ABSTRACTS

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The 2002 Interior Watershed Conference was held in Kamloops on March 13 and 14, 2002. There were more than 300 participants at this event which was coordinated by the Forest Continuing Studies Network. The theme was Watersheds: We're In This Together. The two keynote speakers both spoke eloquently on this topic. Concurrent sessions focussed on:

- Successful Partnering for Watershed Restoration
- Range and Agriculture and its effect on Water Quality
- Watershed Plans, Monitoring and Evaluation
- Restoring and Management of Fish and Wildlife Habitat
- Computer Models in Forest Management
- Research and Science in Watersheds

Alan Thorne, winner of the 2002 Interior Watershed Award.

Congratulations to Alan Thorne, the winner of the 2002 Interior Watershed Award.

Dave Nordquist, Natural Resources Manager, and Greg Witzky, Fisheries Manager with the Adams Lake Indian Band, nominated Alan for this prize. Al was introduced by Dave Nordquist. Al graduated from the University of New Brunswick in 1990 with a Bachelor of Science in Forest Engineering. Since then, Al has worked for International Forest Products Ltd. both on the coast and for the last 9 years at Adams Lake Lumber. His experience includes layout and development planning for watershed restoration. Dave Nordquist attributed Al's success to the collaborative spirit that he brought to all meetings. He has managed the Adams Lake IFPA program. Al lives with his wife and two children in Chase. ▲

Keynote Presentations

A Pragmatic Approach to Watersheds and Water Quality

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Research based results of watershed conditions, ground water, and shade's effects on stream temperature and other water quality conditions were summarized through five active research studies. The first study involved research on the effects of temperature on running water. This is important because there is an optimum temperature above which salmon populations do not do well. It concluded that stream shade is an important factor in decreasing water heating. It demonstrated that water depth, surface area, time and rate of discharge were also important to the temperature of the running water.

The second study involved the temperature response to thermal environment. The implications are that the thermal environment has an influence on stream temperature. It found that air temperature increases with a decrease in elevation, and so does the stream temperature.

In the third study, remote sensing and Geographic Information Systems were used to assess changes in stream morphology and vegetation. This combination of GPS and GIS technology is an excellent tool for time change analysis using large scale imaging to determine for instance, the length of thalweg and right and left streambanks, or the sinuosity of the stream.

In the Meadow Creek Study, the streambank is sloughing. The study looked at the effects of different grazing strategies and wintertime hydrologic events on this creek. It demonstrated that season-long grazing was detrimental to streambanks and associated with high degrees of bank sloughing. Properly managed grazing (timing and fencing) gave results that were similar to non-grazed control areas. The forces of nature during hydrologically active over-winter months were significant. When the ice floes occur, drainage-wide erosion was high regardless of treatment.

Stream temperature related to sub-surface waterflow was the topic of the fifth study. The sub-surface waters were controlled through a head-ditch system. The irrigation water was introduced to the streamwater through the head ditch, resulting in cooler stream temperatures and more flow later in the season during

periods of low water. This study demonstrated that irrigation is not always bad, in fact, it can improve the water temperature situation if it is managed to flow through the soil.

Stating that it is better to get the water into the ground, and have it flow through the ground to the stream can summarize the results of these studies. The temperature of water entering the system is tied to infiltration rates and upland range and forestry conditions.

The essence of beneficial release is:

1) Timing of Flow: Water infiltration into a system can take the top off floods, and increase the amount of water that is available during drought because it is stored underground, thereby not evaporating as quickly.

2) Quality of Flow: If water is added to the system and flows across the ground it warms and can evaporate, or it can carry soil and debris to the soil causing erosion. If the water infiltrates through the layers of soil and rock, the kinetic energy is removed from the water. Nutrients are added to the soil profile, often benefiting plants that grow above. In comparison, if this same water flows straight into the stream system it can cause eutrification. Infiltration also removes fecal coliforms, pathogens and other bacteria that are potentially added to a stream system from range or agricultural land use. If the water transfers through the soil, it ameliorates the water temperature.

All of these studies have been brought together because they all demonstrated the theme of this Conference – Watersheds: We're in this together. A couple of stories about the viewpoints that children have of our watersheds demonstrate that we need to work together on education. The importance of outreach and extension programs in ensuring the stewardship of our watersheds cannot be underestimated. That is where you make contact between research and the person on the ground. It is important to involve landowners, and their families, in the proper management of rangeland and forested land.

"If you want people to have a land ethic, they have to be able to afford it." said Dr. John Buckhouse. ▲

Stewardship of Water in a Crowded and Changing World. How do we achieve ethical conservation and management of water and watersheds?

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The enthusiasm with which we press our search for evidence of water on other planets stands in stark contrast to the profligate manner in which we use and treat water on earth. While we recognize the absolute necessity for water for life as we know it, we are generally poor stewards of earthly water. This is not unique to water. We similarly mistreat our global atmosphere, soils, forests and aquatic and terrestrial animals.

What are the origins of this lack of stewardship, and what are some possible solutions?

The human population increased by a factor of six over the past 200 years. It doubled to more than 6 billion over the past 40 years, and it is expected to increase by another 3-5 billion in the next 100 years. This has put enormous pressure on the world's water resources, especially in climates that favor human habitation. But population increase alone does not explain our environmental impact. It is equally related to a disconnect between people and the land – a disconnect that accompanies urbanization, loss of local experience, a growing dependency on, and faith in, technology, and a persistent inability to understand and predict the longer term and cumulative consequences of our actions.

How can we solve the water problems? By top-down government policy, or by bottom-up, local control of the land and the processes that deliver water from it in a way that serves human and non-human needs? The latter is conceptually the better approach, but with a rapidly increasing proportion of the world's population living in cities and demanding more water or water-related values than this local control may deliver, it is insufficient on its own. The NIMBY syndrome also reduces the effectiveness of local solutions as in a larger context it may simply push the problem from one location to another without actually dealing with it. The top-down government regulation approach has a dismal record of success, largely because centralized decision making, subject to a wide variety of political pressures, generally fails to respect ecological, social and biological diversity, and because economic and urban imperatives frequently overwhelm local

interests. However, government regulation may be the only way of assuring that the regional and bigger picture issues are being addressed, and that the complexities of environmental problems are considered.

In the late 1960's, the Club of Rome was formed to examine global issues and to consider if there were limits to growth. After all, the world's wood supply could be produced from a small fraction of the world's forested land, as could the world's food supply from a small proportion of agricultural land. And there is plenty of water in the world if only its use was managed sustainably. The Limits to Growth study concluded that indeed there is little reason to think that there are any individual technical, sectoral problems that cannot be solved if they could be considered in isolation, but that the interconnectedness between them prevents this and results in failure to provide solutions – that there are indeed limits to growth because of the interconnectedness of the world system. It is the connections between problems and not the problems themselves that often results in the elusiveness of sustainable solutions.

