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The Legacy of WRP

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The Watershed Restoration Program (WRP) was established in 1994 as a provincial initiative under Forest Renewal BC to restore the productive capacity of forest, fisheries and aquatic resources that had been adversely affected by past forest-harvest practices. It came into effect at about the same time as the Forest Practices Code.

The Code was generated largely because of two independent audits done by Tripp consultants from 1993-94, the first commissioned by Ministry of Environment, Lands and Parks, and the second by Ministry of Forests. Both audits caused a strong public response and demand for changes. The reports had similar results, showing many slope failures, about 2/3 from landslides and 1/3 from gully over-loading failures. The landslides and failures resulted in torrents and other damage to fish-bearing streams (Tripp, 1994). It was also evident that many culverts were undersized for flood capacity. The decay of stump roots on overloaded road fills were identified as a primary cause of torrents and landslides. There was no streamside protection in the Interior, and only on the Coast after 1988. On the Coast, the Coastal Fish Forestry guidelines were established in 1988 to control forest harvesting close to streams. Finally in 1995, the Forest Practices Code began to protect streams from disruptive forestry practices.

Past forest-harvest practices had negatively affected water quality, fish stock productivity, and habitat of anadromous and resident fish. Often the many roads required for log transport caused the problems. They resulted in changes to flow and drainage patterns in existing waterbodies. Sometimes, it was a lack of understanding that caused problems, as during the 1960's and 1970's logging was to the edge of the streams, then the streams were "cleaned up", removing logs and trees from streams. Fish passage at road culverts has been a long-standing concern, but the extent of the use of the small tributaries and off-channel refuges by juvenile fish was not well understood. Without intervention and proper deactivation, the old roads often fail at the drainage crossings or saturated side-casts. Logging also caused greater sediment delivery to streams, in part from old roads and in part from the landslides and gully failures. Early forest practices favoured natural restocking of trees, resulting in a dominance of deciduous trees. This promoted the beaver activities, such as damming, on small streams and ponds that are utilized by the fish species. A lack of streamside protection decimated many of the riparian zones, which we now understand to be of key importance to fish habitat and,thus, survival.

Logging was not the only threat to fish habitat. Agricultural practices and urban development caused damage to streams too. In the early years, WRP was focussed on trying to fix the problems caused by logging. This focus has broadened during the duration of the program, and now the program works with the agriculture industry and is also involved in watershed development issues. The goals for watershed restoration have changed as the years progressed to reflect less on seasonal employment, forest rehabilitation requirements and more on aquatic resources, stewardship, and environmental awareness.

With the exception of transition projects, since 1999 the goals of the WRP have been to:

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

As the Watershed Restoration Program will no longer exist by the time you read this it seems like a good time to review the legacy of the projects that were initiated and completed under the WRP. The program has been very successful in mitigating many problems that were caused by past forestry practices. In order to give a balanced retrospective, it is also useful to look in general terms at problems that could have been avoided. As is often the case with retrospectives, hindsight is twenty-twenty. To research this summary, I spoke about the lessons learned with a number of people that have been involved in watershed restoration throughout the province including consultants, engineers, foresters, biologists, licensees, representatives from government agencies, WRP staff and former staff. As environmental regulation moves toward a results-based program, many concerns are being expressed about whether watershed restoration will still occur and whether existing projects will continue to be monitored and maintained in a proper adaptive-management model. There has been a move towards stewardship and sustainability, and in the best

of all worlds, this will be borne out in results-based environmental management. Once again concerns were raised that the information that has been learned through the process of watershed restoration should be made available and proactively shared with those who will be in the decision-making roles. There is a famous quote, credited to George Santayana, that gives us this warning: "Those who do not remember the past are condemned to repeat it."

