CENTRAL WESTCOAST FOREST SOCIETY

Kennedy Watershed Restoration Project

2013/2014 Completion Report

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Executive Summary

The Kennedy Flats Watershed is located in Clayoquot Sound, on the west coast of Vancouver Island, in British Columbia, Canada. Much of the watershed was logged between 1950 and 1980. Logging practices of the time were not designed to protect wildlife or fish habitat, and as a result many of the streams in the area have reduced fish access, poor water quality, and lack the necessary characteristics to support healthy and diverse wildlife populations. Central Westcoast Forest Society initiated the Kennedy Watershed Restoration Project in 1994 to address the conditions affecting wildlife and wild salmon productivity. Since that time, Central Westcoast Forest Society restoration crews have been working to restore the hydrological and ecological functions of the watershed.

Restoration methods have included instream and riparian restoration, landslide restoration and road deactivation. Restoration work continued in 2013/14 thanks to funding from Parks Canada, Habitat Conservation Trust Fund, Ministry of Transportation and Infrastructure, Environment Canada EcoAction Community Funding Program, TD Friends of the Environment, Pacific Salmon Foundation, Schein Foundation, Department of Fisheries and Oceans Recreational Fisheries Conservation Partnerships Program, Alberni Clayoquot Regional District, Recreation Sites and Trails BC, and Shell FuellingChange.

Crew members worked on the 2013/2014 restoration project from May 2013 to March 2014. The restoration project provided employment for 14 local workers from Tofino, Ucluelet and the Toquaht, Ahousaht, Yu?lu?il?ath, and Tla-o-qui-aht First Nations communities. The first day of the project was devoted to training and safety protocol. The previous year's restoration work was inspected at the beginning of the field season completing maintenance as required.

In-stream restoration was completed on Coho Creek for a total of 285 linear metres of stream channel (from Station 0+100 to 0+385 m). To improve water-quality and spawning habitat conditions 51 pieces of large woody debris were repositioned and 28 m^3 of non-embedded small woody debris was removed from a series of debris jams. On Lost Shoe Creek reach 4, 167 m of stream restoration (from Station 4+646 to 4+813 m) was completed, a total of 52 pieces of large woody debris were repositioned and 40 m^3 of small woody debris was removed to enhance aquatic habitat conditions. A total 0.5 ha of riparian restoration was completed on Coho Creek and 2.2 ha on Lost Shoe Creek.

In the Conference Creek Watershed 1,612 m of logging road was deactivated, which included removal of 12 fish impediments at 8 creek crossings, 512 conifer seedlings planted, rehabilitation of 313 m^2 of historical channels, and the addition of 104 pieces of large woody debris and 110 boulders in-stream. Downstream of Highway 4, 1,025 m^2 of stream habitat was restored with 41.95 m^3 of small woody debris removed and 32 pieces of large woody debris repositioned. In this same area, approximately 7.4 ha of riparian area were restored in addition to 50 trees girdled and 20 wildlife cavities created.

In the Twin Rivers Watershed, approximately 1,225 m^2 of stream habitat was restored by removing 41 m^3 of small woody debris and removing and/or repositioning 75 pieces of large woody debris to improve one or more of the following attributes: cover, scour, bank protection, and hydrologic functions, all of which are important components of healthy stream ecosystems. Spawning gravel was placed at 4 sites, resulting in approximately 50 m^2 of spawning area.

An assessment of Sandhill Creek reach SAND2 was completed in February 2014 at the request of Pacific Rim National Parks Reserve. Riparian and instream restoration in this watershed are planned for the 2014/15.

The effectiveness of restoration efforts and changes to wildlife habitat conditions and populations are assessed annually. Two smolt traps were installed in the Lost Shoe Creek watershed and one on Coho Creek to monitor the production of coho smolts. The health and growth of planted conifer seedlings were also monitored to assess health and vigor. A marked improvement in stream condition and wildlife habitat has been documented. Unfortunately, many high priority streams and forests have not been restored and are still unable to support healthy wildlife and salmon populations, and continued restoration efforts are needed.

Introduction

Central Westcoast Forest Society (CWFS) initiated the Kennedy Watershed Restoration Project (KWRP) in 1994. The objectives of the Kennedy Watershed Restoration Project are to accelerate the natural recovery of damaged ecosystems; addressing the root causes responsible for the immediate loss of habitat quantity and quality; and restoring the ecosystem processes that create and maintain habitats through time. Restoration is not intended to return a system to a pre-altered state or fixed condition but to help restore the structure, function, and ecological processes of a system (Kohm and Franklin, 1997). The tools and techniques behind ecosystem restoration are used to improve the biodiversity of degraded areas, increase the abundance and distribution of rare and threatened species, restore landscape connectivity, increase the quantity of environmental goods and services, and contribute to the improvement of human well-being (Society of Ecological Restoration International and IUCN Commission on Ecosystem Management, 2004).

Level I and II Fisheries Habitat Assessment Procedures (FHAP) were completed in 1995 and 1996 according to standards developed for the Watershed Restoration Program (WRP) (Clough et al., 1995; Johnston and Slaney, 1996). The WRP was developed to hasten the recovery of degraded environmental resources in logged watersheds by identifying and re-establishing conditions more similar to those found in un-impacted watersheds. The Level I and II field assessments are part of the WRP assessment procedure. The Level I assessment is a reconnaissance field survey used to identify potentially impaired habitat and helps to prioritize sites for the Level II assessment and prescription phase. The Level II assessment is used to identify physical limitations to salmonid production by quantifying and characterizing the habitat used by different stream-resident life stages. The Level II assessment provides site-specific habitat information that is needed to diagnose the nature of the impairment, as well as to provide the detailed information needed to plan the appropriate habitat rehabilitation project.

The Level I and II Fisheries Habitat Assessment allowed for the development of a detailed watershed restoration plan for the Kennedy Flats which was completed in 2001 (Warttig et al., 2001[4]). Described in this comprehensive plan is the restoration approach to be used, which includes priority rankings for restoration based on level of risk (critical, high, moderate or low) for all stream reaches, roads, and riparian areas in the watershed.