A problem is an issue that does not get solved. An issue that gets solved quickly is not a problem. Problems often persist because they are complex and connected to other issues, and the solutions that are offered ignore or fail to recognize this complexity and these interconnections. It is time for a new Club of Rome-type of study to examine at a global scale and in an on-going process the complex, interconnected world system that we are currently mismanaging, and in which water plays a key role.

The UNESCO World Commission on the Ethics of Scientific Knowledge and Technology is in the formative stage of attempting to generate such a new study. Unlike the top-down word economics model of the Club of Rome study, a new world model must be a combined top-down – bottom-up conception of the world that incorporates a much wider range of controls on world dynamics. Not one of government regulation, the international market place or local processes will address adequately the complexities and linkages we face. It is time to link the different levels of the stewardship process in a series of models at different temporal and spatial scales to help to define what is ethical in water and watershed management, and how water interacts with the other components of the world system of which it is a critical part. ▲

Successful Partnering for Watershed Restoration

The Bonaparte Stewardship Group- What Makes It Work?

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1. A Brief History of the Society - What Made it Come About

- Early Spring 2000- The need to organize
- April 26, 2000- Test the waters for interest
- June 24, 2000- Planning workshop
- November 23, 2000- Further planning workshop
- February 6, 2001- Incorporation
- March 19, 2002- First annual general meeting

2. What Projects Have Been Carried Out to Date

- One whip cutting day
- One whip planting day
- Three tree planting days- seven sites
- Bank stabilization- six sites (including, in some cases, fencing)
- Off-stream watering- one site
- Wrapping trees for beaver protection- three sites
- Workshop
- Exploration of other projects

3. What has Made it Work

- Interest and awareness of members
- Active interest of a few
- Developing and using partnerships
- Common foe or threat
- Habitat Conservation and Stewardship Program (a shameless commercial for the program)

4. What Will Enable it to Continue to Work and Thrive

- More of the above
- Effective turnover from, or some continuation of the HCSP
- Emphasis on labour intensive projects
- Succession of management ▲

Partnering for Watershed Success: The City of Kelowna's Experience

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The creeks in the Kelowna area, like those throughout North America, have been impacted by human development. Forestry, agricultural, industrial and urban activities have resulted in altered drainage patterns, reduced riparian vegetation and increased erosion and pollution. The success of the City of Kelowna's Watershed Stewardship program at overcoming these problems is due in part to the variety of partnerships formed since the program's inception in 1996.

Partnerships provide benefits to both of the parties involved. In a time of scarce funds for environmental works, partnerships are extremely important to accomplish the education and restoration that needs to be done to keep our watersheds healthy. The City has utilized partnerships in all three aspects of its watershed stewardship program: education, stewardship and restoration. Partnerships have been formed with local and provincial governments, businesses, landowners, and non-profit groups.

Working with the Regional District, Fisheries and Oceans Canada and non-profit groups has proved to be a successful way of educating students and the community on a variety of environmental education initiatives. Working together provides a medium where people can learn about different numerous local environmental issues.

Partnering with the community to keep our streams healthy helps instill a sense of stewardship of our local waterways. The City facilitates numerous volunteer opportunities including creek clean-ups; invasive weed removal, replanting and storm drain marking. Organizations participating in the City's "Adopt A Stream Program" receive recognition, through signage, when they commit to stewarding a stretch of stream for a 2-year period.

Partnerships with landowners and businesses allow for restoration and enhancement to occur on private land and in many instances provide valuable in-kind or monetary donations to projects. Government agencies also partner on projects to provide expertise.

Funding partners have been instrumental in implementing many of the educational and restoration projects. Provincial programs such as the Habitat Conservation Trust Fund and local businesses such as TELUS have substantially expanded the amount of restoration work that the City could achieve with its annual allotted budget. Programs, such as the E-Team program provide staff to implement restoration and to maintain past works, ensuring long-term project success.

The City of Kelowna has been proactive in recruiting and maintaining partnerships with government, businesses, landowners and volunteer groups. These partnerships contribute to the overall success of the Watershed Stewardship Program. ▲

Successful Partnerships: The Adams Lake Experience

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Since 1995, Adams Lake Lumber has embarked on an ambitious plan to restore damaged watersheds in the Adams Lake area from past resource extraction activities. This included problems resulting from forestry as well as agriculture and private land management. Because of the proximity of the operation to the famous sockeye salmon run on the Adams River, the need for a coordinated approach by all stakeholders was essential to develop a comprehensive restoration strategy to ensure positive results.

Working with local First Nations, private landowners, and various agencies, Adams Lake Lumber has completed all priority works in the area. This would have not been possible without the involvement of all the partners. With the past problems essentially completed, Adams Lake has now turned to the future to ensure the future health of the watershed.

Future strategies involve the following: restoring salmon populations in the area to a significant enough level to allow for a traditional fishery in the area every year for local Bands. In addition, Adams Lake is working with local researchers to practice new watershed management techniques to ensure future harvesting does not adversely affect the system.

The presentation highlighted a variety of partners including the Adams Lake Indian Band, Ministry of Environment, Ministry of Forests, Fisheries and Oceans Canada, Landowners, Thompson Basin Fisheries Council, Forest Renewal BC, Fisheries Renewal BC, and BC Hydro. There was a focus on procedures we used to help build trust among these organizations so that everyone could focus on the common issues. ▲

Salmon River Watershed Project: 10 Year History of Successful Partnership

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The Salmon River Watershed Project is a community driven initiative that has successfully accessed support for nearly a decade from a broad range of partners to advance a collective vision of watershed sustainability. The process followed, results yielded and lessons learned are offered as a case study in the versatility and effectiveness of a consensus based, ecosystem approach to watershed planning.

What began in 1991 as an expression of "concerns-in-common" between local First Nations and municipal government representatives regarding the condition of the Salmon River came to involve landowners, industry, other government agencies, non-government agencies and citizens in a proactive approach to problem solving. Over the next three years project participants developed an ecosystem approach to watershed sustainability as reflected in the guiding principles, mission statement, vision, goals and objectives of the Salmon River Watershed Roundtable. Since then the SRWR has succeeded in building partnerships with a broad range of stakeholders by maintaining a watershed perspective, using consensus planning methods and by demonstrating respect for all concerns. FRBC contributed significantly during a four-year period (1997-2000) furthering progress toward sustainability goals, along with many other partners, as will be described in the case study. Many planning, field action, monitoring and educational products have resulted from these partnerships. In hindsight, undertaking these activities concurrently has proven critical to enfolding greater stakeholder participation.