When the WRP was initiated, the idea of stream restoration was new. There were not many projects in Canada to look to, and few staff members had experience in this field. Most consulting firms had little or no experience in this type of work and experienced crews were not available. Now there have been approximately 2000 people trained in watershed restoration work by the WRP and cooperative programs offered through the Forestry Continuing Studies Network. Those who have been trained include consultants and professionals, as well as displaced forest workers and First Nations' crews. The BC Advisory Team was established as a mentor program, linking people who had been involved in WRP for years with those who were planning WRP projects, often in geographically isolated communities. The US Forest Service had begun watershed restoration a decade prior to our program in BC. A technical exchange was established with them, and each year there was a formal sharing of information where a team from Washington and Oregon would come to BC and advise our technical staff on specific problems for restoration. In addition there were five technical exchanges between the US staff and those individuals that were conducting watershed restoration in BC. Notes and abstracts from the US/BC Technical Exchanges were highlighted in Streamline (Vol.1-1; Vol. 2-4; Vol. 4-2; Vol. 5-2; and Vol. 6-1). One of the most important legacies of the WRP is the human resource of well-trained people.

The province was divided into the following WRP regions: Vancouver Island, Lower Mainland, Southern Interior, Kootenay, Cariboo, Skeena, and Omineca-Peace. Funding and personnel to accomplish watershed restoration projects came from a variety of sources including Forest Renewal BC, Ministry of Forests, Ministry of Environment (and most recently the Ministries of Water, Land, and Air Protection and Sustainable Resource Management), Stakeholder, and Stewardship groups, First Nations, Fisheries and Oceans Canada, Fisheries Renewal BC, and private landowners.

Another legacy of WRP is a plethora of assessments, and projects, which are listed in the Fisheries Project Registry http://www.canbcdw.pac.dfo-mpo.gc.ca/fpr/Qf_Welcome.asp. The assessments were done and then refined, mistakes were made, and adaptive solutions were developed. Many of these assessments will provide benchmarks for future work towards sustainability and biodiversity in watersheds.

WRP has recaptured, rehabilitated, and constructed at least 750 kilometres of fish habitat that was unavailable because of former logging practices (Zaldokas, 1998, 1999; Underhill, 2000, Cleary and Underhill, 2001). Off-channel and side-channel projects have been constructed to provide fish habitat that may have been there historically, but was not there in 1994 when the program began. Much of this work was off-setting or mitigation because the mainstem impacts could not be restored. Hundreds of large-scale projects to replace lost channel-structuring elements were carried out to restore the amount and quality of fish habitat. Providing fish access through properly installed culverts, bridges, and cross-ditches has been a success story. Experimental introduction of nutrients to streams have been very successful in replicating the food sources of fry that were historically provided by salmon carcasses. Many natural drainage patterns have been re-established and water quality has been improved. Riparian and streambank functions have been restored to pre-logging conditions through bioengineering and silvicultural modifications in many situations. Most of these aquatic projects are listed in the annual compendium (see references above). Road deactivation, which really was one of the major components of the overall Forest Renewal BC program has resulted in far less sediment entering many systems, thereby improving water quality and fish habitat.

Throughout the Watershed Restoration Program there have been lessons learned and the success of the program has been to communicate these lessons and make the changes that are required to adapt the solutions to be more effective. In outlining the lessons learned, I have tried to provide examples. Some examples are from very successful projects, while some of the other examples may reflect projects that did not meet their objectives

Lessons Learned

1.) Approach Restoration in a Whole Watershed Context

At the beginning of watershed restoration in BC and elsewhere, much effort initially went into instream structures. There are stories of instream projects that were completely in-filled with sediment by the year following construction. There were situations where there was a debris-torrent or stream avulsion problem after the construction of the structures. Sometimes

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structures were completely blown out. This lesson was first learned by studying the US Forest Service experience.

Approximately three years ago, there was an extensive planning process to prioritize the watersheds that most needed work, where fish stocks were at risk, and where the work could be done in a feasible manner. These resulting Resource Management Plans were developed in each region, identifiying high priority projects based on factors such as the likelihood of success, existing investment, community water sources and social/ cultural importance. The results were published in the Watershed Restoration Program Planning and Priority Setting for the next Five Years – Phase 3 Watershed Level Planning (Chatwin et al., 2000). At this time, Forest Renewal BC set a program goal of restoring 20% of high priority watersheds by the year 2004. Restoration works within those "target" watersheds have been proceeding until Mar. 31, 2002.