4 This report was updated in 2005, and is currently being updated to include new information up to the end of 2013

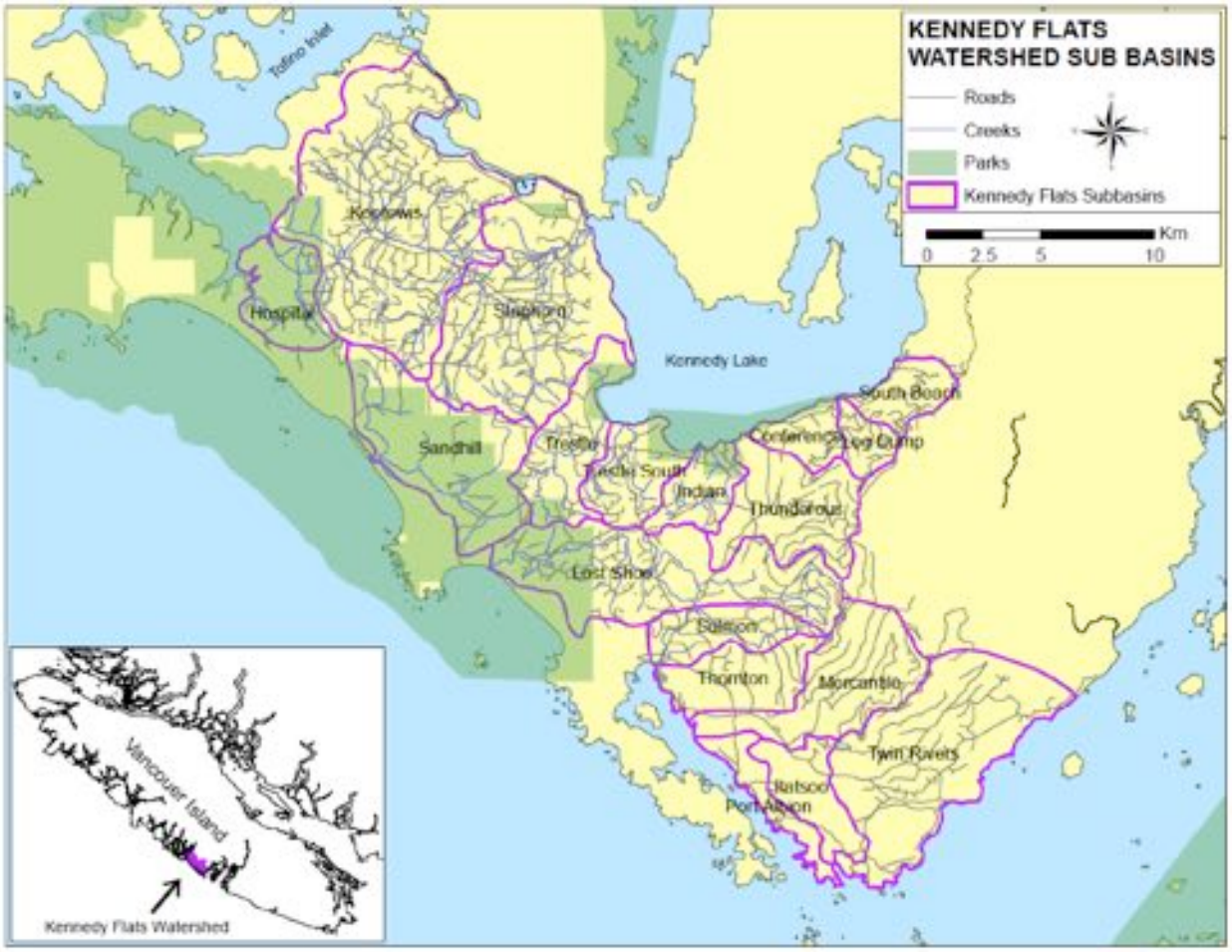

Figure 1. The Kennedy Flats Watershed is located on the west coast of Vancouver Island, British Columbia.

Restoration efforts continued in 2013/2014 thanks to funding from Parks Canada, Habitat Conservation Trust Fund, Ministry of Transportation and Infrastructure, Environment Canada EcoAction Community Funding Program, TD Friends of the Environment, Pacific Salmon Foundation, Schein Foundation, Department of Fisheries and Oceans Recreational Fisheries Conservation Partnerships Program, Alberni Clayoquot Regional District, Recreation Sites and Trails BC, Shell FuellingChange. This completion report includes a description of work undertaken in 2013/2014, including the overall restoration approach and specific methods used. Each year the sites are documented with output tables, before and after photographs, and monitoring templates.

Restoration Area

The Kennedy Flats Watershed is located in Clayoquot Sound, on the west coast of Vancouver Island, British Columbia (Figure 1). The project area is located approximately 100 km southwest of Port Alberni between the communities of Tofino and Ucluelet. It is watershed #249 under the former Ministry of

Environment, Lands and Parks' 2002-2003 Resource Management Plan (Ministry of Environment, Lands and Parks, 2003).

The Kennedy Flats includes the traditional territory and treaty lands of the Tla-o-qui-aht First Nation, Toquaht First Nation and Yuułuʔiłʔatḥ First Nation. Tenure includes Parks Canada (PC), BC Parks (BCP), Tree Farm License 54, 57 and 44 held by Iisaak Forest Resources Ltd., the Regional District landfill site, and small patches of private land owned primarily by International Forest Products Ltd. and Weyerhaeuser Ltd. Most of the Kennedy Flats Watershed is provincial or federal crown land (Figure 1). Currently Iisaak Forest Resources Ltd. is the primary tenure holder on the provincial crown land. Pacific Rim National Park Reserve occupies the majority of the remainder of Kennedy Flats.

The watershed contains approximately 420 km of fish bearing streams. Several creeks within the Kennedy Flats Watershed flow through the Long Beach Unit of the Pacific Rim National Park Reserve (PRNPR) (Figure 1). The Kennedy Flats Watershed covers an area of 129 km^2, and consists of nine sub-basins: Kootowis, Hospital, Sandhill, Staghorn, Trestle, Trestle South, Indian/Harold, Lost Shoe, and Salmon Creeks. There are several adjacent sub-basins (Thunderous, Conference, Log Dump, South Beach, Thornton, Mercantile, Port Albion, Ittatsoo, and Twin Rivers) that have streams with similar characteristics and restoration requirements; the restoration area will likely be expanded to include these sub-basins in the future (Figure 1).