The nature of the SRWR organization facilitates incremental pursuit of a collective sustainability vision that considers economic, ecological and social concerns. Past practices are not criticized; proactive approaches are sought. The versatility of the planning mechanisms used has enabled the SRWR to accept varying levels of technical and funding support from partners while maintaining a community based vision through a set of goals and objectives. The process accepts both technical and non-technical input. This has enfolded participation and support on key issues from a broad stakeholder base and has helped identify avenues through which to advance sustainability goals. ▲

Range and Agriculture and its Effect on Water Quality

Not Your Typical Riparian Restoration Project

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Innovation in the agricultural industry can be like a mudslide, slow to get moving, but as momentum grows large scale changes can result. The riparian restoration project undertaken on the Brady Property of Louis Creek is one such example.

The project involves 13 separate agencies and/or landowners and took over two years to actually get to work on the ground. Fisheries & Oceans provided the funding through the Habitat Restoration & Salmon Enhancement Program (HRSEP). Forest Renewal BC and the Kamloops Stockmen's Association provided research funding.

The innovation in this project is twofold:

1. Riparian restoration techniques
2. Science used in assessing cattle use

A typical fisheries riparian restoration project on ranchland simply installs a 15 m setback fence and incorporates some planting in the reserve zone between the fence and the creek. This project used a combination of a very large (51 ha) cattle exclusion plot, an open grazing area with off-channel watering sites (83 ha) and two rotational grazing pastures with watering sites (46 ha). The landowner initiated the project with the idea that by using carefully controlled grazing we could enhance the shrub/tree component of the riparian corridor while utilizing the valuable grasses found near the stream. The test of the grazing theory comes next year when the 300+ head of cattle are managed in the project area.

Cattle locations are being recorded every 5 minutes using collars with GPS capability. This data will

allow detailed examination of livestock behaviour in the open grazing area and will aid in developing management systems aimed at minimizing livestock use of the stream. Pre-project assessments on fish usage, riparian vegetation composition and benthic invertebrate populations, were all completed to provide a base line for monitoring the response of the system to the alterations of the grazing plan. Long term monitoring of this unique riparian restoration project will hopefully show that carefully controlled cattle use can occur within the riparian zone in conjunction with improvements to overall watershed health.

Participants are coming to realize that the project must be approached with a 20-200 year perspective in order to be successful, and that a single 3 or 4 year funding cycle will not bridge the existing gaps between current condition and sustainability. Many issues identified during planning activities to date remain at the forefront of planning and field action objectives, and have not yet been effectively addressed. Meanwhile, the SRWR continues to make progress. Signs of success continue to encourage greater participation toward the collective vision of sustainability. This presentation outlines the process, partnerships, field actions and lessons learned during the 10-year history of the SRWR as well as an action outline for the future. ▲

Two Ways of Looking at Things

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The Whitevalley Community Resource Centre Society [WCRC] has been partnering with local landowners from the agricultural community for the past five years completing habitat restoration activities on local creeks and rivers. Through cooperation with the government agencies, First Nations, forest companies, BC Hydro and local community groups, over 70 projects have been completed.

The successful implementation and acceptance of these projects in the local agricultural community is through the efforts made initially by the Resource Centre's Program to involve the landowners in the planning process. Through my past involvement as a consultant with government agencies implementing similar types of projects, I was often frustrated by the lack of "buy -in" from the landowners as they tended to look upon these programs as only benefiting the fish, while having negative impacts on their day-to-day operations. This may have been caused by the lack of communication that occurs if the technical staff assigned to design the projects have limited understanding of how the agriculture industry depends on access to the water resource when developing their projects. An emphasis of simply completing the environmental work such as fish habitat structures or channels as required by the funding proponent without consideration to the rancher or landowner, often results in a compromise situation with the landowner, rather than a true partnership when completing projects.

Through the WCRC program, efforts have been made to design the projects to meet the funding proponents concerns such as bank stability or riparian management, but the project is designed to first meet the landowner requirements. The reason it has worked for us is that while the traditional approach of cost estimating the majority of the budget as direct costs to environmental improvement; we see how the landowners, neighbours or perhaps community becoming involved to supply materials or services at reduced rates or in exchange to expand the project. As an example, in exchange for including purchasing a livestock waterer that will allow a producer to better manage his pasture and winter-feeding area; he supplied "cat" work to cut down the cleanup costs on the project through his property. These and other types of cooperative exchanges allow us to extend the budget usually by an additional 30 – 50 % with no additional cash outlay on the part of the landowner. This approach to projects has allowed irrigation system upgrades, new fencing and bank stabilization projects to be completed from funding that was earmarked for fish habitat. The environmental concerns are addressed; but the involvement of the landowner allows for land management improvements to be completed that are cost effective. The involvement of the landowner in this process allows them to become informed as to how his management practices must be designed to meet the proponents objectives with this project. After all, it is going to be the commitment of the landowner as a steward to provide the long-term maintenance of these projects if they are to be successful.

My location, and a personal involvement from the initiation of the restoration program, have allowed me to maintain an active and supporting roll in its present activities. In my capacity as Stewardship Coordinator with the British Columbia Cattlemen's Association, I now draw on the experience gained through being involved with this program to promote similar approaches for ranchers and watershed organizations planning their own restoration projects. Having access to these project sites for tours has allowed me the unique opportunity to be able to take a rancher on a site to demonstrate how a cost-effective irrigation intake system was designed by re-watering an overflow channel. Then, when I take biologists to the same site, I show them the more than 1500 square metres of habitat channel that was built and complexed for less than $7000. ▲

Ranching and Water Quality

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The ranching industry is a major segment of British Columbia's agri-food industry. Most ranches are located near watercourses and have the potential to affect water quality because of ranching activities. A two-year monitoring study is currently being conducted to determine differences between the upstream and downstream quality of water flowing through ranches in the southern interior of British Columbia.

In 1999 five ranching sites were selected and established for sampling and monitoring over the next two years (2000 and 2001). Site selection was based on the criteria that each ranch should have at least 200 head of cattle or more have winter-feeding and/or spring calving areas with a small or intermediate stream flowing through or by the ranch. Data was collected weekly in February and March, and biweekly from April until July 2000 and then monthly for the remainder of the year.

Data gathered at each site includes temperature (air, soil, and water), flow (velocity and discharge with flow meter, stageboards and Star Flow equipment), riparian condition was assessed, and ongoing agricultural activity is monitored. Water quality parameters measured include: bacteria (fecal coliform and fecal streptococcus), pathogens (Giardia and Cryptosporidium), nutrients (nitrate, ammonia, total nitrogen, ortho-phosphate, and total phosphorus), non-filterable residue, pH, dissolved oxygen, conductivity, turbidity, and sediment. First year results generally show higher concentrations of nutrients downstream of the ranch. Second year sampling and analyses needs to be completed by December of 2001 before proper interpretation of data can occur.