Often when there is a specific problem, for example a stream avulsion, a consulting firm is hired to fix the problem. Now we know that some large watersheds probably cannot be "fixed", but the initial response has generally not been: "we can't fix this problem." A Ministry employee, on the other hand, who has been involved in many problems and many watersheds, may be able to see the whole picture and be able to provide a larger perspective to a licensee. Examples of the problems encountered by not approaching the watershed as a whole were seen in early projects in some of the very steep watersheds located on the coast. As the gradient of the stream drops, sediments are deposited. These streams were often used by coho and early spawning steelhead, and their habitat was restricted or of poor quality where the channel braids out and dewaters. Efforts were made in the early days to solve the problem by removing the sediment in the channels. But there was so much material in the system above, that the sediment re-entered the system. The works completed did not generally result in harm to fish, however the project objectives were not met. Perhaps the decision should have been made initially to fix these watersheds from the top-down, first addressing the cause of sediment production, rather than approaching site-specific problems lower in the stream, or river. The moral of the story might be to not work in unstable systems, or to work on the margins looking for off-channel opportunities.

A good example of approaching restoration in a whole watershed context would be the Kennedy Flats Watershed Restoration Program, in the Clayoquot Sound near Tofino. This project combines road deactivation, restoration at road crossings and extensive instream habitat restoration work. It is a jointly managed project involving a management team composed of members of Interfor (the lead proponent), MOF, MELP. Many partners also played important roles in the project, including the Tla-o-qui-aht First Nations and the Uclulelet First Nations, the Thornton Creek Enhancement Society, the Tofino Salmon Enhancement Society, the IWA, and MacMillan Bloedel. Prescriptions specified construction of about 1900 cross ditches, and removal of approximately 900 bridges or culverts, of which, over 400 were estimated to be on fish-bearing watercourses. Instream work involved removing, rearranging, and anchoring wood debris to restore channel capacity and increase scour. Some problems were encountered when streams were over-cleaned initially. Cover habitat was also enhanced, and added in the riparian zone for wildlife. Work started at the upstream reaches of the creeks and proceeded downstream. This was also found to ensure access was maintained for both road and stream work.

Processes are complicated, however, and monitoring work in the Kennedy watershed indicated that there were some problems with clearing the upper reaches first during 1996. The studies concluded that clearing the upper reaches first allowed amore rapid transfer of the water downstream, causing increased flooding of infrastructure and riparian zones, and potential instability of jams in untreated lower reaches. Thus, in 1997, the methodology was modified and, while work continued from the upstream end, the entire lower section was also treated concurrently.

Strong Project Management

Project management is very important to the overall success of the project. Generally the projects have been managed by a variety of personnel including consultants, WRP staff, licensees, staff from stakeholder groups or stewardship groups, First Nations managers.

The management of WRP projects has improved significantly throughout the WRP history as the project managers gained experience. The most successful projects were managed well and were impeccably organized from the assessment and the design process, through permitting, organizing materials and crews. They were carefully supervised through implementation, and all work was monitored. Commitment of the project manager and crews has been identified as very important by many WRP staff. The good projects often have a very keen and organized project manager, and often is a person that lives close to the site, so that they can go back and

check it frequently. This informal monitoring allows for quick and adaptive solutions to improve the project. Monitoring, even in an informal manner, over the period of years is the best way to learn the management skills required. If a contractor goes back to the site to re-visit, they will learn.

Two of the very important aspects of managing watershed restoration projects have been a collaborative approach and clearly stated objectives. The collaborative approach must start during the referral process. It is necessary to work closely with all landowners and stakeholders involved along the stream, and to work as a team with the crews that are constructing structures, installing culverts, or providing bioengineering to the project. Open communication was found to be key. Managers that rushed or ignored the referral process caused major problems for the program. Ignoring an upstream landowner's concerns could jeopardize the project.