Figure 2. Biologist Lily Burke holds an adult salmon that returned to Coho Creek in the Kennedy Flats Watershed.

The Kennedy Flats is part of the Estevan Coastal Plain, and is characterized by low-gradient streams with meandering channels and broad floodplains. The low creek gradients and stable conditions make these creeks attractive to anadromous salmonids (Figure 2). The streams in this area have historically supported populations of coho (*Oncorhynchus kisutch*), chum (*Oncorhynchus keta*), chinook (*Oncorhynchus tshawytscha*), pink (*Oncorhynchus gorbuscha*), and sockeye (*Oncorhynchus nerka*) salmon, as well as, coastal cutthroat trout (*Oncorhynchus clarkii clarkii*), rainbow and steelhead trout

(*Oncorhynchus mykiss*), lamprey, pea mouth chub, stickleback and sculpin (FISS Fish Distribution for Waterbody (ies)).

The Kennedy Flats Watershed is located in the Coastal Western Hemlock biogeoclimatic (BEC) zone; Southern Very Wet, Hypermaritime variant (CWHvh1) (Green and Klinka, 1994). The Southern Very Wet Hypermaritime Coastal Western Hemlock variant (CWHvh1) occurs below 200 meters ASL (above sea level) along the outer coast of Vancouver Island (Green and Klinka, 1994). The climate of this variant is moderated by the proximity of the Pacific Ocean with fog, drizzle and clouds common throughout the year. The zonal forests are dominated with western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicat*a), amabilis fir (*Abies amabilis*), and minor amounts of yellow cedar (*Chamaecyparis nootkatensis*). The dominant understory species include salal (*Gaultheria shallon*), Alaskan blueberry (*Vaccinium alaskaense*), red huckleberry (*Vaccinium parvifolium*), deer fern (*Blechnum spicant*), step moss (*Hylocomium splendens*) and lanky moss (*Rytidiadelphus loreus*) (Green and Klinka, 1994).

Stream Conditions

Much of the watershed was logged between 1950 and 1980, including 26 percent of the Long Beach Unit of PRNPR, prior to the lands being set aside for a National Park purposes in 1970. 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 placed in the stream to facilitate the removal of higher valued logs (Figure 3). Subsequent salvage logging for cedar shake and shingles added to the problem, introducing large amounts of residual waste small woody debris (SWD) into the streams. When combined with large logs that span the width of the stream, the SWD often resulted in debris jams (Figure 3). 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). In many cases 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 Kennedy Flats creeks are generally very low energy and the debris consists of a large amount of western redcedar, which is very decay resistant.

Figure 3. Debris jams in the Kennedy Flats Watershed.

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 stream reaches. The addition of spawning gravel was also necessary in many areas where gravel had been removed and used for road construction, leading to gravel deficiency (W. Warttig, pers. comm.). The altered hydrological function of the streams on the Kennedy Flats also affects the surrounding forests.

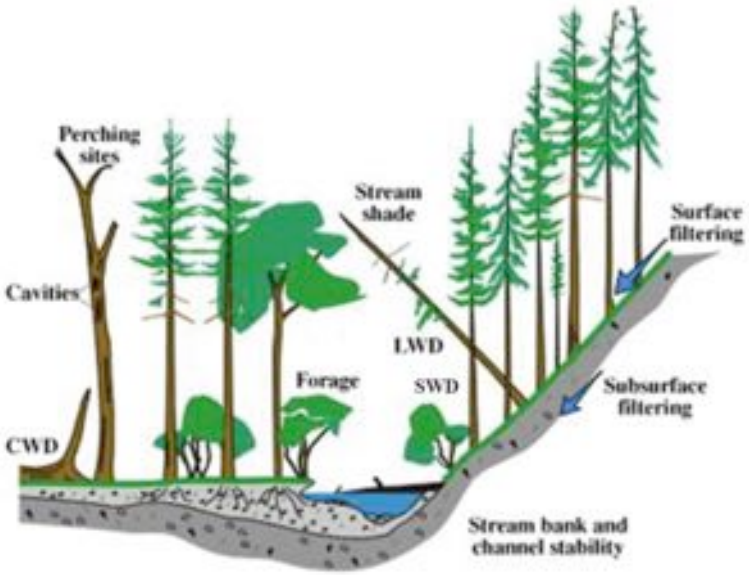

Figure 4. The aquatic and terrestrial ecosystems in a riparian zone are intimately connected by the exchange of water, material and organisms.

Riparian Conditions

Riparian areas are the zone of interaction between the forest and stream (Figure 4); the terrestrial and aquatic systems. The structural and compositional diversity of riparian forests are an outcome of fluvial inundation, windthrow, variable light conditions, irregular substrates and other influences (Benda et al., 1998). Riparian areas are essential components of healthy forest and stream ecosystems, and support the vast majority of wildlife species. Functioning riparian ecosystems provide many of the essential attributes required by fish and other aquatic organisms including shade, bank stability, protection from flood events, a recruitment source of large woody debris and coarse woody debris, and fine leaf and branch material (allochthonous input) (National Research Council, 2002; Warttig, 2011). Approximately 72 percent of terrestrial vertebrates were found to utilize riparian areas (Clayoquot Sound Technical Planning Committee, 2006). Since riparian areas perform a disproportional amount of biological and physical functions on a unit area basis, their restoration can have a major influence on achieving watershed restoration goals (National Research Council, 2002).

Riparian areas are classified into five categories based on stand conditions (Poulin et al., 2000) (Appendix VI). The riparian vegetation type (RVT) classification system differentiates common stand conditions and is a useful tool in the restoration process.

