Kennedy Watershed Restoration Project

Staghorn, Kootowis, Sandhill, Twin Rivers and Lost Shoe Creeks

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2006
Summer Completion Report

For the Central Westcoast Forest Society

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Acknowledgements

We would like to thank Iisaak Forest Resources Ltd for the bulk of this years restoration funding. This First Nations led forest company, which operates exclusively within Clayoquot Sound, allocated $50,000 of their Forest Investment Account (FIA) funding to this restoration project and an additional $8,500 of monitoring funding. Iisaak also provided technical assistance, office use and miscellaneous resources. We also owe special thanks Thomas Martin and his crew from Eagle Eye Forestry.

We are also obliged to International Forest Products Ltd for allocating $32,000 of their FIA funding for stream restoration. FIA is a provincial budget allocation to forest licensees, and is based on the average volume a forest company harvests over a three year period. The purpose of the FIA is to assist government and Licensees to develop a globally recognized, sustainably managed forest industry. Through funding to forest sector associations, researchers, tenure holders, manufacturers, and government agencies, FIA aims to: support sustainable forest management practices; improve the public forest asset base; and promote greater returns from the utilization of public timber. For several years now FIA funding has been used by the Central Westcoast Forest Society (CWFS) for local restoration, planning, research, and monitoring efforts.

Finally we appreciate the assistance of the CWFS board of directors, the regional communities, and local businesses. Without you this could not have been possible.

Executive Summary

Kennedy Flats is located in Clayoquot Sound, on the west coast of Vancouver Island, in British Columbia, Canada. Much of the Kennedy Flats area was logged between 1950 and 1980. Logging and salvage practices of the time were not designed to protect streams or fisheries resources and as a result many of the streams in the area have reduced fish access, poor water quality and altered hydrological function.

The Kennedy Flats Watershed Restoration Project (KWRP) was initiated in 1994 under the federal Canadian Salmon Enhancement and Restoration Fund (CSERF) and continued in 1995 under the provincial Forest Renewal BC (FRBC) Watershed Restoration Program (WRP). Since that time, local restoration crews managed through the Central Westcoast Forest Society have been working to restore the hydrological, biological, riparian, and ecological functions of the Kennedy Flats Watersheds. Methods used have included removal of non-embedded small woody debris (SWD), anchoring of large woody debris (LWD) into functional structures, spawning gravel placement, riparian restoration, landslide restoration and road deactivation. Tofino and Thornton Creek Salmon Enhancement Societies have also been working to augment salmon populations through their hatchery programs and spawning gravel placement projects.

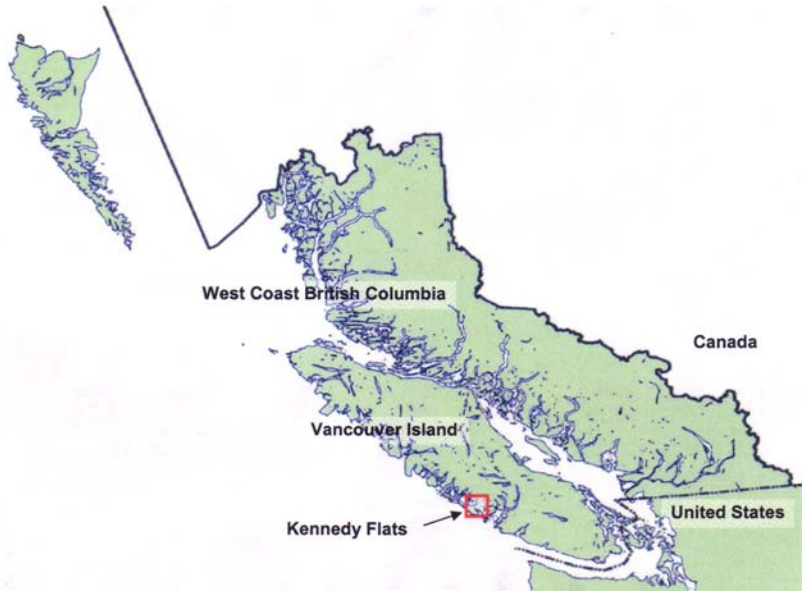

Figure 1.) Kennedy Flats on Vancouver Island, B.C.

Restoration work continued in 2006 thanks to FIA funding from Iisaak Forest Resources Ltd., and International Forest Products Ltd. Corporate funding was also received from Creative Salmon, and stewardship funding from the Tofino Streamkeepers and Tofino and Thornton Salmon Enhancement Societies. Unfortunately, funding expected from Parks Canada Ecosystem Integrity fund did not materialize for 2006, but will be available in 2007. A crew of thirteen worked for three weeks, from August 1st to August 21st. They first completed maintenance work on structures installed in reach 2 of Lost Shoe Creek prior to 2006 then implemented in-stream restoration. In-stream restoration consisted of the removal of non-embedded SWD, the installation of LWD structures, and dismantling of six major log jams over a 230 m stretch on reach 4 of Lost Shoe Creek (LS4) from Station 4 + 635 to Station 4 + 865.

Summary of Restoration Activities Completed in 2006.

Activity	Watersheds	Achievements
Maintenance	Lost Shoe Creek	Conducted maintenance sweeps along LS2 Station 2 + 645 to 2 + 835, 1 LWD cabled, 3 m of cable used
In-Stream	Lost Shoe Creek	Restored 230 m of stream channel on LS4, from Station 4 + 635 to 4 + 865 dismantled 6 log jams, repositioned and cabled 208 LWD, used 405 m of cable, removed 238.5 m^3 of SWD
	Indian Bay Creek	Restored 264 m of stream channel, from Station 0 + 000 to 0 + 264 repositioned and cabled 33 LWD, used 73 m of cable removed 3 m^3 of SWD
	Staghorn Creek	Spawning gravel installation of 300m3 area at bridge sites on S1 and S2.

The CWFS also worked with Creative Salmon Ltd, on in-stream restoration of, 264 m of Indian Bay Creek from Station 0 + 000 m to 0 + 264 m. The crew worked with Creative Salmon employees for two days removing SWD and installing LWD structures to provide cover and scour, and to improve the flow of the stream. The Thornton Creek Enhancement Society under direction of Doug Kimoto installed spawning gravel at two sites on Staghorn Creek.

These and previous years' efforts have resulted in increased fish access and improved health of the creeks and bordering riparian forests. A marked improvement in stream condition, as well as increased fish escapement has been documented through annual monitoring. The local community has benefited from the employment and training opportunities provided by this project, and strong partnerships have been built between various community and stakeholder groups.

