenced in late 1997/early 1998, concurrently with a Channel Condition and Assessment Procedure (CCPA), to provide more detailed information on the watershed, and to identify specific restoration opportunities. A multitude of associated plans and reports were reviewed by the BC Environment, the licensee, and the consultant, to ensure coordination with other initiatives and existing data. These included timber resource plans, access management plans (development and deactivation), lake studies, historic stream discharge information, fish population information, water quality studies, and community plans. Ultimately, a coordinated effort among biologists, foresters, engineers, and hydrologists was used to develop high priority restoration prescriptions for Windermere Creek.

Restoration activities have been completed at seven high-priority sites. These includes stream bank stabilizations and revegetation applying bioengineering techniques; stream bank revetment and sediment controls; fish passage barrier removals and gradient controls; and construction of an inlet catch basin and drain system for diversion of a spring-fed discharge. The project employed ‘standard’ restoration techniques, including v-log weirs, large woody debris placement and tree revetment, boulder cluster armoring, live

cutting placement, revegetation techniques, and construction of an inlet catch basin/drain system. Stakeholder support of these prescriptions and activities was due, in part, to the time and effort taken to provide education and to disseminate information in the planning stages. An important aspect of the Windermere Creek restoration was that in all possible cases, the project employed displaced forest workers, who also received new skills training.

Readers should refer to Streamline Vol. 3 No. 4, page 1, for further information, including technical details of restoration work on Windermere Creek. ▲

## FOLLOW-UP CASE STUDIES

### Kingfisher Creek Restoration for Endangered Middle-Shuswap Coho

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The Kingfisher Creek Watershed includes both Danforth and Hunter’s Creeks in addition to the mainstem river. It drains an area approximately 750 km<sup>2</sup>. The watershed lies within the Interior Cedar-Hemlock biogeoclimatic zone. The drainage flows from north to south and enters the Shuswap river east of Enderby, B.C., near the outflow from Mabel Lake. This area is heavily used for recreation, tourism and timber harvesting.

Both rainbow and bull trout populations are resident in the watershed, and there is evidence that adfluvial rainbow trout from Mabel and Mara Lakes use all three creeks for spawning. Anadromous salmonids in the watershed include a threatened population of coho salmon, as well as small numbers of chinook and sockeye salmon that periodically use the lower reaches for spawning.

Kingfisher Creek was chosen as the representative (demonstration) watershed for the northern portion of the region because of its salmon population. Future WRP projects are likely to use the structures and techniques established here as templates for other works related to interior coho salmon. The partners

involved in this project were: Riverside Forest Products Ltd., Lumby Division, Ministry of Forests, Kingfisher Environmental Interpretive Centre Society, and Spallumcheen First Nations.

The objectives of this project were to:

- provide off-channel spawning, over-wintering, and rearing habitat for resident rainbow trout and coho salmon;
- provide instream spawning and rearing habitat through the re-establishment of large woody debris-boulder structures;
- provide stream channel and floodplain stability to reduce the input of sediment and prevent channel avulsions; and
- provide template structures and techniques to be used in other restoration projects throughout the Kamloops Forest Region.

Preliminary feasibility studies indicated species presence and distribution and provided potential areas for restoration projects. Due to fisheries work window timing restrictions, prescriptions were refined in the field with assistance from P. Slaney, R. Finningan, B. Symonds and B. Franz, and then implemented in 1998.

The rehabilitation work included:

- Development of off-channel spawning and rearing habitat within the floodplain of the lower reach of the Kingfisher Creek mainstem. Using a combination of groundwater sources (0.05 m<sup>3</sup>/s) and a controlled surface water diversion (maximum of 0.85 m<sup>3</sup>/s), 1,200 m of channel and 6,000m<sup>2</sup> of pond habitat were restored. Habitat complexing within this channel included the development of riffle, run, and pool sequences using a variety of rock and woody debris structures. The techniques used were chosen for their applicability to the specific hydraulic conditions of each reach, and to the creation of diversity, and for demonstration purposes. Groundwater sources were natural, perennial springs. The surface water diversion included a 1000 m<sup>2</sup> settling pond and head-gate protected by a 3.5 m berm from freshet flows.
- Upgrading of fish access throughout the groundwater channel adjacent to Hunter's Creek at 10.5 km on the Forest Service Road. This included the hand-placement of rock, minor excavation of the channel, and the addition of 75 discarded pole saplings as cover for the rearing ponds. Trails were also upgraded and 5,000 willow whips were planted throughout the site.
- Stabilization of 200 m of Danforth Creek's eroding channel bank under the BC Hydro right-of-way at 12 km on the F.S.R. There were 1,500 m<sup>3</sup> of overhanging and under cutting bank removed, 500 m<sup>3</sup> of rip-rap (>0.5 m diameter) placed, 24 pieces of LWD (>0.5 m diameter X 10 m length) and 5 rootwads (>2 m diameter) placed within this reach. This