RVT 1: Brush dominated, with poorly stocked conifer component
RVT 2: Over stocked conifer
RVT 3: Deciduous forest over top of a good conifer understory
RVT 4: Deciduous forest with a poor conifer understory
RVT 5: Old growth or very old second growth forest

In the Kennedy Flats Watershed, riparian areas have been significantly altered and reduced (Figure 5). Forest practices such as cross-stream yarding and the removal of riparian vegetation and trees has negatively impacted riparian ecosystems and stream function, simplifying complex habitats and disrupting the natural processes that sustain aquatic and terrestrial ecosystems (Brown et al., 1979; Poulin and Simmons, 2001; Trofymow et al., 2003). Non-functioning (or impaired) riparian ecosystems offer poor bank protection and are a poor supply of large woody debris, which provides many important components of a healthy stream ecosystem such as cover, scour, hydrologic function and habitat. This type of impaired ecosystem will eventually recover, but over an extended period time (Prichard, 1993). The goal of riparian restoration is to accelerate the recovery of the riparian ecosystem.

Figure 5. Riparian areas were significantly altered by historic logging practices.

Policy Changes

In recent years, considerable efforts have been made to develop policies and regulations in British Columbia that protect stream and riparian habitat, considerable efforts have also been made, on the part of Central Westcoast Forest Society and Pacific Rim National Park Reserve, to rehabilitate damaged streams and riparian areas in the Kennedy Flats Watershed as well as other watersheds in both Clayoquot and Barkley Sounds.

Current timber harvesting regulations in British Columbia (BC) now require reserve zones of riparian vegetation adjacent to most fish bearing streams. Prior to 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. As a result of increased public sentiment for Clayoquot Sound, even more extensive stream protection practices were adopted in 1995 with the development of the Clayoquot Sound Scientific Panel Recommendations. Changes in the management of National Parks in Canada also occurred around this time. In 1998, National Parks were no longer managed for the wilderness experience but rather to promote the concept of ecological integrity, management with respect and consciousness of natural processes. In 1997, Pacific Rim National Park Reserve was ranked among the top five national parks whose ecological integrity was deemed at risk. Ecosystem restoration has since been a high priority.

Methods

Restoration Approach

Restoration generally follows 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 deactivation of unstable logging roads and slide stabilization, utilizing re-vegetation and soil bioengineering techniques. In-stream restoration begins only after upslope problems have been addressed, and consists of four phases. For each stream of interest, a Fish Habitat Assessment Procedure (FHAP) is completed, as well as a Level II prescription (Clough, 1995 and 1997).

Specific prescriptions are developed based on site conditions. These generally prescribe the removal of small woody debris, and the addition or placement of large woody debris into functional structures for Phase 1 and 2 of the restoration approach. The objective is to reposition 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 (Appendices I & VII).

Logs, root wads, undercut banks and boulders provide juvenile and adult fish with cover, shelter and protection from predators. These features provide shade and assist in regulating stream temperatures throughout the year. They also add channel complexity and increase insect rearing habitat, which in turn provides food for rearing fish. Examples of restoration structures built or added to provide cover include cover logs, bundles, boulders and A-frame spurs (Slaney and Zaldokas, 1997) (Figure 6).

Scour is a beneficial function within the creek system as it is a means of creating pools and undercut banks. These features provide security and resting areas for juvenile salmon. 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 in-stream 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 (Appendices I & VII) (Figure 6),

Figure 6. A-frame spur CWFS crew built on Coho Creek in

Phase 3 of in-stream restoration includes spawning gravel placement in areas that are deficient (Appendix III). The correct gravel size depends on the gradient and peak flow of the creek. Size can be determined from observation of native gravel in the area. Species utilization is also a factor. Gravel should be suitably mixed with complex sizes similar to the historic condition for the stream reach. Typically small coho, cutthroat and chum streams require washed ¼ to 2 ½ 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, in addition to invertebrate habitat. The boulders facilitate aeration, invertebrate and emergent fry habitat while helping to stabilize the entire bed. Spawning gravel placement sites must be chosen at the site level (see Spawning Gravel Placement SOP in Appendix III for more information).

Phase 4 of riparian restoration generally consists of silviculture treatments (creating gaps, dispersed thinning, topping, and planting) to accelerate the natural recovery process (Appendix VI). Treatments are planned to enhance the development of old-growth attributes in the stand, for example, 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.

Monitoring

During restoration activities water temperature and dissolved oxygen concentrations are monitored and recorded throughout the duration of the stream restoration project to ensure in-stream work does not occur when water temperature exceeds the maximum allowable 20°C (at this temperature fish become severely stressed) or that suspended sediment levels were not harmful (Watershed Management Branch, 1997).

Monitoring efforts are extensive throughout restoration activities and are a key component of successful restoration projects. In-stream structures are monitored annually for three years after installation, and once every five years after that (Warttig et al., 2001). Charts (called Gant Charts) are used to document evaluation of the physical effectiveness of in-stream structures and to note any changes or problems that may have occurred during the winter floods (Appendices VIII and IX). These charts provide a standardized way of grading the structure and performance of an introduced in-stream structure (Koning et al., 1998).

Restoration sites are evaluated using the methods outlined in Koning et al. (1998) (Appendix VIII). Each in-stream structure is assessed for specific physical and biological attributes, and given an overall rating for condition, stability, and maintenance. Possible scores range from 1 to 4, with a score of 4 indicating that a given objective was being exceeded, while a score of 1 indicates failure to meet the objective. During assessments, each jam or structure is 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 successful anchoring methods. The charts are then used to direct the restoration crew on where maintenance was required.

Riparian monitoring plots are used to determine survival rate, health and growth rate of planted conifers as well as the amount of surrounding competing vegetation. Routine monitoring takes place after the completion of a riparian project until it is no longer deemed necessary. At any time if the information collected indicates additional treatment, there may be another restoration project. Photos are taken before and after brushing from permanently established photo points.
Wildlife sign heard and/or observed during restoration activities is recorded and restoration crew are careful not to disturb wildlife and wildlife habitat.

Permits & Approvals

Riparian and 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
- Forest Range and Practices Act (FRPA) and Forest Planning and Practices Regulation (FPPR) (BC Ministry of Forests Lands and Natural Resources Operations)
- Approvals from individual tenure holders
- Letter of support from the local First Nations elected councils.