Introduction

Although current timber harvesting regulations in British Columbia (BC), Canada require reserve zones of riparian vegetation adjacent to fish-bearing streams, this was not always the case. Before the introduction of the Coastal Fisheries/Forestry Guidelines in 1988, and the Forest Practices Code in 1995, most riparian areas were logged to the stream edge. Also starting in 1995, the Clayoquot Sound Scientific Panel recommendations required additional stream protection practices. Historical harvesting practices such as cross-stream yarding and the removal of riparian vegetation and trees have negatively impacted riparian ecosystems and stream function (Figure 1). Declining salmonid populations are commonly associated with this type of habitat degradation (Frissell, 1993). In recent years, considerable efforts have been made to rehabilitate damaged streams and riparian ecosystems in coastal BC.

Figure 2.) Stream Cleaning with Bulldozer, 1971.

The Kennedy Flats Watershed Restoration Project (KWRP) was initiated in 1994 under the federal Canadian Salmon Enhancement and Restoration Fund (CSERF), and continued in 1995 under the provincial FRBC Watershed Restoration Program. The objectives of the project are to restore the hydrological, biological, riparian and ecological functions of the Kennedy Flats Watershed. Level 1 and level 2 habitat inventories were conducted on the watersheds in 1995 and 1996 (Clough *et al*), and a detailed watershed restoration plan was completed in 2001 (Warttig *et al.*, 2001). Described in this comprehensive plan is the restoration approach to be used, which includes priority rankings for restoration (critical, high, moderate or low) for all stream reaches, roads, and riparian areas in the watershed.

This report includes a description of work undertaken in 2006, including the overall restoration approach and specific methods used. Each year the sites are documented with output tables, before/after photos and monitoring templates.

Methods

Restoration Area

Kennedy Flats is located in Clayoquot Sound on the west coast of Vancouver Island. It is Watershed #249 under the Ministry of Environment, Lands and Parks' 2002-2003 Resource Management Plan (MoELP 2003). Most of the area is provincial crown land (Figure 3).

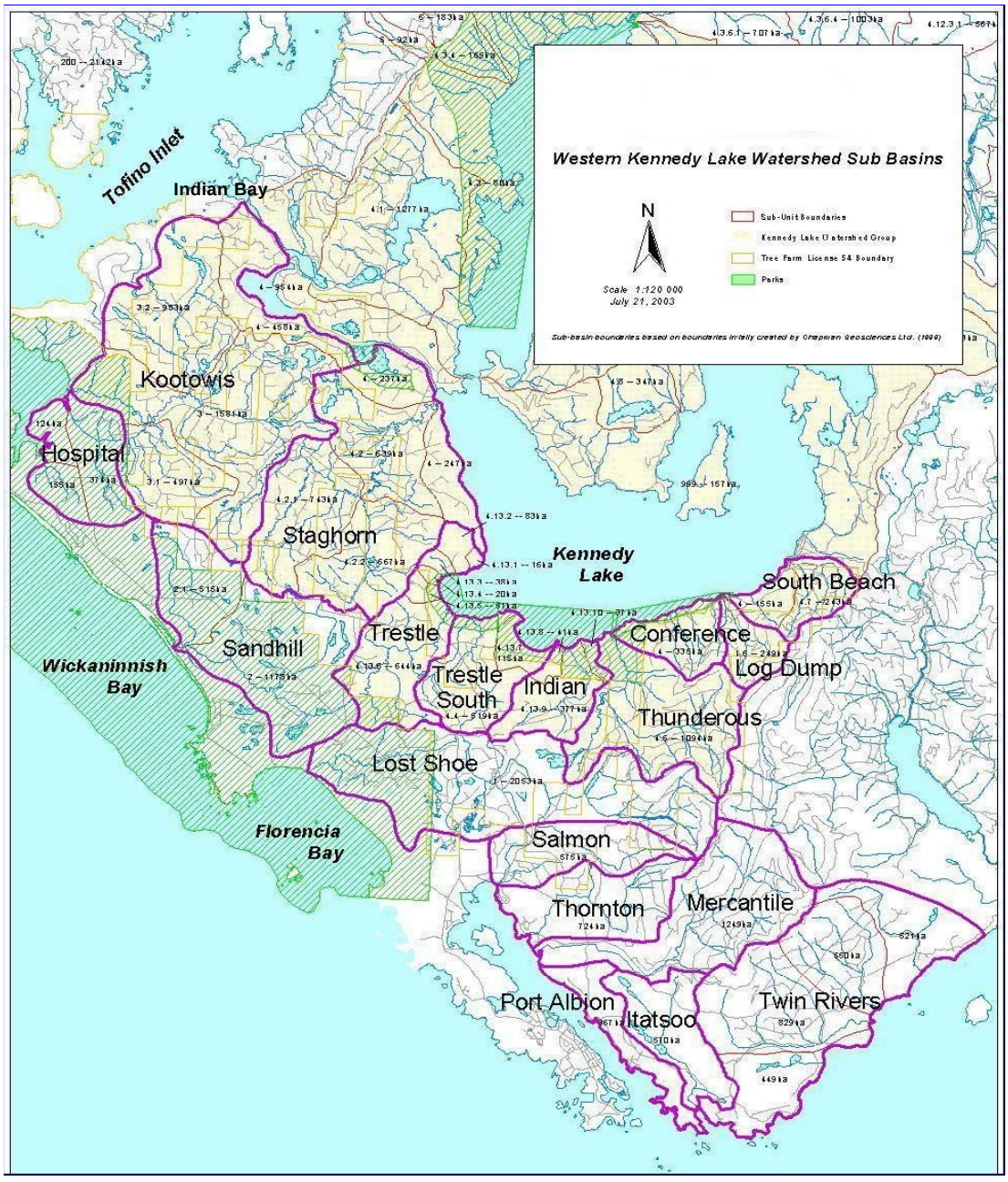

Figure 3.) Kennedy Flats project area and adjacent sub-basins.