created 3 triangular debris catchers, 1 Newbury riffle, 50 m of lateral debris jam and 75 m of protected streambank. Intensive bioengineering revegetated 1 ha of riparian zone with low-growing willow species (BC Hydro requirement).

- Restoration of instream fish habitat throughout a 250 m length adjacent to a bridge crossing of Danforth Creek. Work included the construction of 2 Newbury riffle structures, 4 triangular debris catchers, and 25 m of lateral debris jam.
- Excavation of three (50 m<sup>2</sup> by 1 m deep) off-channel ponds in a spring-fed side channel to Danforth Creek under the BC Hydro right-of-way. Habitat complexing in these ponds includes the addition of woody debris (40% surface area cover) and grade controls to maintain pond depth. Sixty-five pieces of LWD were added to 450 m of the mainstem channel to provide instream fish habitat features and bank and floodplain stability. These were used to augment the few remnant LWD remaining from right-of-way construction 25 years ago.

The total project costs were \$155,500. In all, it restored 1,500 m and 6,125 m<sup>2</sup> of off-channel and 1,000 m of instream spawning, rearing, and over-wintering fish habitat; It also created 356 person-days of employment. This project has the potential to produce an estimated 12,910 coho smolts and 1,633 rainbow trout juveniles annually, if recruited to capacity. To determine the success of the restored habitat, long-term monitoring should be implemented to assess habitat use, and thus refine fish habitat restoration prescriptions for southern interior watersheds. ▲

## Various Thompson Restoration and Enhancement Projects

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There has been a sharp decline in the numbers of the Thompson River coho over the past several years, due to historic over-harvesting, changing ocean conditions, and cumulative habitat loss. Unfortunately, ocean conditions are uncontrollable, but freshwater habitat conditions can be restored and protected. The Department of Fisheries and Oceans (DFO) uses a variety of techniques to improve freshwater fish habitat conditions. Riparian restoration is one of the key techniques used. This includes not only bank stabilization and erosion

control, but also planting and setback fencing to re-establish a riparian corridor. As well, side-channel work provides extremely productive habitat and is used to aid in naturally maintaining stocks where the mainstem is in poor condition or is under recovery. Another component of the DFO strategy is to undertake strategic fry and smolt release programs in areas of grave conservation concern. ▲

## **Marchant Riparian Restoration Project in Harris Creek, Lumby, B.C.**

The Harris Creek system is subject to urban/industrial, forestry and agricultural impacts. As a result, much of the riparian has been lost and the stream banks have become unstable.

As a trial of the North American Green P300 geotextile technique, a 130 meter site was selected on Bloom Road Farm immediately downstream of the confluence of Brett Creek and Harris Creek.

The bank, composed mainly of top soil, clay, and sand, was nearly vertical, and in some cases had a negative slope. It was pulled back at approximately 1:3 slope and a setback trench was dug at the toe to key in the rock. Due to the March/April timing of the project's construction, there was a requirement for zero sediment discharge from the work site. To address this, a small berm was left between the river and the trench so that the rock could be placed in isolation from the main stream flow. A 3 hp. gas pump was used to drain water from the trench to allow for displacement when the rock was placed. Logs with rootwads were buried into the bank at approximately 15 meter intervals to add habitat value to the rock used at the toe of the slope.

Partners in this project include the Department of Fisheries and Oceans, Forest Renewal BC/Watershed Restoration Program, Bloom Road Farm, and River-side Forest Products. ▲

## **Avola Creek Pond Project in Avola Creek, Avola, B.C.**

Historically, the Avola Creek Pond was used as a log sort until the mid-1970's. Since then, the community has made use of it as a swimming area. Due to its previous use for log sorting, excavation to increase the pond's depth was not a feasible option. However, it was possible to raise the pond's level to increase water depth. A berm constructed of pit run material was armoured and planted with native plant species. This

increased spawning and rearing habitat by an additional 60 meters. In the fall of 1998, six pairs of coho were observed to be spawning in the expanded habitat; the total run for the creek was approximately 25 pairs.

