



Field trip to the Mahatta River.

Abstracts from the US – BC Technical Exchange 2001 in Port Hardy, B.C.

For the past five years a number of watershed restoration specialists and planners from B.C., Washington, and Oregon have come together on an annual basis to share technical information. This year, the meeting was in Port Hardy B.C. and involved one day of presentations and panel discussions and two days of field trips to Keogh River, Mahatta River or Nimpkish River. A wonderful banquet and field trip to the Mahatta River were generously supported by Western Forest Products.

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Restoration Activities

Watershed Restoration on the Umpqua National Forest – a Focus on Physical Processes

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Watershed restoration on the Umpqua National Forest has focused on restoring landscape processes at the watershed scale. This approach has resulted in the prioritization of fifth and sixth order watersheds, concentrating restoration funds and workforce efforts. Once a complete picture of restoration for an individual watershed at the sub-basin scale is developed, watershed restoration activities, both terrestrial and aquatic, can be systematically implemented within a focus watershed. The goal is to complete restoration work in one watershed before moving on to the next. Terrestrial-based restoration activities include decommissioning and improving (or storm-proofing) roads and second growth riparian stand management. Road related restoration focuses on restoring sediment and water routing, while riparian stand management focuses on the future condition of stream-side vegetation. Aquatic-based activities include culvert removals and instream large wood placement. Culvert removals are focused on restoring fish passage, as well as sediment and wood routing. Placement of instream wood helps to restore sediment and nutrient routing, while also helping to restore floodplain and side-channel connectivity. Monitoring is a key element in determining the success of this approach. ▲



Inspecting a LWD structure on the Mahatta River.

Slow-Release Fertilizer for Rehabilitating Oligotrophic Streams: Formulation Evaluations

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The addition of inorganic nutrients to naturally oligotrophic streams increases autotrophic production and aids in the restoration of salmonid populations. Twenty-six slow-release fertilizers (varying N-P₂O₅-K₂O ratios and binders; supplied by Lesco Inc., Ohio) were examined using laboratory trough and field experiments to determine an optimum solid pellet fertilizer for use in the Pacific Northwest. A series of indoor trough experiments demonstrated that the majority of samples containing binders of molasses, hydrated lime, vegetable oil, bentonite, starch, acrawax, candle wax, and Daratak® (long chain polymer) dissolved less than 30 % after two months. The fastest dissolution rate occurred in fertilizer pellets with no binder or vegetable oil as binder; further studies with these samples examined the effects of varying N-P₂O₅-K₂O ratios. These were achieved using different percentages of magnesium ammonium phosphate (magamp; 7:40:0) and urea (46:0:0). An optimal continual nutrient release over a period of three to four months was achieved with a fertilizer formulation of 16.75:30.0:0 (percent by weight N-P₂O₅-K₂O), with a ratio of 75 % magamp to 25 % urea, and containing no binder. Nutrient composition of the fertilizer was analyzed to determine that ammonia and phosphate released at similar rates. These studies indicate that slow-release fertilizer may be manufactured for annual application in spring time, to stimulate autotrophic production and restore salmonid production in nutrient-deficient streams. ▲

Process-based Restoration Panel

Development of a Process-Based Restoration Strategy

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Re-creating or repairing watershed structure and function so that natural processes can operate accomplishes most effective restoration at the watershed scale. This requires identification of key processes most affected by disturbance, whether due to natural or human causes. Repair is a multi-year effort, multi-scale in nature (watershed/reach/site), which involves strategic use of integrated treatments and requires documentation and monitoring to communicate results. A strategy for restoration generally should focus on the large-scale allocation of treatments and resources. It also must utilize a variety of tactics for accomplishing specific near-term restoration actions/activities. Strategy development should employ both watershed and reach-scale assessments to identify key processes and locations where they have been most altered. By comparing current conditions to historic or fully-functioning conditions, major gaps can be identified, and these help identify the dysfunctional processes likely to be responsible. A process-based strategy then establishes process goals (general desired conditions), identifies specific, measurable form/function objectives and uses a process/treatment matrix to develop priority treatments, locations, and timing.