With the possibility that the future of watershed restoration may move to results-based implementation, there is a concern that the commitment to careful management of existing restoration projects will not be a priority and there may be much less aquatic rehabilitation. Of course, the financial bottom-line will be the major objective for licensees, which has not been the case to date, with most WRP projects. The objectives for the past few years have been more focussed towards restoring, creating or enhancing fish habitat. Results-based implementation could result in expecting a variety of groups, with third-party delivery, to provide watershed restoration. In the past, when WRP teams were given a lot of leeway, and not provided with adequate training and communication lines, the projects were not done well. As an example, some of the projects carried out under "Delivery 2K," a hands-off project management project piloted in Region 1, achieved lower success than projects carried out with more direction. Yet, the need for forest product certification will continue to ensure some effort is placed on watershed sustainability.

An example of a well-managed project was the San Juan watershed where private forest companies and agencies cooperated in the restoration because of the deterioration of the San Juan River. Although initiated by a court action, this restoration was managed jointly under the San Juan Watershed Agreement, which provided for a Management Committee and a Steering Committee. The agreement was signed on August 1, 1995, and terminated on December 31, 2001. The Management Committee consisted of an Assistant Deputy Minister from MELP, the MOF District Manager, the Chief of Habitat Policy Unit for Fisheries an Oceans Canada (FOC) and the Chief forester from both MacMillan Bloedel Ltd. and TimberWest Forest Ltd. The steering committee also involved Pacheedaht Band, Sooke Renfrew Forestry Society, San Juan Enhancement Society, Cowichan Lake Forest Coop, Renfrew Community Association and the International Woodworkers Association (IWA Union). The San Juan watershed is huge, 665 km^2. This project initially came about as a result of a large fine that was levied against one of the forestry companies.

A coordinator , Bud Iverson, was hired in October 1995, to work for committees, and consulting biologists that were hired in managing this huge project. Detailed assessments and prescriptions were developed for hillside restoration and road deactivation during 1997 and 1998. Terrain mapping was used to map gullies, slides and soil stability and to provide recommendations for treatments where feasible. A report was prepared and used to determine areas of priority for action, and a number of landslide rehabilitation projects were initiated. Hydrometric stations collected data. Stream restoration and enhancement activities were planned and completed on tributaries. Many of these involved the addition of large woody debris (LWD) to the streams. Bioengineering was an important component of the upslope activities. These activities were detailed in Streamline (Iverson and Epps,Vol. 3, No.4). The riparian zone was enhanced and the detailed work and follow-up work was described in Streamline (Muller and Muller, Vol. 4, No.1).

Figure 1. An example of some of the areas chosen for road deactivation in the San Juan watershed.

Anecdotal stories that demonstrated poor management involved roads that were deactivated, then reactivated in order to extract timber. Another problem that occurred early in the history of watershed restoration

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involved a project that initially called for groundwater test pits, monitoring, etc. prior to choosing the site and installing fairly major instream works. There were many referrals required, but the protocol was not followed and a "let's just get it done" mentality set in. As a result the project was installed prior to the proposed data collection and monitoring. The project site that was chosen was poor, the geomorphological risks were high, and in the end, the proponent was required to remove the project. Although fish were probably not harmed by this poor management, it no doubt led to mistrust and misappropriation of funding.

A problem that has faced managers on a project basis, he watershed basin, regional basis, and even program basis was the setting of clear goals and objectives. In the introduction I mentioned that the objectives/goals of WRP had changed through the years. Initially one of the goals was related to forest resources. At least 50 percent of hillslope projects, as a conservative estimate, were likely driven by non-water/fish objectives during those first five years. This did reflect the very broad range of the initial goals of Forest Renewal BC, and did not always mesh clearly with the aquatic goals of the Watershed Restoration Program. As a result restoration of forest resources were removed from the program goals in 1999. Upslope work could still be carried out, but only in areas where fish and aquatic resources were effected.