The CN Rail tracks are adjacent to the project and there were several thousand concrete rail ties stacked for disposal. Approximately 300 of these ties were sandblasted to clean them, and used to construct a variety of structures, including islands and uncut banks. The ties also provided excellent anchor for the woody material that was placed in the pond.

Partners in this project include the Department of Fisheries and Oceans, Weyerhaeuser, CN Rail, and the Community of Avola. ▲

## **Salmon River Smolt Pond Project in Salmon River, Falkland, B.C.**

Coho stock status on the Salmon River is extremely depressed; historically escapements were in the tens of thousands of fish, however, in 1998 returns were less than one hundred. Smolt release programs increase the number of fish that normally migrate to the ocean. Salmon River coho are reared in the Spius Creek Hatchery in the Nicola system. To maximize hatchery adult returns to the natal stream, the fish are transported from the Spius facility to the Salmon River and held for a four to six week period for imprinting prior to downstream migration.

The project itself consists of a river intake leading to a settling pond. A small spring that fed into the channel was diverted to enter further upstream. This ensures that as much water as possible will flow through the two ponds that have been constructed in sequence. Typically, one pond will be used for chinook, and the other for coho. As the project was constructed in March, there was a requirement for zero sediment discharge from the work site. This was accomplished using a variety of means. For the intake, an Aquadam and bulk bag diverted the flow, and a pump ensured that there was a net inflow of clean water into the site. At the confluence of the channel and the river, a silt curtain acted as a buffer. On the channel side of the curtain, a diesel-driven pump was used to pump dirty water onto an adjacent field, thereby maintaining an inflow of clean water. As part of site reclamation, disturbed areas were seeded and a straw mulch layer was spread. Planting of both whips and rooted stock has been carried out in the disturbed areas as well.

Partners in this project include the Department of Fisheries and Oceans, Dennis Lapierre (Habitat Farms), and the Salmon River Roundtable. ▲

## NEW CASE STUDIES

**Deschutes Restoration Projects****Beth Sanchez***Fisheries Biologist**USDA Forest Service, Crescent Ranger District**Deschutes National Forest**P.O. Box 208 Crescent OR 97733**Tel: 541-433-3236**e-mail: bsanchez/r6pnw\_deschutes@fs.fed.us*

The Big Marsh and Soda Creek restoration projects were implemented on the Deschutes National Forest in the Fall of 1997. Both systems had been altered by past management; both systems had been used for cattle and sheep grazing in the past; and the channels had been modified for road protection and drainage of Big Marsh for increased livestock forage. The method used to recreate the original stream characteristics was developed by hydrologist Dave Rosgen. This technique was used by the forest hydrologist and fisheries biologists to redesign Soda and Big Marsh Creeks.

Soda Creek was realigned from a bermed, straight, wide and shallow channel to a meandering channel with pools. The restored section of Soda Creek is now 2,000 feet (610m) long, nearly double its former length. Willows were planted, and grass, rush, and sedge seed was collected locally and spread on the disturbed areas.

Big Marsh was privately owned from 1906 until it came under public ownership in 1982. At that time, there were efforts made to remove the ditches that drained the marsh and allowed it to return to a wetland. Three pieces of legislation guided the direction of land management activities in the marsh: the 1984 Oregon Wilderness Act made Big Marsh part of the Oregon Cascades Recreation Area, and the 1988 Omnibus Oregon Wild and Scenic Rivers Act designated fifteen miles of Big Marsh Creek as a recreational river. In 1988, a progressive reversion in the east ditch was accomplished using a water control head-gate. After nine years, plans were made to totally block off the east ditch. The head-gate was removed, and a permanent dam was built in its place to maintain water flow into the original stream channel. Several dirt berms and side-channels were also constructed to restore connectivity of the floodplain.

Pre-project monitoring included stream surveys, photo points, low elevation aerial photos, Wolman pebble counts, a longitudinal profile, cross-sectional profiles, and electrofishing. Ongoing, post-project monitoring is repeating these surveys. ▲

**Trapping Creek Routine Monitoring of  
Structures Built in 1997:  
Background for Field Visit**
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The project proponent for this restoration work was Pope and Talbot, Boundary Timber Division, Midway, BC. In 1997, 550 large woody debris (LWD) structures were built in Trapping Creek, based on ten different designs. The structures were placed over 8 km of stream in order to restore pools and instream cover in areas affected by previous riparian logging. Following the freshet in 1998, routine monitoring was conducted to evaluate the performance of the structures built in 1997. Structure stability varied with crew experience, runoff conditions at the time of installation, and also with structure type.