Using the upper Horsefly River as an example, the current condition of the floodplain was analyzed to determine gaps between a fully functioning condition and the current condition. Today, the smoothed floodplain has little woody shrub and tree vegetation due to human disturbances from clearing and agriculture activities. Observation of nearby reference locations suggests an historic condition of mature hardwoods, willow shrubs and perhaps more variable topography on the floodplain. The dominant processes

affecting floodplain vegetation and roughness in the upper Horsefly River valley are used here to develop process goals and objectives that are measurable and contain timelines to begin to repair the current condition. A sample matrix is used to prioritize treatments by scoring the individual treatment's ability to restore/repair the major processes identified together with the feasibility, cost, and short-term effectiveness of these treatments. This overall approach provides a concise, accountable, and manageable set of objectives and treatments for a restoration strategy. ▲

(Editor's Note: For further information refer to Cope, R., Frick, R. and Heller, D. 2000. Horsefly River Report: A Process and Function Approach to Restoring an Alluvial Valley. Prepared for Mike Parker, Ministry of Environment, Williams Lake, B.C.)

Full Channel Reconstruction: Enchanted Valley Stream Restoration

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The Enchanted Valley Stream Restoration Project will be completed in summer, 2001. It involves the reconstruction of over one mile of meandering stream channel in a low gradient valley of the Central Oregon Coast Range. The original stream channel was moved to the side, straightened, and diked to accommodate agricultural use over the last century. After the original relocation, the straightened channel cut down into the valley floor, increased in velocity, and began eroding its banks, becoming a problem for both downstream water quality and fish habitat. The primary focus of the project was to restore wetland and floodplain function that once provided high-quality rearing habitat for coho salmon in Enchanted Valley. Most of the new channel was built in 1999 and water was introduced in the fall of 2000. Riparian and floodplain restoration will continue in 2001 and beyond. The project was funded by the Division of State Lands, the Oregon Watershed Enhancement Board, and the Forest Service, and was implemented by the Mapleton Ranger District of the Forest Service. See photos and more detail at <http://www.fs.fed.us/r6/suislaw/enchanted.htm>. ▲

Floodplain and Stream Channel Reconstruction: East Fork Hood River and Clear Branch Creek

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Two large-scale riparian and in-stream restoration projects were completed on the Hood River Ranger District in the East Fork Hood River and Clear Branch as a result of a flood in 1996 that exacerbated degraded conditions in both streams. The approach to restoration design and implementation in each stream differed, but both projects helped restore and improve conditions resulting from the 1996 flood and were meant to mitigate impacts from future flood events. Fish species that are federally listed as threatened, or proposed as threatened, reside in both streams. Funding for both projects was unique because it consisted of multi-year funding that allowed us to plan and design in one or more years and to implement later.

The East Fork Hood River project reach was located in a low gradient, alluvial stream section heavily influenced by two glacial tributaries located further upstream. The goal of the project was to reintroduce large woody debris as roughness material into the stream channel and flood-prone area to restore stream channel development. An excavator placed logs totaling approximately 300,000 board feet in the stream and flood-prone area within a 2,000-foot reach. East Fork Hood River has experienced two significant flood events since the completion of the project in 1998. The first was in the fall of 1999 and the second was a large debris flow, originating from one of the glacial tributaries, in the fall of 2000. Although wood was redistributed and channel shifts occurred from these events, the response was a natural one and project goals and objectives were met.

Clear Branch, on the other hand, is a spring-fed stream with no glacial influences. The one-mile project reach was located upstream from a reservoir in an area that had suffered significant impacts in the past from a combination of natural events and land management activities, including forest fire, intensive logging, and flooding. The overall goal of the project was to improve stream and riparian area function and increase the amount of suitable spawning and rearing habitat for bull trout *Salvelinus confluentus*.

The work in Clear Branch was divided into three separate, but related, sub-projects. Sub-project One involved routing one half or more of the base stream flow into an abandoned stream channel located in the low point of the valley in a stand of mature conifer trees. The abandoned channel, unlike the current channel, was not incised and contained all of the physical elements required to provide excellent fish habitat. Sub-project Two involved the restoration of a rock quarry and access road located in the flood-prone area. The goal was to restore the area to a fully functioning riparian/wetland complex. Finally, 65 whole trees and 450 logs were placed with heavy lift helicopters into 0.4 miles of stream and the adjacent flood-prone area. This increased the connectivity between stream and flood prone area and provided better fish spawning and rearing habitat. ▲



A creative use of LWD and ballast.