Generally the results are showing that downstream values for stream temperature are higher than upstream sites, but there is lots of variability. Generally in water quality measures, bacteria was found in higher concentrations downstream (fecal coliforms and streptococci) however this data is difficult to interpret and several samples are required. Pathogen studies show that Giardia is present in approximately half the downstream locations, Cryptosporidium is present in approximately twenty percent of the downstream locations. These studies are difficult and time-consuming to sample. Nutrient study analysis demonstrated a mean nitrate value that was higher downstream, but it should be noted that all sites had values well below the drinking water criteria. There was no strong trend seasonally. ▲

Integrated Riparian Management: An Introduction to Agroforestry Concepts

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Historically, agriculture has developed on the productive lands, with good soils and access to water – such as deltas, flood plains and valley bottoms. As population, scientific knowledge, and competing demands for finite resources increases, more pressure is placed upon the food production system to produce more food with less impact on the environment. This often results in both economic and resource constraints being placed upon the food producers.

Agroforestry is a land management approach that deliberately combines the production of trees with other crops and/or livestock. By blending agriculture and forestry with conservation practices, agroforestry strives to optimize economic, environmental and social benefits. Agroforestry involves intentional management of the interaction between the components of an integrated agro-ecosystem. Some examples of this intentional management include: alley cropping; forest farming, also known as shade farming; silvipasture, shelter-belts, and integrated riparian buffers.

Integrated riparian management is the management of riparian zones to enhance and protect aquatic resources, while also generating economic benefits. While the long-term economic cost of working the last few metres of land up to the water's edge may be greater than the short-term gain, agricultural businesses need to deal with the realities of cash flow and current revenues. Setting land aside for what is often perceived as a distant, poorly defined societal benefit is not something many producers can justify.

By introducing the concept of managed riparian buffers, with the potential for some income generation while still protecting soil and water resources, it is

hoped that more landowners will adopt this type of management. Riparian restorations have reduced soil erosion and flood damage, improved aquatic resources, and produced marketable products from the riparian buffer. ▲

Watershed Plans, Monitoring and Evaluation

Watershed Prioritization in the Okanagan

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The Okanagan is identified as one of Canada's most endangered ecosystems. Serious declines in fish stocks in the Okanagan have prompted a keen interest by both government and community in watershed restoration and planning for fisheries recovery. At the same time the competition or demand for water is fierce. This area has all of the problems that are inherent when the water is a limiting resource. The community approach, coordinated by the Okanagan Similkameen Boundary Fisheries Partnership (OSBFP), has been to develop inclusive community watershed roundtables that work with NGOs, business and governments in the forestry, agricultural and urban sectors towards a common watershed-based vision and coordination of plans and efforts. This presentation outlined the OSBFP "watershed prioritization" process developed to guide community watershed roundtables and other fisheries stewardship efforts. This process is being integrated with other agency technical fisheries recovery plans (produced by the intergovernmental Okanagan Basin Technical Working Group). The OSBFP had a clear objective to protect and restore indigenous fish stocks. The framework involved development of a strategic plan which is now available on the website. There is currently a governmental track and a community track that have come together in the preparation of these watershed-based fish sustainability planning. Tracking the various plans is a very important part of the process. Please look at the results on the website at www.sylix.org. ▲

Pacific Salmon Endowment Fund: Development and Status

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In June 1998, the Government of Canada announced the Canadian Fisheries Adjustment and Restructuring (CFAR) plan, which included a series of initiatives to fundamentally alter and secure the future of Canada's salmon resource on the West Coast. As part of the CFAR, $30 million was allocated to provide a permanent endowment fund, to be delivered "arms length" from government, to support the goal of achieving sustainable salmon resources and habitat. Because of his unique ability to bring diverse interests together around a common goal and strong, lifelong interest in the environment, Rick Hansen was selected and agreed to act as a "champion" to establish the Pacific Salmon Endowment Fund. He has spearheaded the selection of a steering committee and technical committee. The steering committee came up with a vision statement and a mission.

The vision of the PSEFS is: *To achieve healthy, sustainable and naturally diverse Canadian Pacific salmon stocks.*

Salmon recovery will be supported and implemented through six main program areas. Each program area will be focused and strategic in planning and implementing activities to promote salmon recovery. The program components are:

- develop science-based strategic recovery plans for salmon recovery to set objectives and priorities for investments.
- coordinate investments in watersheds and salmon recovery with government and non-government organizations.
- coordinate and implement recovery, monitoring and assessment activities.
- provide a leadership mechanism to sustain volunteer commitment to salmon recovery and stewardship throughout BC
- rigorously monitor and evaluate program elements and report with a high standard of excellence.
- educate and raise public awareness.

The plan now is to mobilize people and resources from all sectors around the program vision and components. The projects that are chosen need to be monitored and evaluated for both short-term and long-term effectiveness. The projects chosen have been holistic and realistic in their ability to be done successfully. They were within

a target geographic region and had a target species. They had the advantage of being suitable projects to leverage funds from other sources. The two that have been initiated are the Englishman River in the Georgia Basin and Coldwater River in the Thompson Basin. For the first two projects the plan was to ensure a high level of "do-ability." These projects are planned to be ongoing, not a "sunset" program. At this time , through living recovery planning and coordination to allow for adaptive management, the objective is to engage and achieve. ▲

Road Deactivation for Hillslope Restoration: Lessons Learned on the Escalante Watershed Restoration Project

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This abstract is based on the paper published in the proceedings of the Vancouver Geotechnical Society Symposium on Land Reclamation Geotechnique, 25 May 2001. Co-authors are Mike Wise, Mike Leslie, Glynnis Horel, Denis Collins, and Warren Warttig.

Permanent deactivation is often carried out using hillslope restoration for roads on moderate to steep hillslopes. In the Escalante River area, many potentially unstable roads were deactivated in the late 1990s with roadfill pullback due to stability concerns, and the remainder of the roads were cross-ditched with some light pullback. In January 1996, intense rainfall caused approximately 400 landslides on these deactivated roads. Funded by Forest Renewal BC, the Escalante Watershed Restoration Project was initiated to assess the roads in the watershed and carry out deactivation work where needed for long-term road stability. Assessment of the existing deactivation work after the storms provided valuable information on its effectiveness in preventing landslides. Due to the existing roadfill pullback and landslide sites, it was necessary to assess the roads in terms of the expected deactivation work. Several techniques were developed to improve the standard of deactivation and reactivation.

Deactivation prescriptions provided site-specific objectives along the road corridor. Standard operating procedures were developed for the wok in the Escalante to complement the prescriptions and establish expectations and approaches for carrying out the deactivation work. The new techniques that were developed improve the safety and effectiveness of the hillslope restoration work during roadfill pullback and culvert removal. Safety was a prime concern within work on these very steep slopes. A program of "mentoring" was developed to teach less experience operations the deactivation techniques developed by the more experienced operators. Conservative wet weather shutdown criteria were also used, to suspend activities when landslides were relatively more likely to occur. Sorting materials during the pullback enhanced the site productivity. This is achieved by placing fine and organic soil on the upper surface of the roadfill pullback and scattering large woody debris (logs and stumps) on top. Many of the techniques that were developed are now documented in a Best Practices Handbook regarding hillslope restoration (Wong et al, 2001).