Structure stability improved as the crew became more experienced with anchoring procedures, over a six week installation period. This finding emphasizes the importance of proper crew training prior to instream work.

Higher rates of failure had occurred in structures that were built during an unusually rainy period in September. Increased streamflow from the rainy period created difficult conditions for the anchoring crew. Baseflow conditions were found to be ideal for building stable structures.

Stability also varied by structure type ranging from 65% to 100%, with an overall rate of 82% stable structures. Multiple log structures, including log wing deflectors, log V-weirs, and lateral log jams. The last had the highest rates of stability. From a biological standpoint, the lateral log jams created the greatest benefits, and were associated with scour pool development and substantial increases in instream cover. Log wing deflectors and log v-weirs promoted scour pool development, but did little to increase instream cover. Single log structures, such as cover logs and sediment traps, also had high rates of stability. However, logs that ended up parallel to the direction of flow created minimal hydraulic disturbance and were sometimes associated with additional scour and erosion of streambanks. Cross-stream structures such as diagonal log weirs, were the least stable structures, particularly in the wide upper reach that had lacked riparian vegetation. Failures were due to insufficient ballast, log breakage, and insufficient keying of the log back into the bank. A learning point from the field visit was to avoid use of cross-stream sill logs in widened, unstable channels because they exacerbate instability by reducing channel depth.

In 1998, only three multiple log designs were used: lateral log jams; log spurs placed along outside bends with eroding banks; and meander jams placed on top of existing gravel bars. Anchoring techniques were upgraded to include the use of sufficient ballast, tighter cables, and more connections between the individual components within a jam.



Figure 1. Participants at the BC - US Technical Exchange visiting the Trapping Creek Watershed Restoration Project. ▲

## West Kettle Watershed Restoration Project: Background for Field Visit

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Fish habitat restoration work is being carried out in a 2 km section of the West Kettle River, as part of a larger effort to restore this watershed to a more natural and stable condition. At this site, rainbow trout, mountain whitefish, and red-sided shiners are commonly present fish species. Work will eventually include bankside planting of willows, and riparian planting of conifers and cottonwood trees. The risks associated with fish habitat rehabilitation on larger interior streams made the West Kettle project a good choice as a demonstration site.

### **Triangular Log Jams:**

Eight lateral triangular log jam structures at this site were installed in 1997 to create deep pools and provide overhead cover for fish habitat. They emulate what would naturally be present in this river before human impacts of land clearing for forest harvest and agriculture, Highway 33, and the old rail bed from the now defunct Kettle Valley Railroad. Each log structure was fixed on-shore to a tree base, or deadhead. Then it was

ballasted with 1 cubic meter of boulder per log to provide extra stability to allow for debris accumulation. It was anticipated that each structure would, over time, develop into a lateral log jam. The surface armouring layer beside the structure was removed to ensure rapid scour, which effectively emulates one flood event.

### **Box Groins and Bank Stabilization Structures:**

We installed four box groins in 1998, to provide refuge cover for fish (mainly for resident rainbow trout and mountain whitefish). These consisted of 4 logs secured in a slot near the top of the streambank, sloping downward at an upstream angle to the streamflow. The logs generate pool scour and provide cover for adult fish. Care must be taken to ensure adequate ballasting plus boulder revetment on the upsides of the structure to prevent infilling from scour at the upstream log.

Bank stabilization structures consist of logs secured to the bank, with boulder ballasting to prevent flotation. The logs are designed as a ramp to catch woody debris and armour the bank, similar to natural templates. They are meant to be a softer solution for bank erosion protection, replacing the more conventional rock rip-rap. There are two sets of three bank stabilization structures located near the midsection of the treatment area (installed in 1998).

Additional triangular log jam, bank stabilization and debris reef structures will be constructed to augment fish habitat complexity while reducing bankside erosion. The structures consist of hemlock and larch logs, using rounded river boulders for ballast. In particular, the bank stabilization structures will provide an example to private landowners of the positive benefits of these for reducing erosion along their riverfront farm land. Our work will be followed with increased riparian planting of willows, cottonwoods, and conifers.