Use Of Whole Trees In Restoration

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This large wood fish restoration project was located in the Rogue and Siskiyou National Forest in southwest Oregon. A mobile yarder was used to pull over large diameter conifers into the south fork of the Coquille River using a process called tree lining. Tree lining involves setting up logging cables and blocks from a parking area and pulling over designated trees into the wetted channel. Reach capabilities can extend up to a mile away, depending upon topography. Selected trees are pulled over at specific azimuths and once upended, they are left in place. This process allows whole tree

lengths to remain intact, giving the project area a natural appearance. Lined trees have their rootwads partially anchored into the soil, which adds to structure stability. No fastening cables are used to hold these trees in place. These trees provide the key structure element in forming debris jams and increasing habitat complexity. A video illustrating this unique and useful technique is available. ▲

The Latest in Riparian Restoration

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Two years ago restoration specialists talked about “breaking new ground in riparian restoration.” Since then, restoring riparian stands adjacent to British Columbia’s streams has moved into high gear. Riparian assessment techniques have been streamlined and no less than 500-600 hectares of riparian forests have been treated to date in coastal forests alone. An incomplete survey of riparian specialists indicates that in excess of 500 hectares have been prescribed for treatment each year for the next three to five years. If spread out along B.C.’s rivers and streams, this area is the equivalent of 100 kilometers of riparian forest or more to be treated per year. This does not include interior sites.

On the coast, emphasis is being placed on ecosystem restoration. A wide range of silvicultural and terrestrial techniques is being employed to speed recovery of forest characteristics needed for fish habitat, water quality and channel stability. The importance of wildlife in achieving aquatic ecosystem objectives is becoming better understood. Techniques that help to build healthy, diverse wildlife populations in riparian areas are being incorporated into silvicultural projects that are undertaken to save fish.

The riparian restoration work sponsored by Western Forest Products Ltd. in the Keogh River is an example of the commitment forest companies are making toward restoration of riparian stands. These companies are also helping to develop new approaches to ecosystem restoration. Approximately fifty percent of the riparian stands adjacent to the Keogh River have been treated and plans are in place to complete the watershed by 2002. Silvicultural treatments in the

watershed cover the full range of manipulations used in coast forests. For example, overstocked conifer stands are being thinned to improve conifer growth and establishment. Both uniform and variable-density spacing is used to take advantage of productive conifer growing sites, while allowing natural gaps and clusters of trees to prevail in areas where conifer growth is influenced by high soil moisture, poor nutrients, and intense brush competition. In deciduous-dominated areas, treatments are diverse. Alder can be either an asset or a liability. Where conifers are needed, alder is being managed to improve conifer growth and establishment by releasing conifers through removal of overstory trees. Elsewhere, alder is being managed as an interim surrogate for large woody debris by sustaining maximum growth rates through spacing of trees.

Silvicultural treatments remove trees from stands to improve the growth of residual trees. Thirty to forty-five percent, or more, of the basal area of trees have been removed from conifer stands at Keogh River. The trees are surplus to the riparian densities needed to achieve the desired future condition for the riparian forest. However, they are an integral component of the riparian ecosystem and are manipulated to speed recovery of stand characteristics needed for a wide range of biodiversity and wildlife objectives. Trees were topped and girdled to create snags; this reduced the risk of windthrow and created a component of dead and dying trees. Cavities suitable for use by birds, bats, small mammals and other wildlife were cut in the standing snags and downed logs. While use of surplus trees to achieve wildlife objectives has gained wider acceptance, a controversial technique being tested at Keogh River involves placing whole trees in streams at the time of a silvicultural treatment. In February 2000, nine river structures were constructed using two to five trees at each site. All trees were directionally felled. Trees were wedged between existing trees, stumps, or high ground. Artificial ballast was not used. Post-treatment monitoring indicated all structures had remained stable through one year of winter and spring floods. In March 2001, an additional eleven structures were constructed using alder thinnings in addition to three mature balsam fir and western hemlock trees.

These techniques are some of the latest ideas emerging from the restoration work being done in BC. Some hold promise for reducing the cost of watershed restoration, while others will provide options for meeting both aquatic and terrestrial restoration objectives. ▲



Risk Analysis and Application to Road Management

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Over the past year and a half, the Olympic National Forest has developed a process to help us evaluate the benefits and uses of forest roads against potential risks the roads present to aquatic habitat and terrestrial wildlife. The interdisciplinary analysis was GIS-based and was limited to available information that could be applied consistently across the forest.