Primary tenure holders on the provincial crown land are currently International Forest Products Ltd., and Iisaak Forest Resources Ltd. Pacific Rim National Park Reserve occupies the majority of the remainder of Kennedy Flats. The watershed is designated a target watershed, of high priority for restoration. The Kennedy Flats covers an area of 129 km^2, and consists of nine watersheds; Kootowis, Hospital, Sandhill, Staghorn, Trestle, Trestle South, Indian, Lost Shoe, and Salmon Creeks There are several adjacent watersheds that have streams with similar characteristics and restoration requirements; the restoration area will likely be expanded to include these watersheds in the future increasing total area to 197 km^2. The Kennedy Flats is part of the Estevan Coastal Plain, and is characterized by low-gradient streams with meandering channels and broad floodplains. The streams in this area have historically supported populations of coho, chum, chinook, pink, and sockeye salmon, as well as steelhead, cutthroat trout, rainbow trout, lamprey, pea mouth chub, stickleback and sculpin (Warttig et al., 2001).

Much of the Kennedy Watershed was logged between 1950 and 1980. Early logging practices often involved cross-stream yarding, the use of under-sized wood-box culverts, and poorly built roads. After harvest, large amounts of both small and large woody debris (LWD) were left in-stream. Subsequent salvage logging for shake and shingle added to the problem, introducing large amounts of residual waste small woody debris (SWD) into the streams. When combined with large downed logs that span the width of the stream, the SWD often results in debris jams (Figure 4). These jams restrict water flow within the stream, and lead to flooding in the surrounding riparian forest, reduced scouring ability, and poorer water quality (Warttig et al., 2001).

Figure 4.) Debris Jam in Lost Shoe Creek.

In many case the debris jams also blocked or impaired adult and juvenile salmon movement. These artificially created jams have resisted natural restoration processes (decay, blow outs) as the creeks are generally very low energy and the debris consists mainly of western red cedar (Thuja plicata Donn.), which is very decay resistant. A comparison of current conditions with air photos taken in the 1980's clearly shows individual logs within un-restored jams that have not moved since that time. The severity and frequency of jams, along with the slow natural recovery, has made LWD and SWD restoration necessary in many reaches. The addition of spawning gravel may also be necessary. In many of the KWRP streams, gravel was removed and used for road construction, leading to gravel deficiency (R. Redhead, pers. comm.).

The altered hydrological function of the streams on the Kennedy Flats also affects the surrounding forests. In many areas, regenerating conifers are suppressed by fast-growing colonizing shrub and tree species (Salix and Alnus spp.). These deciduous trees are neither as large nor as long-lived as mature conifers, and do not provide the same level of bank protection or large woody debris recruitment that would occur in a fully functional riparian forest.

Restoration Approach

Restoration is generally following a top-down approach, meaning that restoration begins in upslope areas, and proceeds downstream. Sediment input from the surrounding hillsides must first be stabilized. This is accomplished via logging road deactivation and slide stabilization utilizing revegetation and soil bioengineering techniques. In-stream restoration begins only after upslope problems have been addressed, and consists of four phases (Table 1). For each stream of interest, a Fish Habitat Assessment Procedure is completed, as well as a Level II prescription (Clough, 1997).

Table 1. Multi-phase restoration approach.

Phase	Activity
Phase 1	Removal of SWD and re-orientation of existing LWD
Phase 2	Maintenance, monitoring and addition of LWD in deficient areas
Phase 3	Addition of spawning gravel in deficient areas
Phase 4	Riparian restoration

Site-specific prescriptions are developed. These generally prescribe the removal of small woody debris, and the addition or placement of large woody debris into functional structures. The objective is to re-position LWD/SWD jams to maximize their hydraulic and habitat functions. Specific objectives of LWD placement are to improve one or more of the following attributes: cover, scour, bank protection, and hydrologic function, which are all important components of healthy stream ecosystems.

Cover provides juvenile and adult fish with shelter and protection from predators. Cover structures also provide shade and assist in regulating stream temperatures in addition to improving channel complexity and providing insect rearing habitat. Examples of structures providing cover include cover logs, bundles, and A-frame spurs (Slaney and Zaldokas, 1997).

Scour is a beneficial function within the creek system as it is a means of creating pools and undercut banks. It is also an important factor in defining the thalweg (the line of deepest water in a stream channel as seen from above), improving water quality through aeration, and maintaining spawning habitat through the flushing of fine sediment and organics. Scour can be enhanced through the construction of structures which influence the direction of flow, such as boulders, weirs, and A-frame spurs. Both cover and scour objectives can be addressed by the same in-stream structure (Figure 5).

Figure 5.) LWD spurs at Lost Shoe Creek provide cover and erosion protection.

Phase 3 of in-stream restoration includes spawning gravel placement in areas that are deficient. Phase 4 (riparian restoration) generally consists of silvicultural treatments to accelerate old growth characteristics. Treatments are planned to enhance the development of old-growth attributes in the stand, e.g., by creating snags and gaps to enhance structural diversity, and may be carried out concurrently with in-stream restoration. This restoration approach is described in more detail in the Kennedy Watershed Restoration Plan, which can be downloaded from the CWFS website at www.clayoquot.org.

Permits and Approvals

In-stream work, of the type done here, requires approval from several government levels. Approvals were obtained under the following:

- Canadian Environmental Assessment Act
- Canadian Fisheries Act
- British Columbia Water Act

For work on provincial crown land (Tree Farm Licenses 54 and 57), the following permits and approvals were required:

- Section 9 of the Water Act
- Section 52 of the Forest Act (BC Ministry of Forests)
- Approvals from individual tenure holders
- Letter of support from the Central Region Board (CRB) or local First Nations

Staffing

There was a core crew of thirteen people from Eagle Eye Forestry (Thomas Martin, owner & crew supervisor) and CWFS. Additional help was provided by Creative Salmon Company Ltd (Spencer Evans, Manager), which donated up to five people in the restoration of Indian Bay Creek. This partnership arrangement was beneficial, as the Creative Salmon employees gained hands-on experience and training in stream restoration techniques, while providing useful extra labour that assisted in the restoration of an area that was significantly damaged by historic logging practices. The Tofino and Thornton Creek Societies organized by Doug Kimoto undertook the spawning gravel placement this year.

Training

The Central Westcoast Forest Society (CWFS), D.R. Clough Consulting (Dave Clough RPBio, Project Biologist), and International Forest Products Ltd. (Warren Warttig RPBio, Planning Biologist) were involved in the assessment and implementation of the restoration work. Jack Newman returned for his fifth year as the project manager, and was responsible for overseeing in-stream operations as well as monitoring water quality and weather to ensure a safe working environment for both the crew and the fish. The field crew consisted of thirteen local workers, several of whom had worked on the project in previous years.