### **Evaluating our Success:**

We have installed a total of 20 structures since 1996 and are currently evaluating the success of our work, based on fish counts in this section of the river and compared to an upstream control (untreated) section. To assist evaluation, we have posted signs and have requested that people fill out fishing record cards and drop them into boxes. Initial results from underwater counts of fish have indicated about a seven-fold greater abundance of age >1 yr rainbow colonizing the structures, thus augmenting trout numbers and angler opportunities. (Only one structure, a box groin, failed up to spring 1999, as a result of inadequate ballast on shore.)

For further information contact Phil Epp at Tel: (250) 490-8274, Watershed Restoration Program, Ministry of Environment, Lands and Parks, Penticton. ▲

## Central and Northern Interior Fish Access

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The interior of British Columbia experiences relatively low amounts of rainfall per watershed area and thus the stream widths are generally smaller. This may lead to greater use of culverts for crossing streams. Fish species such as bull trout and grayling are at risk because they tend to use the smaller streams (1<sup>st</sup> to 3<sup>rd</sup> order streams), where culverts have been installed.

Re-establishing the fish passage can be a cost-effective means of increasing the productive capacity of the system. In this discussion (summarized on pages 9 to 12 of this issue of Streamline), there are criteria suggested for prioritizing restoration of culverts and fish barriers based on the FPCI (Fish Passage Culvert Inspections). Habitat gain is the most significant advantage of addressing barriers at culvert crossings. A study on the Skagit River in the Puget Sound area of Washington estimated culvert barriers to decrease summer and winter smolt production by 13% and 6% on a basin-wide scale, however this increased to 44% and 58% production losses in tributary type habitats (Beechie *et al.* 1994).

For further information, please see pages 9-14 this issue of Streamline. ▲



## INNOVATIONS/EFFECTIVENESS MONITORING

### Aquatic and Riparian Effectiveness Monitoring for the Northwest Forest Plan

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The Aquatic and Riparian Effectiveness Monitoring Program for the Northwest Forest Plan is presently being developed by an inter-agency team of scientists and technical staff. It is intended to evaluate how successful the Aquatic Conservation Strategy (ACS) is in restoring the ecological health of watersheds and their aquatic ecosystems. It will determine, based on a rotating panel sampling design, present watershed condition, track trends in this condition over time, and report on the ACS's effectiveness across the region. A conceptual model provides a framework for selection of indicators that, considered in aggregate, describe watershed condition. Indicator information for in-channel, riparian/floodplain, and upslope processes will be evaluated using a knowledge-based decision support system, of which the physical, biological and chemical components and relations are developed by provincial expert panels with local knowledge of system functions. The advantages of the system are that it is a transparent procedure (regarding the data used, assumed relationships between data elements, and the analysis performed), is repeatable, and can be updated easily as better information on relationships becomes available. The product will be a histogram of watershed conditions defined as a probability of each watershed being in a functional state, and, by tracking individual indicator values and representing them as a function of a reference condition. An initial pilot test of these concepts has been completed and results of this approach show promise. This program proposal is in preparation for scientific and agency peer review. Once completed, it will be presented to agency executives for their consideration. ▲

## Breaking New Ground in Riparian Restoration

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Functioning riparian ecosystems are needed for long-term restoration of fish habitat, water quality and channel stability. In watersheds where logging has removed timber to stream edges, riparian attributes critical for creating and maintaining fish habitat and protecting water quality are lost or significantly impaired. Although natural re-vegetation and efforts by logging companies to re-establish vegetation in most watersheds has been successful, it is only the beginning of a complex and very long process of restoring the ecological characteristics required for riparian areas to function properly and for fish habitats to recover.

Riparian restoration is new to British Columbia. Unlike in the Pacific Northwest, where the past 10 years has seen advancements in testing and assessing restoration techniques, B.C. is just breaking ground. Our report provides a brief overview of methods developed in B.C. for assessing riparian stands, and shares with you some of our ideas on restoring these stands.

### Assessment Methodology

- a detailed description of the methodology used in B.C. is given in Koning (1999) *Riparian Assessment and Prescription Procedures (RAPP) Watershed Restoration Technical Circular No. 6*.
- assessments are intended to provide governmental agencies with all of the necessary information for approval to undertake work in the riparian area.
- a brief overview is completed using large-scale aerial photography (1:2,500 – 1:5,000). Riparian polygons in the area of interest are mapped on overlays.
- riparian polygons are stratified into riparian vegetation types (RVT's) with similar riparian restoration opportunities.
- field information is collected to determine the degree of riparian dysfunction and stand condition such as vegetation composition of the overstory and understory, number of stems/ha, heights and diameters of trees, year of harvest, and soils.
- riparian restoration prescriptions are prepared and sites prioritized for treatment.