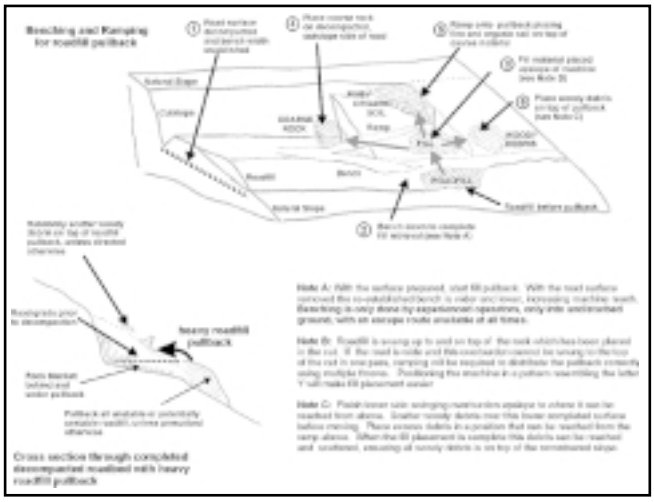

Figure 1. Benching and ramping for retrieval of roadfill during hillslope restoration. Numbers in top sketch indicate suggested sequence for placing material in roadcut.

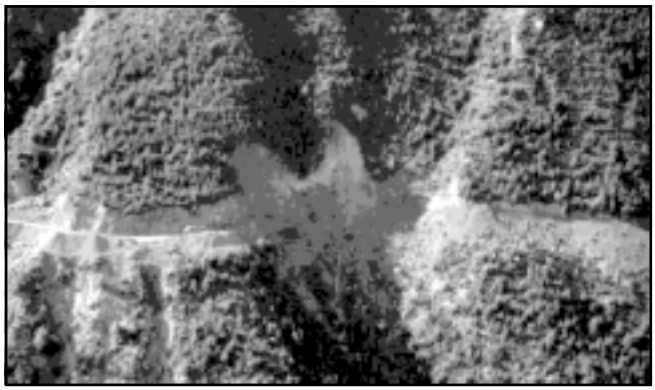

Figure 2. Photo of roadfill pullback and end-hauling in gully area; note truck and excavator on left side of gully. Systems usually represent a higher risk to downslope areas, due to increased debris flow runout distances and greater sediment transport rates in these areas. ▲

Restoring and Management of Fish and Wildlife Habitat

In-Stream, Off-Channel and Fish Access Restoration: A Provincial Evaluation of Performance

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A Provincial performance evaluation of in-stream, off-channel and fish access components of the Watershed Restoration Program was conducted in 2000 and 2001. The objective of the evaluation was to determine the success of projects in terms of meeting restoration objectives and make recommendations on how to improve rehabilitation effectiveness. A total of 18 fish access, 32 off-channel and 552 in-stream sites or structures were evaluated from all regions of the Province. Expert teams using standardized forms to minimize inter-team variation evaluated projects subjectively. All sites were visited on the ground and ratings made at the time of viewing. Projects were selected after having experienced 1-3 years of freshet floods. Preliminary results indicate that aquatic activities of the Watershed Restoration Program has had a high success level for all three restoration components: 96% of fish access projects, 93% of off-channel and 81% of in-stream structures were meeting or exceeding restoration objectives. However, the success of in-stream restoration was predicted to drop to 68% when performance was forecast over a 20-year period (the minimal interval over which most projects are designed to remain functional). Quality of construction contributed significantly to the projected decrease in project success. This and other factors relating to success and failure in both the short-term and long-term are discussed, as are recommendations to increase success at meeting or exceeding performance objectives in the future.

Editor's Note: the complete paper on this topic is presented on p.3 of this issue of Streamline. ▲

Riparian Restoration: What, Were, When, Why and How

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As the Watershed Restoration Program (WRP) winds down, efforts are being made to ensure that the techniques developed and the lessons learned are documented so that future practitioners can proceed with effective restoration projects. One area of expertise that has been poorly defined and communicated is riparian restoration at the stand-modification level. In fact, when the history of riparian restoration projects was examined, only approximately 20 of the almost 450 riparian projects identified in the Fisheries Project Registry and elsewhere were stand-modification projects. Currently, most riparian restoration in BC is done via 3 programs: WRP, Terrestrial Ecosystem Restoration Program (TERP) and Sustainable Harvest (SH). The US Pacific Northwest has also been quite active in riparian restoration for over a decade now. With WRP, TERP and SH all being eliminated, and government's now role being defined as "they who write standards", the need for riparian restoration Best Management Practices (BMP) has become evident. To this end, a workshop was held in Richmond March 7-8, bringing together top riparian practitioners from BC, Washington and Oregon. The workshop participants identified certainties, uncertainties and opportunities for multi-objective prescriptions. Tanis Douglas gave a presentation on riparian prescriptions with wildlife habitat objectives. One new technique involves shooting bullets charged with fungus into trees, resulting in viable trees with holes for dens. This talk emphasized the need to address biodiversity rather than single species, and the potential difficulty in providing habitat on a timeline that is appropriate for the species being targeted. Workshop results are being written up (#1 below) and some aspects of the workshop will be incorporated into publication (#2

below), which focuses on silviculture treatments. Non-silviculture riparian restoration BMP's are not completed yet, but an excellent foundation has been laid for the completion of this project.

Several documents on riparian restoration will be available soon. Some of those documents and the contacts for them are listed here:

1. Riparian Restoration BMP Workshop results (Heather.Deal@gems1.gov.bc.ca)
2. Recommended Riparian Zone Silviculture Treatments (Brendan.Holden@gems3.gov.bc.ca)
3. Guidelines for Enhancement of Second Growth Forested Riparian Zones (Glen.Johnson@gems2.gov.bc.ca)
4. Silviculture and Restoration Standards and Best Management Practices (Colene Wood, MWLAP) ▲

Restoring Fish Habitat in the Pine River Near Chetwynd

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In August 2000, Pembina Pipeline Corporation's crude oil pipeline burst near its crossing of Pine River at Calazon Creek, about 80km upstream of Chetwynd BC. About 450 m^3 of crude oil entered the river coating the bed and banks as well as numerous log jams between the break site and Big Boulder Creek – a distance of approximately 30km. As part of river cleanup, most log jams were either fully or partially removed by crews or excavators and the contaminated wood burnt on-site. The log jams had been an important component of channel morphology and their removal led to a situation where the main channel could avulse or reoccupy side, back or abandoned channels, as occurred during a small storm while cleanup was underway. The potential channel instability was thought to have negative long-term implication for fish habitat, sediment supply and infrastructure along Pine River.