Initially the project was devoted to training and preparation, with an emphasis on safety. To adequately instruct all crew members on fire safety, as well as to comply with the Worker's Compensation Board (WCB) requirements, the S-100 Basic Fire Suppression Course was delivered by Hugh Young on August 1st. Mr. Young also provided the crew with Workplace Hazardous Materials Information System (WHIMS) training.

The BC Forest Safety Council, which is responsible for the Faller Training Standard & Certification Program, provided Steve Telosky, a Qualified Supervisor / Trainer, who instructed a two day Basic Chainsaw Operators Course (Figure 6).

Occupational First Aid Level 1 with transportation endorsement was also provided to the crew in a two day course put on by North Island College. Weekly tailgate meetings held every Friday allowed crew members to discuss any safety or work related issues.

Figure 6.) Practical component of the Basic Chainsaw Operators Course

The afternoon of August 8th was also devoted to a pre-work orientation reviewing safety regulations, procedures and guidelines. Specifically, Emergency Transportation Procedures, Significant Environmental Aspects, Standard Operating Procedures (SOP's), Job Safety Breakdown, and helicopter safety procedures were discussed. In addition, the WCB requirements for safety gear (hard hats, caulk boots, chaps, high visibility vests and whistles), fire tools, and on-site First Aid equipment were reviewed. Laminated handouts containing information on Emergency Transportation Procedures, SOP's, and example diagrams of in-stream log structures from Slaney and Zaldokas (1997) were given to each crew member.

Training continued informally throughout the project. Many of the crew were returning for their 5th or 6th season, and newer crew members benefited greatly from their experience.

Maintenance

Maintenance sweeps were conducted on all 2005 restoration sites from Station 2+645 m to 2+835 m on Reach LS2, covering a total of 190 m of stream length. During the maintenance sweeps crew members checked old cables, removed non-embedded SWD, and repositioned any LWD which had moved as a result of the winter storms.

In-stream Restoration

The site level choice of reaches at Indian Bay Creek and Lost Shoe Creek, for the 2006 restoration program was based on assessments completed in the spring of this year.

Restoration of both sites was carried out according to the methods outlined in the Standard Operation Procedures for in-stream work (Appendix I & II). Non-embedded small woody debris was removed from the creeks; any debris embedded in the creek bed was left in place to minimize the release of trapped sediment and hydrogen sulfide gas. Removed SWD was piled above the high water mark, ensuring that it would not return to the system during high flows. In areas with especially low banks (e.g., Lost Shoe Creek-Reach LS3), higher areas were brushed using chain saws and the SWD was double tossed into these clearings. These debris piles provide valuable cover and feeding habitat for wildlife, including birds, mammals, amphibians and invertebrates. Once most SWD was removed from the system, the remaining LWD within, and often wood adjacent to the creek, was repositioned to improve creek scour and cover. During the 2006 project, structures that were installed included A-frame spurs, bundles, and cover logs (Figure 7).

Figure 7.) Repositioning LWD to provide cover and scour.

LWD was re-oriented where necessary using peaveys, pike poles, turfers, and chainsaw winches; and cabled into place using galvanized steel cable (3/8–5/8" in diameter). Holes for the cable were drilled in the logs using gas-powered augers. Where drilling was not feasible, notching, staples, crosby-clamps and multiple wraps were used to secure the cable. See Appendix VI for photos of restoration techniques and operational procedures. Ballast rocks and standing dead trees and stumps were used as anchors. Live trees were used as anchors only where no other options existed.

Spawning Gravel and Riparian Restoration

Although in previous years significant work in spawning gravel and riparian restoration was undertaken using standard methods (Appendix III). A shortfall in funding contributions resulted in cancellation of this activity from our 2006 objectives. Thanks to the volunteer efforts of Doug Kimoto (Thornton Creek Enhancement Society & Thornton Creek Volunteers) spawning gravel placement was done in 2006. He arranged for gravel truckloads to be dumped at logging road-crossing sites for best access to the creeks. A crane was used to sling gravel out from the road location. This allowed a wider distribution of the gravel to 30m above or below sites. Three bridge crossing sites on the lower reach of Staghorn Creek (S1 & S2) were completed. The Society members also applied gravel to Muriel Creek on the West Main Road outside our project area. The capital costs of the project ($2000) were paid for with DFO Public Involvement Program funds claimed through the Societies.

Monitoring

Monitoring is a key component of stream restoration. In-stream structures are to be monitored annually for three years after installation, and once every five years after that (Warttig et al., 2001). Charts are used to document evaluation of the effectiveness of in-stream structures and to note any changes or problems that may have occurred during the winter floods. These charts provide a standardized way of grading the structure and performance of an introduced in-stream structure (Koning et al., 1997).

The 2005 restoration sites were evaluated during maintenance sweeps at the beginning of the field season (Appendix IV). Using the methods outlined in Koning et al. (1997), each in-stream structure was assessed for specific physical and biological attributes, and given an overall rating for condition, stability, and maintenance. Possible scores ranged from 1 to 4, with a score of 4 indicating that a given objective was being exceeded, while a score of 1 indicated failure to meet the objective. During assessments, each jam site was evaluated for evidence of structural failures, non-functional structures, proximity of debris piles to the creek channel and SWD accumulation. All structures were checked to ensure that work was completed, and to confirm proper cabling and anchoring methods.

The 2006 restoration works were documented by site number, location and expected physical and biological attributes (Appendix V). A photo log of before and after pictures is taken for every site (Appendix VI). The 2006 work will be assessed in the spring/summer of 2007, after the winter high flows.

Water quality was assessed weekly on Lost Shoe Creek for the duration of the project. Temperature, pH, and dissolved oxygen (DO) content were recorded at each site and compared to guidelines to ensure safe in-stream working conditions and prevent undue stress to fish (Appendix VI). Although nutrient sampling and/or fry density assessment have been done in previous years, they were undertaken in 2006 by Environment Canada in cooperation with Parks Canada; who have initiated an extensive water quality and benthic invertebrate monitoring program as a component of monitoring for improved ecosystem integrity due to restoration activities.

Reporting

Daily progress reports were filled out by each crew supervisor. In addition, tasks and accomplishments, current work areas, adjustments, and safety issues were discussed daily by all parties involved with the project. A record of attendance and safety issues was made at each weekly safety meeting. A mid-project report was completed by the project manager to keep the project sponsors informed of progress made.