Staffing

Central Westcoast Forest Society hired fourteen local residents from Tofino, Ucluelet and the Ahousaht, Toquaht, Yuułuʔiłʔatḥ, and Tla-o-qui-aht First Nations communities as crew members (Figure 7). For some members of the crew, it was their tenth season and younger crew members benefited greatly from their knowledge and experience. Planning biologists Dave Clough (RPBio) and Warren Warttig (RPBio) were involved in the assessment and implementation of the restoration work, in addition to, providing technical support throughout the project. Lily Burke (RPBio) was the project biologist and acting Executive Director, and was responsible for overseeing riparian and stream prescriptions, restoration and monitoring efforts, as well as safety and technical reporting with assistance from Jessica Hutchinson (EP), CWFS Executive Director. The crew was composed of project managers Kat McGlynn and Jamie Pascoe (PGeo), and restoration crew Emily Thicke, Lisa Fletcher (BIT), Adrian Burnie, Patrick Callow, Lawrence Sutherland, Chuck Mack, Leonard Mack, Andrew Mack, Dominique Charlie, Liam Mackenzie, and Ken Easton.

Training

The first day of the project was devoted to a pre-work orientation reviewing safety regulations, procedures and guidelines, specifically: Emergency Transportation Procedures, Significant Environmental Aspects, Job Safety Breakdown, and Standard Operating Procedures (SOP's) (Appendices I-V) were discussed. In addition, the Work Safe BC (WSBC) 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 made available to each crew member (Appendix VII).

Figure 7. Restoration crew members from 2013.

Lost Shoe Creek Restoration Project

Fish Monitoring

Juvenile Fish Trapping

LS2A lies within a small sub-basin of Lost Shoe Creek with a catchment area of approximately 71 ha. The main channel of LS2A has a length of 838 m with an average gradient of <2%. This stream is "lake headed" by a small wetland called Swan Lake. Swan Lake (more aptly classified as a marsh wetland) has a wetted area of 4.0 ha, surrounded by peat bog of 1.8 ha for a total of 5.8 ha. The LS2A tributary is 3.5 km upstream from the ocean and is within PRNPR (Figure 17). When the riparian corridor surrounding LS2A was logged in the 1960s, SWD and LWD were dumped into the streambed to clear areas for timber extraction. The build-up of woody debris and sediment in LS2A degraded the historic stream channel morphology and restricted fish access. Juvenile fish sampling in 2009 and 2010 determined a zero fish count for LS2A and Swan Lake. LS2A would have historically provided refuge for juvenile salmonids during peak winter flows. Low gradient tributaries have lower flow rates allowing the fish to conserve energy and also offer protection from predators when slower metabolic rates (as a result of cooler water in the winter) make fish more susceptible to predation. Reconnecting isolated habitats is one of the most effective restoration techniques for revitalizing salmonid populations (Roni et al., 2002). Thanks to the restoration efforts by Parks Canada and Central Westcoast Forest Society juvenile salmonids have been observed once again in LS2A for the first time in close to 40 years!

Figure 8. The first coho found in LS2A in 40 years at weir 6.

Gee traps were set in LS2A on April 25, 2013 at 4 sites. In total 1 cutthroat trout and 2 coho were caught as well as 1 red-legged frog (Table 1) (Figure 8). LS2A will continue to be monitored to assess the production and distribution of salmonids in the system.

Table 1. The results from juvenile fish sampling on LS2A in 2013.

Trap	Location	UTM	Cutthroat	Coho	Red-legged frog
1	upstream deactivated bridge	0309860 // 5431451	0	0	1
2	downstream deactivated bridge	0309869 // 5431484	1	0	0
3	upstream Weir 10	0309844 // 5431582	0	0	0
4	upstream Weir 6	0309858 // 5431643	0	2	0

Smolt Trap Monitoring

Two smolt traps were installed on Lost Shoe Creek, one at reach LS3B1 of Lost Shoe Creek and the other at the off-channel habitat in reach 4 (LS4) (Figure 9). The smolt traps were installed to monitor out-migration of salmon smolts, primarily coho, and water quality.

Figure 9. LS3B1 smolt trap in operation.

The design used for the smolt trap was the same as that used during the 2007 through 2010 smolt trapping program on Lost Shoe Creek. The traps consist of 4 foot by 8 foot long wood (2x4's) frame panels covered in ¼ inch galvanized hardware cloth. The trap panels were placed into the streambed and anchored with gravel, sand bags and wooden backstays. The trap was shaped in a V-weir to increase the surface area, and thus decrease the surface pressure on the screens. The panel shape also encouraged migrants to funnel into a 4-inch flexible plastic pipe that led to the 6ft x 4ft wooden capture box. The static head of the panels was maintained by regular cleaning to ensure a head differential of 2 –6 inches between the entrance of the pipe and the capture box. This head differential was usually enough to maintain the fish in the box until removed by the crew. The trap box was checked once daily. Fish species were identified and weight and fork length was recorded as well as water temperature and dissolved oxygen.

A trout mesh net was used to catch fish in the smolt trap and place them in a 5-gallon pail. The pail was half filled with creek water and leaf litter to provide cover for the fish and reduce stress. Generally 5 fish were caught at a time and brought to shore. A separate 5-gallon pail was half filled with creek water and a few drops of clove oil were added to the pail to act as an anesthetic to sedate the fish. Using a dip net, fish were transferred to the clove oil bucket, placing only a few fish in at a time. Once the fish were sedated, clearly visible by the slowing of swimming motions, they were removed by hand and fork length and weight were measured. They were then placed in a viewfinder to observe fish health, such as parasites and/or lesions (Figure 10). Once observations were completed the fish were placed in a third bucket, the recovery bucket, that was half filled with cool creek water and leaf litter to allow the fish to recover from the clove oil effects. Once the fish showed visible signs of recovery, usually after 5 minutes, they were carefully netted and returned to the creek.