Information Management/Monitoring of Projects
A lack of monitoring programs and project success became evident as more and more projects were implemented. This became problematic for the WRP and Forest Renewal BC because there were a lack of statistics regarding the work that occurred. When I was researching this article, I was unable to determine the number of kilometres of road that have been deactivated.

In the beginning WRP projects were constructed to meet specific objectives, however money was not always allowed in the funding for ongoing monitoring and adaptive maintenance. WRP practitioners suggested that it would have been useful to set up some of the WRP projects purely as experiments. As many of the projects were quite experimental in the first place, it led to projects being considered "failures" if the objectives were not met. If they had been purely experimental, then research objectives would have been met, and perhaps surprising results would have occurred in teaching us other lessons. Also in the beginning, the information was not as easily shared between ministries, and with all people that were doing watershed restoration. This has improved as the program matured and the knowledge base expanded.

Another suggestion was that, perhaps when the program was established, there should have been approximately one million dollars that was put into a trust fund or investment fund, and now, years later, the interest from the initial investment could have been used to support ongoing monitoring and maintenance.

Sometimes in our restoration program, we did take a chance and try something that wasn't tried and tested. This approach often resulted in a gain of knowledge that could be applied to other systems. An example of a great project that did have a novel approach was the instream work in Colt Creek (Figure 2). There had been long-standing instream issues with this creek, and the road that had been developed along the corridor. The restoration work involved very large-scale tree revetments (up to thirty trees in a structure). These have stood up well, and met objectives very well. Monitoring of this project concurs with some of the research that has been coming from the US studies and their conclusion is to the "go big".

Program Coordination and Financial Management
In the beginning the WRP was given the direction to have region-by-region coordination. In retrospect, starting with central coordination may have been wise,

Figure 2. Very large tree revetments in Colt Creek have successfully met project objectives.

as re-inventing the program sometimes led to the spinning of wheels. Sometimes the work had been done successfully in another region, or even in the same region by a different ministry, and the information could have been shared. Sometimes the Ministry of Forests and Ministry of Environment worked hand in hand, other times it was more difficult.

The financial management based almost entirely on a budget, which must be spent or lost by fiscal year-end leads to much waste in government budgetting. We are dealing with biological systems that have their own patterns. For the first few years, it seemed incredibly difficult to "roll the projects out" each spring, as the budget process dragged into summer. Sometimes projects would optimally be accomplished in April and May, but the money is never available, because budgets

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are not approved at that time. If the money is not spent by Mar. 31, it is lost. There is no possibility for credits to be issued if a manager is careful, and may not have spent all that money.

Long-term funding would allow work to proceed at the optimal time of year. The San Juan WRP was based on long-term fund management because much of the funding was from the private forest companies. Results-based management may also assist in this management over the long term, however, this will only work if there are annual expectations for the monitoring and reporting.

Technical Expertise
Some individuals chose watershed restoration as a career, and embraced that career. Many of these individuals have strong training in forestry, or engineering, or environmental studies. There are, however, other individuals who found themselves in watershed restoration because of the economic situation in the province. Still others fell into it as a member of a stewardship society. Now, members of societies are providing project management for many WRP projects. Some people had embraced the concept and objectives of the program, while others were just trying to piece together a living in the area that they live. Some of these individuals saw the opportunities in Watershed Restoration Program, or were talked into it during the years when there were many projects requiring crews. All individuals were provided the opportunity for training. They were often displaced forest workers, or their chosen work may have been in commercial fishing and guiding but they did need to supplement their chosen work. Watershed restoration wasn't a chosen field for all, and sometimes this was reflected in the quality of the work.

The lesson learned is to provide projects with sufficient technical expertise to support the project staff. The referral process ensures that experts from other disciplines check the project, but most frequently it is preferable to obtain technical advice prior to the referral stage. This should be done by involving a variety of disciplines in the assessment and planning process.