Results and Discussion

Restoration Summary

In 2006 restoration efforts were undertaken on Lost Shoe Creek and Indian Bay Creek. These activities included reach maintenance, removal of SWD jams, LWD structure anchoring, and improving fish access. Maintenance activities included inspection and repair of 190 m of stream length in Lost Shoe Creek (LS 2) for Station 2 + 645 m to 2 + 835 m.

In-stream activities included removal of approximately 241 m^3 of non-embedded SWD from the streams. Crew members positioned 242 pieces of LWD into functional structures and anchored them with approximately 481 m of cable. Summarized in Table 3 are the restoration activities and locations, as well as amounts of materials used.

Table 3.). 2006 Restoration Activities.

Stream Segment and Station	Activity	Length (m)	No. LWD Anchored	SWD Volume (m^3)	Cable length (m)	Spawning Gravel Area (m^2)
Lost Shoe LS2 2+645 to 2+835	Maintenance	190	1	0	3	0
Lost Shoe LS4 4+635 to 4+865	In-stream	230	208	239	405	0
Indian Bay Creek IB1 0+000 to 0+264	In-stream	264	33	3	73	0
Staghorn S1	In Stream	30	0	0	0	150
Staghorn S2	In Stream	30	0	0	0	150
Total		744	242	242	481	300

Routine Monitoring and Maintenance

Monitoring assessments were completed in 2006 along Lost Shoe Creek stream segment LS2 from 2+645m to 2+835m (190 m) where 5 LWD sites were constructed (Appendix IV). In general, in-stream structures established in 2005 were successful in meeting physical and biological performance objectives. At site 1 (reach LS2) the banks had stabilized and the stream bed had cut deeper into the channel. This site received perfect scores for bank protection and pool creation, and no maintenance was required. In 2005 the stream at LS2, site 2 lacked a defined thalweg, and was braided and shallow, with segmented pools. In 2006, the site was found to have defined thalweg and deep continuous pools and received a close to perfect scores on the monitoring assessments; the stream bed cut deeper, and there were no segmented pools present, however it received a score of 1 for lacking instream cover. Site 3 received perfect scores; the bank had continued to erode and was now filling in the area behind where the LWD was anchored up the banks. A root-wad could be used at the top of the incline to help stabilize the bank further. At site 4 near perfect scores were received because of one loose log that required repositioning and cabling. Site 5 received perfect scores and no maintenance was required.

In-stream Restoration

In-stream restoration in 2006 occurred in Lost Shoe Creek draining into Florencia Bay and Indian Bay Creek located just north of Kootowis Creek draining into Browning Passage.

Lost Shoe Creek – Reach LS4

Restoration was undertaken in 2006 at segment stations 4+635m to 4+865m representing jams 50 – 57 of our cumulative count on Lost Shoe Creek. This short 230 m long reach is located between Highway 4A and the West Main logging road bridges. It was assessed as high risk in the restoration plan and in need of immediate restoration. It was also the upper-most segment of Lost Shoe Creek untreated for in-stream LWD and SWD prescriptions. The stream channel was

braided and wide, with low banks and a series of significant debris jams. The jams were causing back eddies and segmented pools; at higher flows the jams were causing stream diversion into the flood plain resulting in drying summer pools during low flow periods, trapping fish.

In accordance with the Standard Operation Procedures for in-stream work (see Appendix I) non-embedded SWD was removed first. Since the banks are especially low in this area, all SWD was relocated well beyond the extent of the stream flood plain. An estimated 238.5 m^3 of SWD was removed from this 230 m stretch of LS4. Following the SWD removal phase, the crew worked to reposition and anchor 208 pieces of LWD into functional in-stream structures. At several jams, such as station 4+662m, LWD was removed from the centre of the creek and anchored along the banks so as to delineate the thalweg, directing the flow of the stream and preventing further flooding of the surrounding riparian area. At station 4+707m the crew hand excavated a 200 m long channel and removed approximately 1.5 m^3 of soil to connect a significant river right bank side channel. This work should reduce flooding of the West Main Road and improve fish passage at lower flows. Where LWD was not present (i.e. station 4+857m and station 4+865m) logs from a deactivated bridge were brought in; and from these logs in-stream A-frame structures were constructed. The crew also helped with the removal and proper disposal of 15 creosote logs that were found at the edge of the stream bank.

Indian Bay Creek

Indian Bay Creek was selected for in-stream restoration in 2006 for two reasons: it had been significantly damaged by historic logging and it was a feasible project for the Creative Salmon Ltd staff to undertake. The stream channel was found to be braided with scarce pools that were shallow and devoid of in-stream cover and LWD. Creative Salmon staff, Barb Cannon and Dave Bailey along with Dave Clough, RPBio identified the work plan in spring 2006 (Appendix VII). At prospective restoration sites, flagging tape was placed to instruct the crew members on location of LWD placements. The joint crews of KWRP and Creative Salmon worked August 10th and 11th restoring 264 m of stream channel; using approximately 73 m of cable they repositioned and anchored 33 LWD into functional in-stream structures. Before and after photos for in-stream restoration sites can be found in Appendix VI.

Water Quality Monitoring

Water quality assessments for 2006 were conducted by Environment Canada. This information will be relayed when it has become available.

Labour

A total of 13 crewmembers worked on the 2006 restoration project, for a total of 148.5 person-days not including project management (Table 5).

Table 4.) Summary of labour activity.

Activity	Days	Avg. Crew	Person-days	Work Sites
Training	4.5	10	45.0	N/A
Maintenance	0.5	3	1.5	Lost Shoe Creek
In-stream	8.5	12	102.0	Lost Shoe Creek, Indian Bay Creek
Total			148.5	

The crew was composed of workers from local west coast communities, including ten First Nation employees (Figure 8). Residents of Tofino, Ucluelet, and Port Alberni were employed on the project.

Figure 8.) Members of the 2006 KWRP restoration crew.

Budget

Project funds and expenditures incurred during the project season are summarized in Table 5. All funds were directed through CWFS accounts and managed accordingly; this included worker payroll, management payroll, consultant fees, direct expenses, and equipment rentals. Regrettably in 2006 the anticipated $100, 000 from Parks Canada Ecosystem Integrity fund was not administered in due time. This funding however can be carried over into 2007, and added to the 2007 funding for a total of $200, 000 for the next years restoration and ecosystem integrity monitoring programs.

Table 5.) Summary of funds and expenditures.