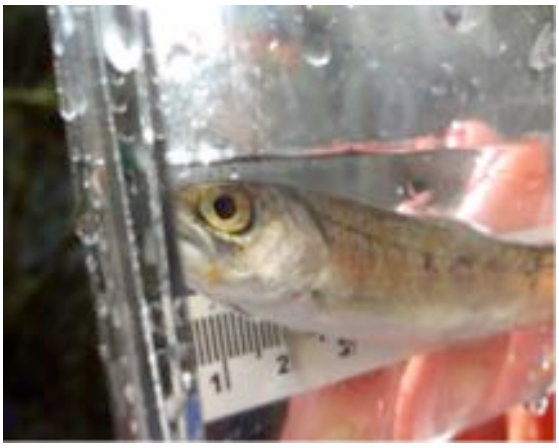

Figure 10. Parasite observed on coho smolt. near the mouth.

LS3B1 Smolt Trap

The LS3B1 trap was in operation from April 27 – June 10, 2013. No smolts were observed in the trap until April 29th, when 22 coho smolts were captured. There were five high water events while the trap was in operation (May 12-14 and 28 – 29). On these days the creek water level was higher than the trap panels and fish were able to swim above the screens. Unfortunately, peak migration occurred during the first high water event from May 12-14 when the highest daily number of smolts was observed. The total fish counted through the trap during operation was 304 fish, with 201 being coho smolts. Coastal cutthroat trout, coastrange sculpin (*Cottus aleuticus*), Dolly Varden (*Salvelinus malma malma*) and three-spine stickleback (*Gasterosteus aculeatus*) were also collected.

The migratory peak with 43 coho smolts occurred on May 13, at a water temperature of 9.5°C (Figure 11). In 2007, 2008, and 2010, the migratory peak occurred on May 20 with 70, 161 and 124 smolts captured respectively (Clough, 2010). The peak migration in 2009 occurred on May 27 with 85 smolts. An unidentified parasite was observed on 67 of the 201 coho smolts caught in 2013. The parasite was noted near the mouth and/or pelvic fin of the fish, and was small and white (Figure 10). A specimen was collected and preserved in isopropyl rubbing alcohol and later Identified by Simon R.M. Jones, Aquatic Animal Health Section, Pacific Biological Station, Fisheries and Oceans Canada, as the copepod *Salmincola californiensi.*

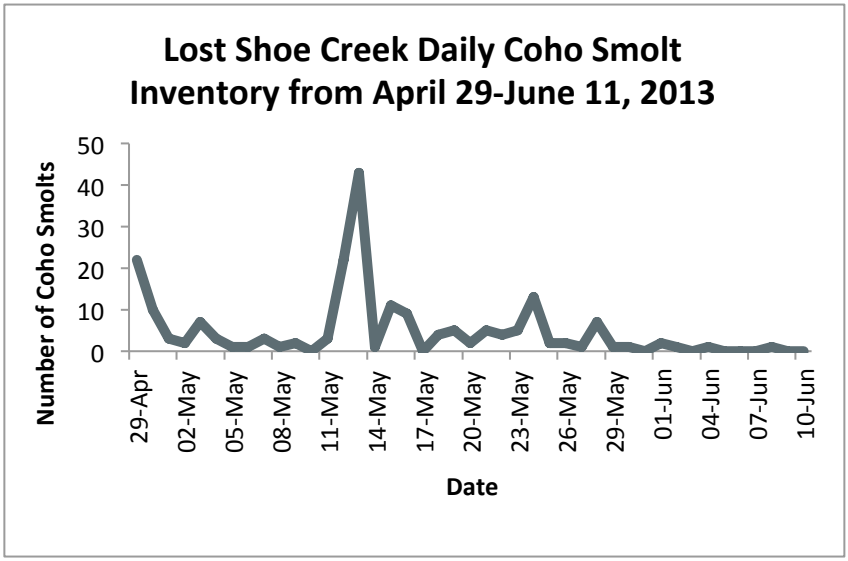

Figure 11: Daily Coho Smolt Inventory at Lost Shoe Creek from April until June, 2013

Off-Channel Smolt Trap

The Lost Shoe Creek off-channel smolt trap was operated through the spring from May 10 to June 1, 2013. As the off-channel was constructed the previous year (2012), it was the first year the salmon had access to this spawning and rearing habitat. The trap was installed fairly late in the year, likely resulting in many migration days missed. On the first day of operation 34 coho fry were caught in the trap. A total of 114 fish were caught in the trap during the period of operation. The total fish counted through the trap during operation was 8 coho smolts, 102 coho fry, 1 chinook smolt, 3 three-spined stickleback, and 2 lampreys. The migratory peak of smolts occurred on May 12 with 4 smolts at a water temperature of 10.9 °C (Figure 12). Also found in the trap was one red-legged frog and one Northwestern salamander.

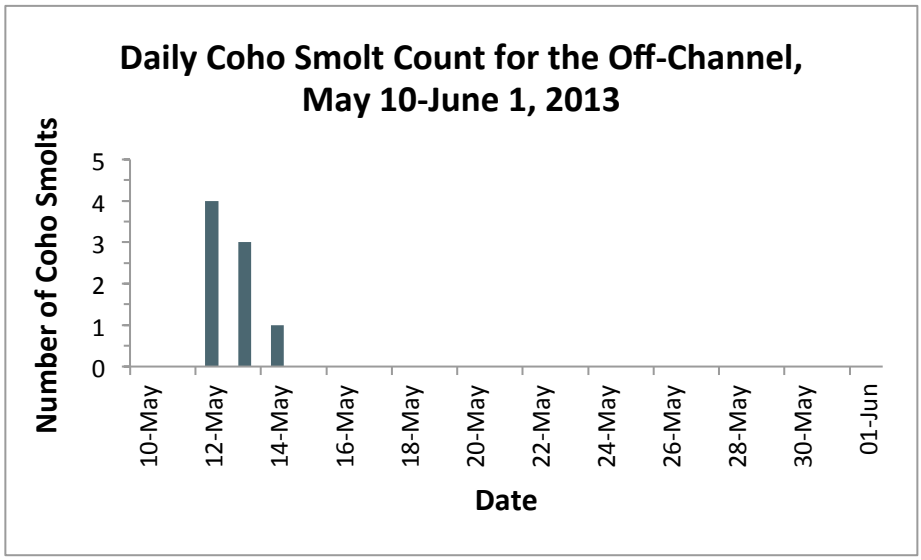

Figure 12. Daily Coho Smolt Inventory at off-channel.