Five factors were assessed for each road segment. They included the need for public access, the need for management-related access, risk to aquatic habitat, risk to threatened and endangered terrestrial species, and whether the road segments were located within various high value watersheds. Each of the five factors consisted of several elements that were summed together for an overall composite ranking. Elements of the aquatic risk rating include geologic hazard, potential for delivery to fish habitat, stream crossing density, riparian zone proximity, and upslope hazards.

The interdisciplinary, forest-wide roads evaluation has allowed us to identify roads segments that pose high risk to aquatic resources, to develop potential road management options that address aquatic concerns and access needs, and to prioritize opportunities across the landscape. Potential uses of the roads analysis include identifying roads for decommissioning, prioritizing road maintenance needs, identifying potential road drainage and stability upgrades, and helping with repair/decommission decisions at storm damage sites.

For a copy of the Power Point presentation, details on how analysis factors were developed, and potential management options, see the Olympic National Forest intranet website at fswb.f9.r6.fs.fed.us/eng/rms/index.htm. ▲



Matching Road Decommissioning Treatments to Restoration

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Road decommissioning objectives are first defined for a watershed with an area of approximately 100,000 acres or 40,500 hectares, then are further refined for sub-watersheds, approximately 15,000 acres or 6,100 hectares. These objectives relate to reducing sediment delivery to streams and improving fish habitat, improving floodplain stream interaction, and restoring riparian vegetation for improving water quality and fish habitat. The objectives are then integrated into a watershed analysis process to determine the locations and treatment options to meet the stated objectives. The roads are categorized into ridgetop and drawbottom, and treatments range from road closure with barricades to complete re-contouring back to the original hillslope. Associated with the road treatments are culvert correction, seeding, and planting. ▲

Mahatta River Restoration Overview

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The Mahatta River watershed encompasses 120 square kilometers of coastal rainforest on the north end of Vancouver Island. The river supports all five species of Pacific salmon and is particularly renowned for its summer run of steelhead. However, reduced marine survival and the impact of past logging practices have greatly reduced the number of coho, salmon, and steelhead returning to the river.

As part of the commitment of Western Forest Products (WFP) to watershed restoration, Northwest Hydraulic Consultants (nch) undertook a program to stabilize the river and to restore essential rearing habitat, which had been damaged by past harvesting.

Given the remote location, the uncertain river conditions during construction, and the variable nature of the

construction materials, the initial designs were mostly conceptual. WFP's and nhc's challenge was to creatively engineer the structures during construction so that they would function naturally in the wilderness setting. This included the following works:

- Twenty large logjams were installed; these increased the habitat variation essential for a healthy aquatic ecosystem, and also protected rapidly eroding gravel banks.
- Seven rock riffles were constructed; these created spawning habitat and holding pools, and also controlled riverbed elevations.
- Six off-channel ponds were developed; these restored the winter habitat critical to rearing fish.

A post-construction assessment of the physical and biological performance of the structures found that they meet or exceed the project objectives. Project production estimates indicate that the constructed works could increase by forty percent the number of coho salmon and steelhead returning in four years. ▲

Nimpkish Watershed Enhancing Environmental Values Program – Pink Creek and Sebalhall River Field Tour

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Stream restoration began in the Nimpkish Watershed with Overview and Level 1 Assessments in 1995, followed by construction of instream works in 1997. Since then, 649 structures have been built at 42 sites in 11 subwatersheds.

The Nimpkish field trip visited two sites. The nearer site is Pink Creek, which joins near the mouth of Nimpkish Lake and is the only tributary that supports pink salmon. Logging began early in the twentieth century. Coarse sediment aggradation and drying of spawning areas on lower Pink Creek as well as trapping and killing of juvenile trout and salmon in flood channels have been problems since the 1970s. Restoration work in Pink Creek that was inspected during the field tour included LWD structures along the upper section, channel re-construction along the lower section, an intake that splits flows into a complex off-channel and a berm constructed to prevent flooding of the road.