Item	Amount
Wages	$42,330.00
Biologists/Contractors	$6,750.00
Truck rental and fuel	$2,125.00
First aid/radio/safety equip	$660.00
Equipment Rental	$6,675.00
Heavy machinery	$1,250.00
Materials and supplies	$10,933.33
Miscellaneous	$322.13
Subtotal	$71,045.46
Assessments/permits/reports	$2,000.00
Audit	$1,500.00
CWFS admin	$7,454.55
Total	$82,000.01

Future Opportunities

As of the end of 2006 in-stream restoration activities, close to 70 km of 420 km of Kennedy Flats streams have been fully restored. There are substantial future opportunities for restoration work. There is an on-going need for research, monitoring and maintenance on these previously treated reaches. There remain many high priority stream reaches that have yet to be restored, (several upstream reaches on Lost Shoe Creek). Further road deactivation and riparian restoration activities are also required. The Kennedy Flats Restoration Plan (Warttig et al., 2001,) contains a detailed discussion of these sites.

There is also continued need for spawning gravel placement and monitoring. Lack of spawning gravel is a key limiting factor for salmonid populations in many of the streams in the watershed (Clough, 1995; Warttig et al., 2001). Finally, an initial assessment was completed on the lower section of the East river in the Twin Rivers sub-basin. Several debris jams are present with reasonably good access, making this area a good candidate for restoration if suitable funding can be obtained.

Conclusion

Since the beginning of the Kennedy Watershed Restoration Project twelve years ago, approximately almost 70 km of stream habitat have been restored in the Kennedy Watershed. In addition, 62.5 ha of riparian forest have been restored, 48 ha of slide area have been revegetated and/or soil bioengineered, and 247 km of logging road have been deactivated. As stream restoration progresses, qualitative monitoring seems to indicate improvement in overall stream conditions and health of the riparian forests. Future funding will support a more comprehensive monitoring program would help to better quantify the effects of restoration efforts.

In 2006, restoration objectives were met through removal of SWD and placement of flood stable-LWD to stabilize the stream banks, to maximize cover and channel scour. Many improvements in hydraulic function will likely occur over the next year in the reaches that were restored this season (e.g., defined thalweg, improved fish access, evidence of scour pools, declining flood water levels, exposure of historic spawning gravel and LWD). The SWD that is removed during annual maintenance sweeps provides evidence that built-up organic debris on the creek bottom is being successfully scoured during high winter flows. More quality creek habitat is now available for fish for spawning, rearing and feeding. Past observation of fish and redds at spawning gravel placement sites appears to confirm this. Results from monitoring of spawning gravel placement sites indicate high use and very high egg to alevin survival. Combined increases in stream and riparian area health would indicate increased functional ability and hence a corresponding increase in ecosystem integrity.

The local community has benefited from the employment and training provided by the project, and partnerships have been encouraged between various community and stakeholder groups. This project provides an example of the type of large-scale planning and long-term commitment that is necessary to effectively restore damaged watersheds and promote positive local stewardship values.

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Appendix I: LWD Placement Standard Operating Procedures

KWRP S.O.P. – Wood Debris Placement
In-Stream Work Methods – June 22, 2001

This SOP is a general description based on past monitoring of six years of projects. The objective is to provide workers, agencies and partners with a basic understanding of the restoration process in historic logging debris laden streams.

- The LWD recovery should address three functions cover, bank protection, and scour. Some sites may offer both cover and scour while at others only one.
- Cover is an objective that maximizes the shade, predator protection/refuge, and complexity of in-stream and over stream wetted areas. The structure should be a stable in-stream refuge for fry and adults and contribute where necessary to overhead cover to reduce solar radiation and predator observation. It offers secondary habitat for birds, mammals, amphibians and invertebrates. Cover LWD can be constructed from any size or shape of LWD, preferably in clusters.
- Scour is a function that creates pools or gravel bars though LWD placed to constrict and or deflect flow. These structures require more specific anchoring and placement than cover to ensure they function and resist the forces of water.
- Utilize SWD such as treetops, large limbs and slabs in bundles to mimic LWD.
- Most LWD structures only need removal of SWD pieces to return functionality. Where there is a high degree of SWD and little LWD, make use of the bundling of SWD or import LWD to the site.
- If LWD pieces float free during the removal of non-embedding SWD, cable them in place in the nearest functional site. Mimic Sec. 9 examples where possible. A guideline of 25% removal of small woody debris should be considered.
- Do not remove embedded pieces of LWD or SWD, their locations are to be designed around and disturbance may release sediment or poisonous gases.
- Restoration involves maintenance; our sites must be re-visited to ensure they remain anchored and functioning. The first year after restoration is the most important for removal of SWD and re-anchoring or tightening of cables as necessary. Often the embedded SWD from the year previous is dislodged due to channel scour. Maintenance involves a short time period but is necessary.
- Look for LWD sources in the forest/floodplain that can contribute to the stream habitat.
- Work with Riparian Treatment specialists for sources of trees to fall in the riparian zone for LWD sources (must be organized through Warren Warttig, RPBio of Interfor).
- Where possible, to minimize helicopter removal of SWD, make use of SWD waste by building piles in the forest for wildlife above the active floodplain. Duckbill or cable a perimeter of LWD around SWD piles to prevent escapes back into the creek in wide floodplain areas or steep slopes.
- Create clustered LWD complexes rather than separate pieces to offer better function.
- SWD may be cut for ease of removal but refer to Work In Stream SOP. Never cut LWD without permission from a supervisor.

Appendix II: Monitoring methodology during in-stream work SOP

S.O.P.

KWRP Monitoring Methodology during In-Stream Work

- Monitor environmental conditions (temperature, suspended sediment) at work sites.
- If fish are present and work-site stream temperature exceeds 20º C:
  1. Limit substrate disturbance to prevent release of trapped gases and sediment or if unmanageable …
  2. Move to an alternate site where the water temperature is cooler or work can proceed without harmful disturbance.
- Monitor and control sediment through:
  1.) Careful work procedures
  2.) Sediment control structures to isolate generation.
- In sites where work operations could generate sediment, ensure sediment control is in place and operating efficiently. If harmful sediment generation is apparent during work;
  1.) Stop work until sediment clears and proceed in a more cautious manner.
  2.) Move to an alternate site until the sediment clears.
  3.) Shut down in-stream operations.
- If fish are present, visually monitor for stress (racing, gulping or dying) at all times.
- Consider isolating site for fry removal before work.
- If fish stress occurs from operations;
  1. Proceed with restoration work in a more cautious manner, or
  2. Move to an alternate site, or
  3. Shut down in-stream operations.