### Riparian Restoration in Coastal Forests of BC

- overstocked conifer forests and mixed deciduous-conifer forests are two common stand conditions that occur in coastal watersheds.

- these conditions can slow or prevent the long-term recovery of fish habitat, water quality, and channel stability.
- restoration prescriptions are being applied to the riparian reserve zone of logged streams
- the primary restoration goal is to improve the growth and survival of conifer trees, and to achieve the largest size of trees (diameter) in the shortest possible time.
- biodiversity and wildlife objectives influence prescriptions, as stand modifications intended to achieve large wood are those that accelerate the return of mature or old growth forest characteristics.
- target stand conditions include: low-conifer stocking densities, variable density retention, gaps, clusters, largest and most windfirm trees, ecologically preferred tree species, multiple canopy layers, and a component of dead and dying trees.
- prescriptions include: thinning overstocked conifer stands, topping or girdling to create dead and dying trees (wildlife trees and LWD), fertilizing nutrient-poor sites, releasing understory conifers by total or partial canopy removal, and managing for large alder by thinning and planting conifers, willow and cottonwood. ▲

## South Fork Coquille River Wood Placement Project

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This project was completed with an equipment rental contract that pulled over-large diameter conifers from the Powers-Glendale Bike Path route and hauled them about 4 miles, to the upper South Fork of the Coquille River, for instream placement. Rootwads were essential for weight and stability concerns and as natural ballasting. The stream is low gradient, 1% or less, and the tributary watershed above the site is about 8,000 acres. Six standing green trees and numerous downed trees were used. All trees were placed using a mobile yarder with a 1 inch mainline and 5/8 inch haulback line. Numerous straps, blocks and different-sized chokers were used during placement. No fastening cables were used to attach these wood pieces and whole trees. Twenty brush bundles (using damaged tree branches and pieces) were tied with hemp rope after completion of the structures.

Two control and treatment reaches were set up prior to project implementation. Both reaches were physically similar in appearance. During the winter of 1996, a 75-year flood event occurred. Only 4 of 51 marked

and tagged structures were displaced from the treatment area. The rest of the structures piled up and created log jams where the lining tree structures were located. These log jams have provided abundant cover for native cutthroat trout. Results from Level III monitoring efforts indicate treated areas have increased P:R ratio, increased pool depth, increased pool volume, while decreasing surface area. In addition, gravel recruitment covered bedrock and re-attached the flood plain. ▲

rehabilitation for juvenile salmonids in streams may partly counteract recent dramatic and persistent declines in survival observed in freshwater and marine life stages.

For more information, please see: Stream rehabilitation in British Columbia's watershed restoration program: juvenile salmonid response in the Keogh and Waukwaas rivers, 1998. Province of British Columbia, Ministry of Environment, Lands and Parks, Watershed Restoration Project Report No. 12. ▲

## Steelhead and Coho Responses to Habitat Structure Setting

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The effectiveness of stream habitat rehabilitation was evaluated in year two of a five-year program in the treated (logged and rehabilitated) watershed, the Keogh River, compared to the neighbouring and untreated (logged, no rehabilitation) watershed, the Waukwaas River.

Anadromous salmonid density and growth were compared in untreated and treated reaches of the Keogh River, which contained a variety of stream habitat structures as well as fertilized and unfertilized sections. Treatments were added annually to previously untreated reaches, starting upstream and working downstream with various placements of structures, and starting downstream and working upstream with an annual addition of slow-release fertilizer, incrementally from 1997 to 1999.

Significant increases were found overall in steelhead parr and fry abundance and coho fry abundance, at the watershed level, and in reaches treated with rehabilitation structures, compared to untreated controls both within and between watersheds, despite low levels of adult escapement.

Detailed analyses of structure usage by species indicated variation from year to year; climatic factors (stream discharge) may have influenced annual variations in species and age-class distributions. A diversity of structural types appears to provide an optimum strategy for habitat rehabilitation, rather than singular types. Analysis of salmonid growth in-stream continued to indicate that significantly larger salmonids were found in fertilized sections. Results indicate that habitat



An example of fish barriers caused by road construction: Central and Northern Interior Fish Access by Michael Parker (see page 9A).