We have come such a long way in training a brain trust that it would be a pity to lose many of these individuals to new opportunities outside BC or to different careers because the whole program has been cancelled. Practitioners have all learned from the training, from observing successes and failures and from monitoring. The restoration work has been far better during the past few years. The protocol set in action by FRBC in 1999 has led to a much more focussed and organized program. Projects really don't have many problems any more, as much of the Routine Effectiveness Evaluation (REE) is showing 80 - 90 % success (Wilson, et al., 2002).

Spend restoration money where there is the technical / physical ability to fix the problems.
This warning may be particularly useful to licensees that are assuming new work in watershed stewardship. It was heartening to hear that one of the criteria for projects that will be funded by the Pacific Salmon Endowment Fund is "do-ability." Some of the early work in particular that was funded within the Watershed Restoration Program was in areas that we did not have knowledge about all the processes, such as alluvial and colluvial fans. Research has been ongoing about this topic and is reported in Wilford, et al., 2002. It will be interesting to have more information on treating problems within the instability of fans. If the process isn't understood, it is difficult to predict what will happen. Another example where we may not have the technical or physical ability to fix the problems are found within watersheds that were heavily affected by riparian logging. It is important that the results or information determined are disseminated quickly.

Hillslope Restoration
Approximately eighty percent of WRP funds were expended on hillslope restoration. Although I began by talking about the importance of a holistic, top-down approach to watersheds, perhaps it was overdone in some cases. Full deactivation in certain cases at considerable costs was done to a very high standard, when partial deactivation would have been successful in meeting objectives for water quality and fish habitat. We have learned lessons in managing forest road deactivation and some of these lessons were outlined in Allison and Tait, 2000. More careful analysis assists decision makers and managers to more carefully choose the level of deactivation that is required. Part of the problem may have been a cautious approach by professionals because of their liability, but part of the problem may have been a result of unclear objectives for the program and inefficient prescriptions. Partial deactivation would have sometimes accomplished the objectives, with full deactivation reserved for the sites of most risk of slope failure. Recent deactivation work has been significantly more cost effective, so we have learned from our past mistakes. Road deactivation in the U.S. seems to have followed the same evolution from full deactivation, or obliteration, to partial deactivation.

Channel Structuring Elements
In mature and old-growth forests, streams are filled with abundant pieces of large wood that store sediments

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and affect the morphology of the stream. Hundreds of large-scale projects to replace lost channel-structuring elements were implemented to restore the amount and quality of fish habitat. Many of the projects involved the addition of large woody debris (LWD) to the streams. The lessons learned regarding instream restoration structures are well summarized in Evaluating the Performance of Channel and Fish Habitat Restoration Projects in B.C.'s Watershed Restoration Program on p. 3 - this Streamline.

One of the lessons learned by practitioners was to "go big". Of course this depends on the size of the system. For instance, LWD structures in small streams could be a waste of money and effort. In a small stream, successful channel structuring may involve construction of a stone line. However, in medium-sized and large streams, particularly when there is a large fluctuation in flow, large composite structures are required. These structures should be as large as possible, well-anchored, and ballasted. In some systems the importance of large boulders and woody debris combined with boulders is evident, and practitioners also mention the importance of sufficient ballast. Proper anchoring and ballasting has been shown to increase the success rates of LWD structures by 7 to 30 % (D'Aoust, 2001).

Another lesson learned was that "logs are not trees". Whenever possible the use of whole trees to create structuring elements will be most successful. The rootwads in particular, add complexity and trap smaller woody debris to provide additional cover for fish.

A recent and interesting example of channel structuring was seen in the work on the Pine River. This project was undertaken after a huge oil spill from the Pembina pipeline. As part of the river cleanup, most of the 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 re-occupy side, back, or abandoned channels. The potential channel instability was thought to have negative long-term implications for fish habitat (Abstracts, p. 12A). Northwest Hydraulic Consultants Ltd. was contracted to provide assessment ant subsequent mitigation where practical. Monstrous logjams were quickly constructed during the fall of 2000, very soon after the oil spill. Post-freshet monitoring revealed that three of the sites needed maintenance, a new jam needed to be constructed and one logjam had failed.