If problems persist, stop work at the problem site, and contact the Project Biologist.

Appendix III: Spawning Gravel Placement SOP

Spawning Gravel Placement

Gravel:

- Washed (Clean) round rock,
- Rock size should be a mixture ranging from +/- 20% of larger sand sized to ¼ inch washed pit run

Placement Sites:

- Areas of existing scour where there has been sufficient scour to remove organics and there is insufficient natural gravels,
- Tail out of pools,
- Areas of sufficient depth for water cover at low flows.

Placement Amounts:

- Depth 4" in 0.5 to 4.0 m wide channel width (take caution not to exceed winter low flow stream depths),
- Depth 6" in > 4.0 m wide channel width,
- Length equal to channel width.

Here are some of the guiding principles used for gravel placement in small, low gradient, streams.

Gravel Size: This depends on the gradient and peak flow of the creek. Sizes can be determined from observation of native gravel in the area. Species utilization is also a factor. Gravel should be suitably mixed and complex sizes similar to the historic condition for the stream reach. Typically small coho/cutthroat/chum streams require washed 1/4 to 2 1/2 inch round rock with a mix of 10 % cobble and a few boulders as well. The cobble acts to create aeration sites for the substrate, as well as invertebrate habitat. The boulders facilitate aeration, invertebrate and emergent fry habitat while helping to stabilize the entire bed.

Sites: Gravel sites are located in glides, riffles and pool tail outs. Do not place in pool bottoms. Select sites that offer 1-3 ft per second water velocity during spawning. This can be found natural or enhanced by creation of "quicks" through LWD and Boulder placement along the banks.

Small streams are easiest. Streams wider than 5 meters have complex thalwegs and placement can be more difficult to determine and should be done with site by site prescriptions.

Many glides can be made into spawning riffles by the addition of control structures at the downstream end. ie logs, boulder or cobble. This material must be sized large enough to hold the gravel in place and prevent washout, again use existing native substrate as a guide.

Substrate: The site substrate should be relatively impermeable and firm such as gravel, hardpan or clay. Avoid placement on soft substrates such as mud as the gravel will quickly become embedded. Some removal of sticks, mud, in-stream vegetation or dirty gravel is allowed, too much indicates a poor site selection.

Depth: Gravel depths of 1/10th of channel width are a good rule of thumb. This places the gravel in depths similar to the natural, healthy, stream sites. Too much gravel may wash out then fill pools or create dry areas at low flow. The material must be submerged during low winter flow.

Width & Length: Place gravel in square shaped deposits with lengths equal to the channel width. Most spawning areas in low gradient (0-2%) streams are one channel width long and wide. Exceptions are long riffles created by confined channels with less than the reach average width or areas of higher gradient. Do not spread it wider than the low flow margins along each bank and ensure a thalweg by spreading it in a shallow vee with a rake or with boots.

D. Clough & W. Warttig

Appendix IV: Routine Monitoring Form KWRP Lost Shoe 2005 Restoration Sites – 2006 Assessment.

Performance Objectives																									
Physical																			Biological					
Stream	Distance	ID #	Structure Type	Pool	Riffle	Substrate	StreamCover	Off-channel	Fish Access	Nutrients	High Flow	Low Flow	Overall Rating	Species	Life Stage	Over wintering	Rearing	Spawning	Incubation	Overall rating	Condition	Stability	Maintenance	Recommendatio	Comments
Lost Shoe LS2	2+645 to2+680	Jam 1	LWD	4	4	4	4		4		4	4		All	All	4				4	4	4	4		Stable banks covering top LWD
Lost Shoe LS2	2+708	Jam 2	LWD	4	4	4	1		4		4	4		All	All	4				4	4	4	4		LWD structure covered with sand, limited cover here
Lost Shoe LS2	2+716 to 2+769	Jam 3	LWD	4	4	4	4		4		4	4		All	All	4				4	4	4	4		Needs root wad at top
Lost Shoe LS2	2+808	Jam 4	LWD	4	4	4	4		4		4	4		All	All	4				4	4	4	3		Loose log cabled upstream
Lost Shoe LS2	2+835	Jam 5	LWD	4	4	4	4		4		4	4		All	All	4				4	4	4	4		No maintenance required

Appendix V: Routine Monitoring Form KWRP Lost Shoe 2006 In-stream Restoration Sites.

Performance Objectives																									
Physical																			Biological					
Stream Segment	Distance	Jam ID #	Structure Type	Pool	Riffle	Substrate	StreamCover	Off-channel	Fish Access	Nutrients	High Flow	Low Flow	Overall	Species	Life Stage	Over	Rearing	Spawning	Incubation	Overall rating	Condition	Stability	Maintenance	Recommendation	Comments
LS4	4+635	51	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		10 LWD on LB
LS4	4+662	52	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 4 LWD, RB 11 LWD
LS4	4+682	52	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 12 LWD
LS4	4+693	52	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 6 LWD, RB 5 LWD, RWD repositioned on RB
LS4	4+707	53	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		RB 11 LWD, LWD blocks overflow
LS4	4+717	53	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		Soil removed to open side channel from W. Main
LS4	4+720	53	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 8 LWD, RB 4 LWD
LS4	4+722	54	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 29 LWD, RB 33 LWD
LS4	4+795	55	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB 4 LWD, RB 17 LWD, RB 7 LWD US to stop overflow
LS4	4+813	56	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		RB 17 LWD
LS4	4+857	56	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		RB Built A-frame brought in 4 LWD took out 3 LWD
LS4	4+865	57	LWD	0	0	0	0		0		0	0	0			0	0			0	0	0	0		LB brought in 5 LWD, LB brought in 2 LWD

Appendix VI: KWRP 2006 - Photos of Restoration Sites (Plates 1-4).

Appendix VI: KWRP 2006
Lost Shoe Creek Photo Page 1

1.) Jam 51- 4+635m before.

3.) Jam 52 - 4+682m before.

2.) Jam 51 - 4+635m after.

4.) Jam 52 - 4+682m after.

Appendix VI: KWRP 2006
Lost Shoe Creek Photo Page 2

5.) Jam 53 - 4+717m before.

7.) Jam 54 - 4+722m before.

6.) Jam 53 - 4+717m after.

8.) Jam 54- 4+722 m after.

Appendix VI: KWRP 2006
Lost Shoe Creek Photo Page 3

9.) Jam 55 - 4+795m before.

11.) Jam 56 - 4+813m before.

10.) Jam 55 - 4+795m after.