The off-channel provides winter habitat for juvenile salmon during the winter months, when flows are higher and temperatures are lower in the main channel. The off-channel was constructed in 2012 and salmon may have spawned in the channel in the fall of 2012. Salmon alevin emerged from the gravel in the spring of 2013 and they will remain in the off-channel for 1 year before heading out to sea in the spring of 2014. The 2014 smolt trap, therefore, will be the first year to evaluate salmon production in the off-channel habitat. A minimum of 5 years inventory on the off-channel site will be required to provide an understanding of the wild stock within this system and the effectiveness of the off-channel habitat.

A total of 12 volunteers from the communities of Tofino and Ucluelet assisted in checking the smolt traps from the time of installation until removal, contributing 84 hours of volunteer time (Figure 13 & 14). Mr. Alan McCarthy, Yuułuʔiłʔatḥ Fisheries Manager, was provided a tour of the smolt trap and assisted in smolt collection on May 10, 2013.

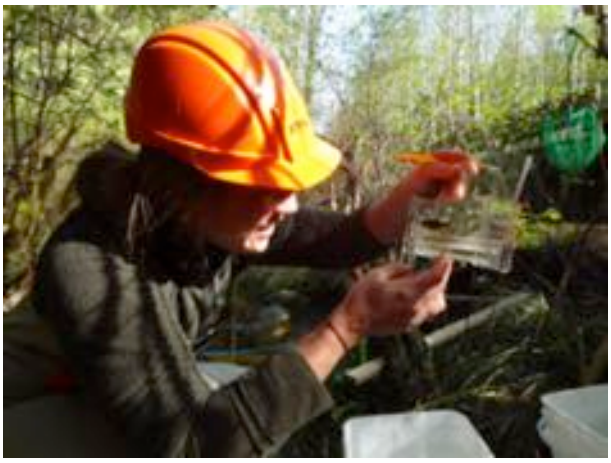

Figure 13. Measuring fish length at the Lost Shoe Creek Smolt Trap, 2013

Figure 14. Tofino and Ucluelet volunteers checking the Lost Shoe Creek Smolt Trap.

Stream Monitoring

Water Quality Monitoring

During restoration activities water temperature and dissolved oxygen concentrations were monitored throughout the duration of the stream restoration project to ensure in-stream work did not occur when water temperature exceeded the maximum allowable 20°C (at this temperature fish become severely stressed) (Table 2).

Table 2. Water quality point sample data taken at LS4 during restoration activities.

LS4 Location	Date (m-d-y)	DO (mg/L)	% Sat	Temp (°C)
4+635 m	07/31/2013	8.8	83	11.5
4+635 m	01/08/2013	8.5	82	12.5
4+635 m	02/08/2013	8.5	82	12.5
4+635 m	06/08/2013	8.8	84	12.1
4+635 m	07/08/2013	8.7	84	12.5
4+635 m	08/08/2013	8.8	86	13.2
4+416 m	07/31/2013	9.3	88	11.8
4+416 m	01/08/2013	8.7	82	11.6
4+416 m	02/08/2013	8.6	80	11.5
4+416 m	06/08/2013	9.0	85	11.9
4+416 m	07/31/2013	9.0	86	11.8
4+416 m	08/08/2013	9.0	85	11.9

Gant Charts

The 2012/2013 restoration sites on LS2A from Station 0+497 to 0+721 m were evaluated in March 2014 (Appendix VIII). In the 2012/13-field season 62 pieces of LWD was added to LS2A to increase in-stream cover and habitat, to scour pools and create a pool-riffle sequence. The work successfully increased in-stream cover and the frequency and depth of pools. The sites all received near perfect scores of 3 or 4 out of 4 for biological and overall objectives. At station 0+428 to 0+567 m and station 0+676 to 0+721 m LWD should be added instream and positioned to scour pools and undercut banks. These features would provide the necessary security and resting areas for young salmon (fry). Deep pools also retain water during low flow periods providing valuable year round rearing habitat. Addition of a mixture of ¼ to 2½ inch round rock with a mix of 10 % cobble and a few boulders is also recommended to improve spawning habitat conditions. Larger gravel and cobble would provide valuable invertebrate habitat and help aerate the gravel bed. See 2012/2013 Gant Charts for specific spawning gravel placement locations (Appendix VIII).

In September 2012, 528 linear metres of off-channel habitat were constructed providing a total habitat area of 1692 m^2. The objective was to increase the year-round aquatic habitat for salmonids. Artificially constructed off-channels have been shown to provide high quality rearing habitat for young salmonids, helping to restore and enhance adult salmon abundance. A spawning platform or riffle was also constructed to aerate the water, and increase turbulence, air contact and the amount of dissolved oxygen concentrations. Shallow benches were constructed on the banks of the channel to allow semi-aquatic vegetation to establish in the shallower areas. The shallow benches will also provide more suitable habitat for amphibian breeding and will allow small mammals to safely enter and exit the channel. A total of 228 LWD was placed in the channel achieving the target of 25-30% of the aquatic surface area being LWD. Longer stem LWD was buried part-way into berms or driven into the channel to act as debris catchers or sweepers. The LWD also provide cover, protection from predation and shade to help moderate temperature fluctuations.

The 2012/13 Lost Shoe Creek off-channel habitat was evaluated in March 2014 to determine if the project achieved the physical and biological objectives. The work successfully increased the availability of year round aquatic habitat. The spawning platform at station 0+010 m received a near perfect score (4 out of 4) but additional spawning gravel is needed. Addition of a mixture of ¼ to 2½ inch round rock with a mix of 10 % cobble and a few boulders is also recommended to improve spawning habitat conditions. Larger gravel and cobble would provide valuable invertebrate habitat and help aerate the gravel bed. Additional in-stream cover logs are needed at 0+015 m, from station 0+195 to 0+255 m, and in tributary 1 and 2. In-stream logs provide shade and moderate water temperature while providing insect rearing habitat and in turn food for rearing fish. Grass seed and vegetation such as native reeds and sedges should be planted on the banks of the off-channel habitat. Once established, vegetation reduces erosion, provides shade, rearing habitat for amphibians, and is an important source of food for aquatic organisms.