Northwest Hydraulic Consultants Ltd. (nhc) was contracted in the fall of 2000 to assess potential morphologic impacts of logjam removal on Pine River and mitigate the effects or restore the jams, where practical. We assessed the more than forty sites where cleanup work had occurred, prioritizing each for reconstruction based on the potential for channel shifting, danger to existing floodplain infrastructure, bed material recruitment or erosion, and fisheries concerns. Nine logjams were rated as a high priority for immediate reconstruction and were rebuilt or repaired in the fall of 2000. The key issues addressed in design and construction were re-creating log jam functions with smaller volumes of wood, anchoring or attaching the new log jams, and restoring appropriate portions of flow in the main channel and its side channels to maintain channel stability and fish habitat.

Post-freshet monitoring surveys in June 2001 revealed that three of the nine sites required some maintenance and one log jam had failed. A variety of factors lead to this failure including channel bed adjustments and increased flows in the main channel compare to the side channel, following cleanup work. To ensure that the repairs at the site were stable, an additional log jam at the head of the side channel to reduce the flow into the channel was constructed. Work will continue in 2002 with post-freshet monitoring.

Figure 1. These huge logjams were constructed following removal and subsequent burning of logjams that were in place in Pine River during a Pembina Pipeline oilspill that occurred in August 2000. ▲

Preliminary Biological Assessment Results of Fish Habitat Restoration Projects and Implications on Project Development

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Assessment of existing fish habitat restoration projects to determine fish utilization was undertaken in the southern interior of BC during the summer of 2001 and continued during the winter of 2001/02. For FOC, coho are the primary species of concern and the focus of the work, though numbers of chinook, rainbow/

steelhead trout and other species are recorded. In addition to the trapping process physical measurements are taken of the sites including but not limited to riparian density and recovery, flow, temperature, and instream cover/habitat type. A mark re-capture protocol using gee traps is being used as the primary method used for enumeration with very limited use electroshocking in a few special cases to verify presence/absence. Control sites are chosen for comparison to riparian stabilization techniques and ground/surface water off-channel complexes. Within these project types, specific habitat features, such as pools, rock clusters, undercut banks, and woody material, are chosen to determine fish preference of these different structures. Juvenile assessment is planned to continue for the next several years.

In addition to furthering knowledge of interior coho life history, improvements in the development and selection of restoration prescriptions can be made. The type of projects developed to benefit fish can be based on preferred habitat area such as riparian, instream or off-channel for a specific watershed. From each of the specific habitat features assessed, the fish preferred physical parameters such as flow, DO or temperature can be used for improving the design of projects. We did find out that coho seem to prefer the woody structures, while steelhead and Chinook prefer the riprap. Design alterations may include altering the placement or orientation of structures, construction methods used to build the structures, or changes in materials used such as increasing the use of rock or wood. ▲

Computer Models in Forest Management

Criteria and Indicators Development: The Foothills Model Forest Experience

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The Foothills Model Forest (FMF) is a multi-partner based research organization located in the Foothills and Rocky Mountain regions of west-central Alberta. It encompasses an area of 2.75 million hectares and includes the landbases of Jasper National Park of Canada, Weldwood of Canada's (Hinton Division) Forest Management Agreement Area, Willmore Wilderness Area and Alberta Crown Management Units. It is part of a network of 12 Model Forests across Canada, which as members of the Canadian Model Forest Network, seek to research and address Sustainable Forest Management (SFM) issues at a number of different scales.

An important focus of the Foothills Model Forest program over the past four years has been the development for reporting of Local Level Indicators (LLI) in support of the Canadian Council of Forest Ministers' commitment to the development and reporting of criteria and indicators of SFM.

The FMF addresses the process of LLI development in a multi-partnered, multi-jurisdictional environment. A process was undertaken to achieve agreement of shared values, goals, and objectives in the development of its initial draft set of indicators of SFM for the FMF landbase. This process had challenges of its rationalization of the initial draft indicator set in a multi-jurisdictional environment with partners of varied resource and land management mandates. It came down to a common and agreed set of meaningful, relevant, cost-effective indicators, which can be reported in a common format for all four landbases encompassed in the FMF. ▲

The Emergence of New Catchment-Based Tools and Spatial Data Models

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Catchment, or watershed-based, approaches are currently being rediscovered as tools of choice for coordinating the involvement of scientists, regulators, politicians and the concerned public in discussions pertaining to developing policies, plans and operational management decisions for catchment areas.

Scientists can make a major contribution to effective watershed management approaches by providing credible, cost-efficient and useful data and tools that describe the physical environment of defined watersheds of interest. Effective descriptions of the environment of watersheds must describe not only the physical characteristics of the environment at specified locations (e.g. its soils, vegetation communities, geological materials) but also the major processes that operate within the watershed. Several spatial data models have emerged in recent years that aim to develop and describe explicit hydrological linkages between adjacent spatial entities (Maidment, 2000; Flanagan et al., 2000; Band et al., 2000).

These spatial data models not only describe the physical characteristics and current status of specific

locations in the landscape, but also facilitate procedures for modeling the movement of water, or materials carried by water, between adjacent entities. This presentation illustrated the concepts involved in, and the advantages derived from, defining integrated land and water spatial entities. It uses examples from a recently completed pilot project within the Cariboo Forest Region of BC. This work was done in collaboration with Tracey Earle from Lignum in the Cariboo region. The examples illustrate how spatial entities defined from digital elevation data by considering both geomorphic shape and hydrological connectivity were useful in predicting the environmental conditions required for estimating the most likely ecological classification (Site Series) at given locations. The examples also demonstrate how definition of hydrological linkages between defined spatial entities (e.g. hillslopes, portions of hillslopes, sub-watersheds, channels and sinks) may offer significant advantages for many other analyses of interest for assessment of watershed processes and their possible impacts.

It is argued that such new, integrated, land and water spatial data models will become increasingly necessary and valuable for supporting watershed-based management approaches. The models describe, and can directly support modeling of, interactions between entities arising from the movement of water from any entity to its downslope neighbor or neighbors. Both the data needed to support them and the tools needed to implement them are becoming increasingly feasible and affordable to obtain.

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Streamflow Models In Integrated Forest-Watershed Planning: How Much Complexity Is Warranted?