The Sebalhall River drip fertilization site was the

second site visited. Sebalhall River flows out of Vernon Lake to the Nimpkish River. Yookwa Creek joins the Sebalhall just below the lake outlet. Logging of Yookwa Creek's fan resulted in accelerated coarse sediment transport to Sebalhall River, aggradation and widening along the main river. A number of studies have examined different options to rehabilitate Yookwa Creek. However, to date, the main rehabilitative work has been the construction of the Sebalhall side channel by the Department of Fisheries and Oceans, with an intake at the bridge, just at the drip fertilization site. The site visit examined the fertilization site and the side channel. ▲

Aquatic Ecosystem Restoration Treatments at the Keogh River: 1996-2000

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Assessments of fish habitat using standard protocols at the Keogh River during the mid-1990s indicated poor to low-fair conditions in old forest harvest cut-blocks, particularly where both sides of the mainstem were logged to the riverbanks. Historically, 20 of 33 km of riparian areas were logged to one or both banks, and as a result, ten of the twenty kilometers were prescribed for large wood and boulder rehabilitation to replace lost fish habitat. Although about sixty percent of tributaries also underwent past riparian logging, sufficient large wood currently remains to defer channel rehabilitation there until wood loss (decay at three percent a year) progresses further, or about two decades. Fish habitat rehabilitation objectives were four-fold: (1) replace mainstem pool-maintaining LWD no longer recruited in old (1970s) cutblocks; (2) provide mainstem rehabilitative structural elements (boulders) in riffles that LWD otherwise provided in the old cutblocks; (3) Restore and expand salmonid off-channel over-wintering refuges (ponds) on the mainstem, and (4) replace nutrients (N and P), provided historically by carcasses of salmon runs using low-level concentrations of nutrients from slow-release

briquettes. The latter are used until salmon stocks recover from a combination of overfishing, climate shift, and past land-use practices. In total, aquatic rehabilitation has resulted in about 500 instream structures over ten kilometers, seven off-channel ponds at five sites, and about forty kilometers of streams fertilized on an annual basis. Various types of LWD structures were installed to achieve benefits for the short-term (twenty to fifty years) until it achieves its natural re-supply from recovering riparian areas. The primary LWD structural design was various lateral configurations of boulder-ballasted triangular log-rootwad structures, chosen because of confirmed stability as well as their functionality as prime salmonid habitat in both summer and winter. By 2000/01, much of the prescribed work was completed via a cooperative partnership between Ministry of Environment, Lands, and Parks; Western Forest Products Ltd.; BC Conservation Foundation; Ministry of Agriculture, Food and Fisheries; and Kwakiutl First Nations. Only minor works are remaining in 2001 to finish the restoration plan. To date there have been positive aquatic ecosystem responses, which are evident from an intensive effectiveness evaluation of sea-run fish stocks of the Keogh. ▲

Positive Responses to Watershed-Level Inorganic Nutrient Addition and Stream Habitat Structures by Keogh River Steelhead Trout

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Positive responses in steelhead trout abundance and yield were obtained from watershed-level restoration treatments in the Keogh River on northern Vancouver

Island, based on preliminary analyses and compared to an untreated neighbouring watershed (Waukwaas River). The population, now capable of thriving, was below replacement recruitment prior to addition of inorganic nutrients and instream habitat structures, judged as the two key components of several restoration activities. Sampling during summers indicated annual increases in densities of Keogh River steelhead fry and parr as the rehabilitation treatments progressed from 1997 to 2000. Fry densities were five times greater than pre-treatment data. Steelhead parr densities indicated an increase of 3.8 times over pre-treatment or internal untreated values; increases in sites with both nutrient briquettes and habitat structure additions were 2.5 to 1.9 times higher than sites with either nutrient additions or habitat structures, respectively. Average size of all species of juvenile salmonids increased incrementally and significantly through the years of rehabilitation treatment and when compared to fish in the Waukwaas River. Steelhead smolt yield in 2000 increased to 2,338 fish, the highest yield since 1993, but lower than a previous average (>7000) due to low escapement. Current yield was an improvement over the historic low of 1998 (<1,000 steelhead smolts). Coho smolt yield increased to 74,459, or twenty percent above the historic average (62,000 smolts; 1975-1999), well above the very low counts of 1998 (22,000), but below the historic maximum yield (105,000 in 1981). An analysis of condition factors indicated a steadily improving trend in both steelhead and coho smolts. A significant increase in steelhead smolt recruitment at low escapement, from <2 to >64 smolts per spawner, was observed over the last 4 brood years (1995-1998). Further increases in smolt yield and recruitment are predicted for 2001 and beyond. ▲



And the winner is... the Keogh River, showing positive responses in steelhead abundance and yield. Located behind Pat Slaney is the West 80 Pond.