Riparian Restoration

On the topic of riparian restoration, I received differing opinions. One person felt that the best investment of all during the process of watershed restoration had been in riparian restoration, and that if the program were to begin over again, he would suggest riparian restoration be a place that more money was invested. A differing opinion was that riparian restoration had been a waste of money because returns are in the distant future. The R.R.S.P. of WRP, it is true that this is a long term investment. The hopes of riparian restoration is to accelerate a successional process that would usually take about 200 years.

Sometimes the riparian restoration is very simple, such as installing anti-browsing tree cones to protect trees like red cedar. An example of some excellent riparian restoration has been the work done at the Keogh River by Western Forest Products and Poulin & Associates. These treatments included thinning (with thinned trees added to existing LWD structures in-stream) and creation of wildlife trees and dens.

Bioengineering

There were many lessons learned in bioengineering along the way. Many details are presented in David Polster's article for Streamline Vol.4, No.4. This is another instance where technical expertise is required to have the work be successful. More than a few individuals mentioned that it shouldn't be a fish biologist, or a hydrologist designing the bioengineering work. This is a place for a vegetation management specialist or an ecologist to be consulted. Some of the lessons that we hope have been learned are:

1. Know your species – there were examples where trembling aspen was used instead of willow, resulting in 100% mortality.
2. Don't plant in August – depending on your region, but in many of the interior zones, the August plantings don't make it. The plantings will leaf out beautifully in September and October, but by next April they are dead.
3. If possible, attempt to get cuttings or whole shrub clumps planted deeply along streambanks so that they are into the water table. Dessication over winter is a significant problem, particulary in the interior.
4. Plantings require maintenance, nutrients and water. Many of the ideal examples come from small stream slope stabilization projects where the landowners will continue to water and care for the bioengineering projects on an ongoing basis.
5. Black cottonwood isn't the right species for bar stabilization

Culvert Replacement

Hundreds of kilometres of fish habitat have been

recaptured by replacement of culverts and bridges. Although this is particularly true in the Cariboo and Omineca-Peace regions, most regions have benefitted from this type of WRP projects. All of the practitioners that I spoke with felt that restoration money had been well-invested in fish passage assessments and replacements. This conclusion is borne out by the REE process (Wilson et al., 2002).

Off-Channel Projects

For the most part, the construction of off-channel and side channel projects have been a big success for investment of restoration funding. A major key to the success of any off-channel project is the development of an intake that will supply a constant supply of water. There have been many off-channel projects constructed, as well as side channels and ponds.

One of the many successful examples of off-channel habitat that was created is the Anderson Creek off-channel pond (Figure 3). It was constructed to restore off-channel pond and fish habitat cut off by road construction. It has resulted in an excellent low maintenance site with high productivity and refuge values for fish. It has also been excellent for educational opportunities and provided additional habitat value to waterfowl and wildlife.

Although off-channel projects have been very successful, they will require continuing maintenance. Beavers are a significant threat to preventing fish access into many off-channel projects, particularly as vegetation succession occurs enough to provide cover and forage for beavers. For instance, the outlet of Anderson Pond is a prime example where several beaver dams have likely reduced access for juvenile fish, although adults gain passage during peak flows. Vegetation management will likely be required during the next few years to minimize beaver activity in the outlet channel that are crucial for access by juvenile fish, searching for over-wintering habitat.