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Annual water yield models have been criticized as watershed assessment tools because of their limited ability to represent the full range of forest harvest effects on hydrologic processes governing streamflow in forested watersheds. However their relatively modest data requirements along with their ability to project the cumulative effect of forest disturbance and subsequent hydrologic recovery on streamflows make models of this type particularly suitable for integrated forest watershed planning. Annual water yields in Alberta are reasonably well correlated with both average and maximum annual peakflow events allowing for adequate representation of these hydrologic variables using annual water yield models along with broadly available hydrometric and climatic data. The forest planning in Alberta is accomplished by strategic, tactical and operational levels. Options for model simplification will be discussed using two annual yield models (WRENSS and ECA - Alberta). Simple cause and effect modeling are not often possible because of the two driving variables – climate which can't be predicted and forest condition. The ECA (Equivalent Clearcut Area) model can be criticized because of lack of data. The WRENSS is a serious attempt at a detailed water balance simulation . In conclusion, there was an agreement by the presenter with the quote: "All models are wrong, but some are useful." ▲

Water Resource Optimization Modeling for Forest Management

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There are broad modeling issues and problems involved in optimizing water quality, storage and flow in forest management planning. The level 1 IWAP is our current basic watershed-modeling tool. The IWAP method uses a series of basic variables to analyze probable changes to watershed hydrograph as a result of management activities. This presentation looks at the data and variables behind the IWAP, and

watershed modeling, and examines the potential benefits of using more sophisticated watershed models. Issues examined include:

- The basic variables influencing watershed modeling
- The magnitude of variation expected for each variable due to changes in land use at both the stand and watershed level
- Potential tools for managing hydrograph and water quality within a forestry setting
- Economic implications, both benefits and costs, of water storage and flow optimization. ▲

Research and Science in Watersheds

Science, Watershed, and Stream Channel Morphology

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The objectives of this presentation were to outline what is known about stream channel morphology and to apply this knowledge to the management of streams. Generally channel morphology depends on many factors of which sediment and debris supply, riparian vegetation and direct disturbance of channel bank and bed are the most important in a forestry context. In a coastal stream the morphology varies longitudinally from stream mouth to the headwater. It includes riffle-pool habitat, cascade-pool habitat, and near the top of the system, very stable step-pool morphology in the headwater zone. In plateau regions of the province's interior, the morphology is different. The headwaters of the river may be riffle-pool, and the step pools may occur downstream.

Large Woody Debris (LWD) is critical in riffle-pool morphologies where it causes scour and fill, leading to channel complexity. The LWD is supplied by landslides on the coast, while it is more often generated from floods inland. Large loads of debris are delivered episodically and create huge logjams. Over time, a complex and diverse stream evolves from these initial disturbances.

In a results-based code world, it may be difficult to determine cause of identified channel disturbances. Three case studies illustrate the potential problems. Dramatic changes in a section of Carnation Creek (Vancouver Island) could have been attributed to logging, when the actual cause was more influenced by hillslope processes upstream. The Yakoun River (Queen Charlotte Islands) shows the importance of historical management activities. Removal of LWD at the turn of the twentieth century influenced channel conditions for much of the century. Finally, an extreme example from Donna Creek (MacKenzie Forest District) illustrates the problems of determining the cause of channel changes due to legal arguments. These studies are intended only as a caution when using channel disturbance as a measurable result in results-based management. ▲

Sediment from Road Erosion and Landslides – Application of Research Results to Watershed-Scale Risk Assessment

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Sediment in streams is a natural and important component of watershed systems. However, too much sediment, or short-term increases in sediment yield, can reduce the value of a stream for domestic water supply and for fish habitat. Sediment from forest development is therefore an important management issue, and drives much of the content of the Forest Practices Code concerning watersheds. There are two main sources of development-related sediment: erosion from roads, and landslides.

Two long-term sediment budget studies are in progress in the Nelson Forest Region, in the West Arm Demonstration Forest and the City of Cranbrook watersheds. Results from these studies show that forest development can cause an appreciable increase in sediment supply to streams, mostly from erosion of logging roads. Increases observed so far are mostly of short duration and have had only minor impacts on water quality. Sediment inputs vary greatly from place to place, due to the geologic and hydrologic properties of the watersheds as well as to engineering practices.

Recent research into road erosion processes has enabled us to develop improved methods for mapping and assessing erosion and sedimentation risks from forest development.

Also in the last five years, we have studied the distribution and frequency of landslides in the Nelson Forest Region. Because no landslides occur in most watersheds in most years, sediment input from landslides must be treated as a risk, not as a continuous

process. In any watershed containing landslide-prone terrain, there is a very small probability of a very large input of sediment to the stream. A risk assessment approach must be used in planning forest road systems, to minimize risks to stream channels and water quality.

The sediment load of streams is mainly a function of climate and geology, but forest development can lead to risks from increased sediment supply. The episodic nature of sediment inputs from road erosion and landslides raises important questions about how risk can be evaluated, and water quality impacts monitored, under the proposed results-based Forest Practices Code. ▲

Science-Based Forest Management on Fans

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Throughout the province, forest managers have encountered problems on fans. A fan is a landform the surface of which forms a segment of a cone that radiates downslope from the point where a stream emerges from the confines of a mountain. Bridges are characteristically of insufficient size to withstand periodic debris flows, hyperconcentrated flows and bedload/debris associated with major floods (hydrogeomorphic events). Roads are frequently eroded by unexpected broadcast flows. Riparian reserves are absent where there are no fish values, or too narrow to contain sediments and water, resulting in impacts to growing sites and improvements. The BC Forest Practices Code provides little direction for forestry activities on fans and the current terrain stability mapping does not identify hazards on fans.

To address this knowledge gap, a research project was initiated in 1999 to develop a hazard classification for forestry on fans. The classification is based on an inventory of 63 fans and their watersheds in the Prince Rupert Forest Region. Forest stands are the leading indicator for the classification. Other site features and watershed attributes are also used.

Forest stand types are used to identify zones of activity on a fan rather than to typify a whole fan. We found that disturbances as expressed in forest stands range from narrow (4 m. along the channel) to wide (1 kilometre from the present channel). However, very few cases were found where the whole fan surface is being actively influenced by hydrogeomorphic events. On the other hand, all fans showed some level of disturbance (i.e., we didn't find any stable fans).

Reliable use of airphotos for forest stand type classification is limited to FS4 cohorts that are at least 20 meters wide. On airphotos, FS3 stands may be confused with open grown stands on devil's club ecosystems. Field identification is required to positively identify forest stand types and determine time periods of disturbance. Forest cover maps were not found to be reliable for stand type classification.

Fieldwork is also required to identify a range of site features related to forestry prescriptions. In particular, the nature of the stream channel, the hydrogeomorphic role played by riparian vegetation, and evidence to identify the type of hydrogeomorphic processes.

Analysis of watershed attributes is currently ongoing. Several trends are emerging. The objective of the research project over the next two years is to test the fan hazard classification and provide training to operational foresters, engineers and geoscientists in other areas of the province. This research and extension project has demonstrated that sustainable forest management is possible on fans.

(Editor's note: This paper is presented in its entirety in Streamline 6:03.) ▲

Is Water Quality Sampling an Effective Means of Monitoring Watershed Condition?