12.) Jam 56 - 4+813m after.

Appendix VI: KWRP 2006
Lost Shoe Creek Photo Page 4

13.) Sidechannel - before.

15.) Sidechannel - before.

14.) Sidechannel - after.

16.) Sidechannel - after.

Appendix VII: Indian Bay 2006 Restoration Plan

D. R. Clough Consulting
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June 6, 2006

Spencer Evans
Creative Salmon Co. Ltd.
612 Campbell St.
Tofino, B.C. V0R 2Z0 (Office: 725-2884/Fax: 725-2885, Pen Site Office: 726-8162)

RE: Indian Bay Creek Restoration Plan – Summer 2006

Objective: The objective of this activity is to restore stream habitat in a Clayoquot Sound drainage at the head of Indian Bay. The scope of work was designed to provide the best results for a one-day work party.

Background: Indian Bay Creek was selected for restoration this year based on assessment of ten Clayoquot Sound drainages in the vicinity of Creative Salmon salt water rearing pen sites. The reports by D.R. Clough Consulting were:

- June 2004 " Environmental Assessment: Freshwater Habitat of the Indian Bay and Eagle Bay Area"
- November 2004 " Baxter, Dawley and McCall Fish Farms Freshwater Habitat Environmental Assessment, Part 2- August 2004.

The area streams were all inventoried using the USHP Habitat Survey Methodology as well as water quality samples and fish presence. The survey methodology in these reports allows for a consistent comparison of each stream as well as the standard method used on most small streams on Vancouver Island. Preparation for the restoration projects has been done by training the community as well as Creative Salmon staff. The company sponsored Streamkeeper Certificate Courses in 2002, 2004 and Tofino Streamkeepers sponsored a course in 2006.

The rationale for the 2005 Baxter Creek 2 selection for restoration was because;

1. It had been significantly damaged by historic logging.
2. It was small enough that we could get all our work done in one day
3. and had few fish in the summer to accidentally harm with inexperienced crew.

The habitat work was a success; all the structures were assessed after the winter and are helping the creek recover pool depth and confinement, while offering spawning habitat and better fish access. This is described in a summary report written in March 2006 "Baxter Creek 2; Post Restoration Summary and Follow-up Inspection".

The selection of Indian Bay Creek for restoration was concluded for the same reasons as Baxter Creek 2. It offered reasonable chance for success in a small stream within the scope of one or two days work. The 2004 assessment identified two reaches; Reach 1 went from the estuary upstream to the anadromous barrier at 267m. Reach 2 was Resident Cutthroat habitat in a more recently logged over area ending at 700m. The survey found the usual historic logging impacts; lack of instream cover, Large Woody Debris, few and shallow pools, sediment loading and braided channels. Fortunately the riparian zone has recovered in the lower reach and offers potential LWD donor logs to be used through thinning of the stand.

On March 6, 2006 the restoration plan priority areas at Indian Bay Creek were determined by an onsite visit by D.R. Clough with Benoit Chambon, Dave Bailey and Barb Cannon of Creative Salmon Co Ltd.

Work Plan – Indian Bay Creek 2006.
The stream has been measured and distances with stations flagged in the field. Restoration sites were actually marked with flagging tape at the angles where logs should be placed. Trees were selected and flagged from the riparian zone from standing and downed sources.

Site (m)	Description	Materials	Priority
Mouth 0+000	Nothing planned, 100m wide gravel beach, good fish access. Old squatters shack to the east may need a cleanup of garbage and lumber.	Wheelbarrow, crowbars	Low
30	First riffle & pool, lots of Coho fry, needs overhead LWD to provide returning spawners cover and more spawning gravel with anchor rocks.	4- 4m LWD 4-duckbills 10m Cable 2 wheelbarrow loads gravel, 1 load anchor rock	Medium
38 –51	Shallow pool needs confinement with LWD along banks.	4 – 5m LWD, 10 m Cable 4 Duckbills	Medium
52.5-59	Shallow pool at metal tag reference site. Needs LWD cover.	4 LWD & 2 Roots 4 duckbills	Medium
067-72	Deeper pool starting to form, needs more LWD added at right bank	3-5m LWD, 2 Roots 2 duckbills, 10 m cable	High
072	Next pool upstream needs help scouring deeper. Need LWD pinch on both banks. Plug RB FP as well.	5 – 5m LWD, 4 duckbills, 10 m cable	High
090	Natural upstream V-weir and aggraded bed above,. Hemlocks are rotting and may blow out. Difficult to replace,	2 6m LWD, 4 Duckbills, 10m cable	Medium
134	Big log placed for old water intake, perpendicular placement is creating erosion, cut cable, swing downstream & anchor with log as spur.	4 5m LWD & 2 roots 4 duckbills 10m cable	High
167	Large pool, has some LWD, could use more	3 –LWD, 5m cable	Medium
192	Last large pool, could add more LWD, remove SWD	3-LWD, 5m cable	Medium
264	End Coho access at 27% drop.		

Tools Required: Gloves, Rakes, Pry Bars, Peavey, Winches (Turfers), Socket Set, Hand Wrenches, Crescent Wrench, Chainsaw, Sledgehammer, Axe, Shovels, Rakes, Wheelbarrow.

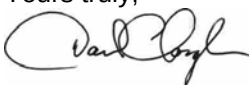
Materials Required: Every log placed requires 3/8 inch clamps (30), 3/8 inch galvanized cable (100m), and Staples (40), Duckbill Anchors (24) & Driver, 5 gallon plastic buckets, Flagging tape, Geotextile Cloth.

Operations: The high priority work areas are expected to be completed in one day or less, most are only 1-2 hour activities for two to four people. There is enough work here for at least two full days for a work party of 6-8 persons. At least one experienced person, myself, Jack Newman or another of environmental professional will be onsite to direct and supervise.

Environmental Concerns: The work will be done in July August or September when at lowest flow. There will be some fish in the remaining pools to consider. Work will have to ensure no disturbance to these areas. Fry removal should not be necessary. All will be instructed to avoid walking in wetted areas. r standing pools and all fry would be emerged from the gravel. Access routes will be established with the least impact on the riparian areas.

Permits: A Section 9 Notification is likely required for this work and needs to have signature by the DFO Community Advisor, Barry Cordocedo,756-7263 as well as the legal description and property owner signature (Interfor, Don McMillan). Then forwarded to Water, Land and Air Protection in Nanaimo.

Yours truly,



Dave Clough, RP Bio