Concluding Remarks

There are people that view WRP through rose-coloured glasses, while others that think it was a colossal waste of money. WRP has left a legacy for future generations of British Columbians. Although it has been demonstrated that we can increase fish populations by treating streams, by adding complexity, or nutrients, we cannot protect some species of fish from global warming and other challenges to their survival in the ocean. WRP has accomplished what could be done at the local level; it has improved aquatic resources in key watersheds throughout the province. WRP has increased the management of watersheds, and provided ample opportunities for community based

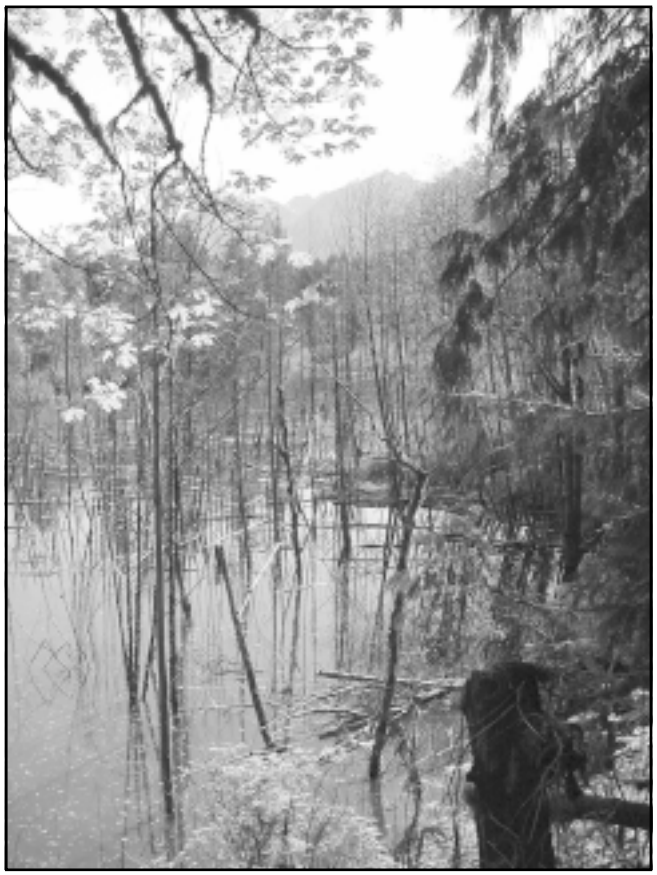

Figure 3. Off-channel habitat constructed at Anderson Channel is an example of mitigation for damage caused to the mainstem of the river by past forest practices.

employment, training and stewardship. The legacy of well-trained people from industry, consulting companies, First Nations, and stewardship groups will keep our streams and rivers as a vital resource for future generations.

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Technical Tip

Environmental Mitigation Prescriptions

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A site-by-site assessment of previously prescribed road deactivation and slope stabilization measures was undertaken on northern Vancouver Island in the spring of 1996. The purpose of this assessment was to prescribe appropriate environmental mitigation measures that would enable road deactivation and slope stabilization works to proceed, where possible, outside the fisheries timing window.

Preliminary standard prescriptions for access and deactivation were developed prior to the field assessment work. These incorporated stream classifications and various mitigative measures and environmental controls into separate access and deactivation prescriptions. Field assessments consisted of stream classification by a fisheries specialist in conjunction with an Erosion and Sediment Delivery (ESD) risk assessment by a geotechnical engineer. It is important to note that an ESD risk assessment should be conducted by an individual with an understanding of erosion processes, slope stability, and road deactivation and slope stabilization activities. Based on the results of the stream classification and the ESD risk, site specific Environmental Mitigation Prescriptions (EMPs) were prepared utilizing the standard prescriptions as a guide. Modification of the preliminary standard prescriptions during the field program was necessary to reflect the results of the field assessment.

Environmental Mitigation Prescriptions consist of site specific prescriptions for mitigative measures, environmental monitoring and timing of work with respect to peak flows. They are to be employed during the implementation of prescribed road deactivation and slope stabilization measures, including activities associated with redeveloping access to old roads. While applicable predominantly at stream crossings, EMP's may be applied to any site.

To determine the appropriate EMP for a site, the Erosion and Sediment Delivery (ESD) risk is first estimated based on three basic parameters:

i) **Connectivity:** The proximity and connection of the stream crossing or site to a fish-bearing stream or fisheries sensitive habitat.