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Many forest management and watershed rehabilitation activities are undertaken with the objective of protecting water quality. In a "results based" context, the monitoring of water quality would appear to be a means of assessing the effectiveness of those activities. A review of several studies indicates that it is difficult and expensive to monitor water quality in such a manner that the land use impacts are detectable. In order for a monitoring program to be effective one must be able to separate the natural variation in a parameter from the incremental effects of land use. We examined three case studies in southeastern B.C., where we monitored effects of land use. These are:

1. Matthew Creek study wherein we looked at the effects of a fire for 10 years after the fire, which had burned a 22 km^2 area. Impacts of nitrate and a number of other parameters were detectable for 4 years after the fire. An upstream/downstream sampling design and an unburned control were factors that made this monitoring effective.
2. A Monitoring Program to Study the Effects of Cattle Grazing on Water Quality on McMurdo Bench. An upstream/downstream sampling design provided local residents with assurance that there were minimal effects of grazing on their drinking water.
3. A Sediment Budget study to test the Watershed Assessment Procedure. The sediment yield was compared in 11 watersheds subjected to various levels of historic cut.

Common characteristics of each program were: a sampling frequency that was appropriate to the parameter being measured, a means of separating the treatment effect from natural variation, sampling of parameters known to be impacted by that land use, appropriate replication where possible, and sampling locations as close to the activity to be able to identify which land use was causing the problem. There were problems inherent with setting water quality objectives. The results of the McMurdo Beach study demonstrated that if you keep the cattle out of the stream the local water user can have the same water quality as protected areas. The conclusions based on all the watersheds studied were that watersheds change in a complex manner. The water quality changes continually in response to many variables. In order to measure and interpret the results, there must be a control. ▲

Assessing the Effectiveness of Logging Road Deactivation Using Stream Silt and Aquatic Invertebrates

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A five-year, multi-proponent watershed study is being conducted in the Nahatlatch River Watershed west of Boston Bar, B.C. The study was initiated because the Boothroyd Indian Band had concerns about the water quality and it seemed that road deactivation was causing turbidity. This study examines logging road deactivation levels and techniques and their ongoing impacts on stream silt levels and stream invertebrates. This FRBC-funded project has provided the opportunity for scientists, First Nations, logging companies, and other government and private firms to explore the effects of logging roads on water quality. Results will be used in the development of management strategies.

We examined water quality in six streams chosen for their varied logging road histories. We measured Total Suspended Solids (TSS) and Turbidity daily using ISCO 6700 automatic water samplers. Stream invertebrates were collected using Hester-Dendy multi-plate invertebrate samplers following a 42-day colonization period. The combination of silt characteristics and invertebrate communities within each stream was used to gauge the effectiveness of that stream's road deactivation methods.

Log and Mehatl Creeks, and the Upper Nahatlatch River were on the order of ten to twenty times as silty (measured both as TSS and turbidity) as Kookipi, Squakum, and Tachewana Creeks. These streams differed in their levels of road deactivation (Squakum and Tachewana Creeks: roads over 20 years old, un-deactivated; Log and Kookipi Creeks, and Upper Nahatlatch River: active logging roads, un-deactivated; and Mehatl Creek: no roads). Mehatl and Log Creeks, and the Upper Nahatlatch River also have glacial influences (excessive silt), which need to be quantified in order to accurately assess the effectiveness of that stream's road deactivation scheme. The multi-plate invertebrate samplers were dominated by Ephemeroptera, specifically by the families Heptageniidae and Baetidae. EPT (Ephemeroptera, Plecoptera and Trichoptera) and diversity indices were used to compare the biology of the streams.

The conclusions were that the two sub-basins with active logging have turbidity and sediment issues. Old logging roads do not contribute sediment to the streams. Natural sources of sediment also affect the turbidity. ▲

Snow Research and Watershed Assessment in the Southern Interior

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Watershed assessment guidelines in British Columbia

use rates of harvest and regrowth to evaluate forestry-related hydrologic change. In the interior, these guidelines are based on the idea that snowmelt generated streamflow is one of the key watershed processes that can be affected by forest land-use. Snow research generally involves detailed measurements of basic processes at the plot or stand scale. The results of this research are often extrapolated over broad geographic areas and forest types for use in operational planning. Research results may also be used to develop provincial forest practices guidelines. However, with increasing regulatory constraints on timber harvesting and with greater concern for water resources, the validity of guidelines based on limited local data and on indicator criteria, such as snow, is often questioned.

Snow research in the Kamloops and Nelson Forest Regions, as well as in other parts of the province, is beginning to improve our understanding of the interactions between forest cover, snow, and local watershed processes. Research in the southern interior has focussed on mature, clearcut, and juvenile stands of lodgepole pine, Engelmann spruce and subalpine fir at Mayson Lake and Upper Penticton Creek, and of mixed species at Trapping Creek. The results of this research show significant differences in snow accumulation and melt rate among forest types, a varied effect of juvenile stands on snow processes, and that snowmelt from desynchronised stands over a watershed can become synchronised following harvesting. Currently, these results would be extrapolated to other stands based on tree height. The research has shown that other forest inventory variables, representative of the interception capacity and shading characteristics of a stand, are likely to be more effective predictors of differences in peak snow accumulation and melt among stands. Understanding the relationships between stand characteristics and fundamental hydrologic processes, such as snow accumulation and melt, will improve our ability to assess the effects of changes in forest cover on watershed response. ▲

Stream Channel Monitoring in the Southern Interior of British Columbia

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Stream channels are in a state of dynamic equilibrium as streamflow and sediment supply vary and framework elements develop, erode, and migrate downstream. There is, however, a lack of knowledge on the diversity of stream function and on the rates of change found in streams in the four main biogeoclimatic zones in the southern interior of British Columbia: Interior Douglas-Fir (IDF), Montane Spruce (MS), Interior Cedar-Hemlock (ICH), and Engelmann Spruce-Subalpine Fir (ESSF). This project is designed to monitor channel morphology in unlogged and logged watersheds throughout the southern interior of British Columbia. Permanent cross-sections provide detailed topographic survey information, which, with a complementary orthoimage, present a readily repeatable and descriptive tool to monitor channel change. A total of 29 cross-section reaches have been established in 13 watersheds to begin the process of systematic collection of data for southern interior streams. These reaches will provide insight on the framework and function of streams and the rate of change in the channels. Over time this should include some major climatic events (rainfall, snowfall, snowmelt or fire) that may cause more change in one event than many years of normal weather. This photographic methodology is a relatively new technique for monitoring a watershed and supplies the spatial and temporal indicators of management activities on watersheds and riparian zones. It can be used to detect long-term and short-term changes. ▲

Each year it is heartwarming to see that there are more and more indications that industry is assuming the role of environmental stewards. In this case industry is supporting the watershed stewardship groups financially. Harry James, General Manager, Health, Safety & Environment for Gibson Petroleum presented cheques to Wes Ilinsky from the Eagle River Roundtable Society and Mike Wallis from the Salmon River Watershed Roundtable Society to support the successful work that has been accomplished in these two watersheds.