This year's restoration sites in reach 4 (LS4) will be evaluated in March 2015, after 1 year of high winter flows (Appendix IX).

Stream Maintenance

A maintenance sweep of the in-stream restoration work completed on LS2A in 2012/13 was conducted at the beginning of the 2013/2014 restoration season; the crew walked from station 0+000 to 0+256.9 m, the restoration sites received near perfect scores as they were achieving both the physical and biological objectives (see KWRP Report 2012/2013 Appendix VIII) (Figure 15). A mixture of ¼ to 2 ½ inch rock with a mixture of 10% larger cobble sized gravel was recommended at stations 0+066 m and 0+110 m. This mixture is ideal for smaller coho/cutthroat trout streams like LS2A as it provides additional habitat for invertebrates and helps to aerate the substrate. No gravel was added in 2013/2014 but this recommendation should be carried forward on future restoration projects at this site.

Stream Restoration

In 2006 in-stream restoration was completed on LS4 from station 4+635 to 4+865 m (Figure 15). Seven log jams in this reach were dismantled and 208 pieces of LWD were relocated and anchored to the stream bank. 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. The LWD repositioning in 2006 protected and raised the creek banks and successfully re-established a single channel with no segmented pools or trapped fish observed. Further restoration work was needed at this site in 2013. This reach was uncharacteristically wide, lacking a defined thalwag and pool-riffle sequence. In-stream restoration activities were focused on the enhancement of fish habitat features such as deep pools and riffles for rearing and spawning habitat. In-stream activities included hand removal of small woody debris (SWD) and repositioning large woody debris (LWD) by use of hand winches and pulley systems. All SWD was relocated well beyond the extent of the stream flood plain.

Repositioned LWD was secured in position with 3/8” cable and clamps. LWD was positioned strategically in the creek bed in an attempt to direct water flow towards the thalweg, aid in pool and riffle creation,

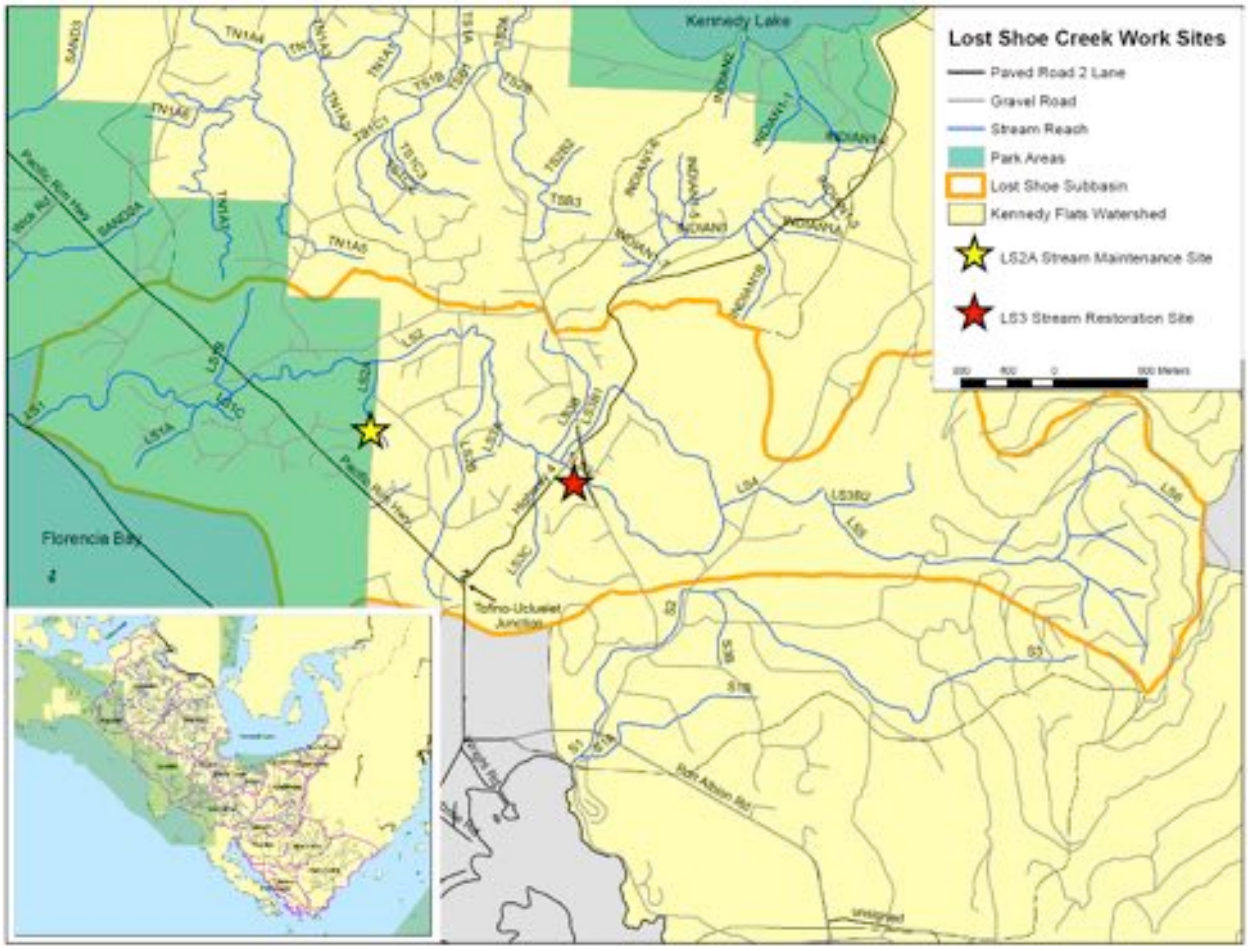

Figure 15. Lost Shoe Creek stream restoration work sites.

provide shade and cover features for fish and other aquatic life, and to protect the creek banks.

Prior to commencement of restoration activities, the project manager and biologist reviewed restoration sites to ensure that the restoration crew could properly carry out the prescribed treatments. A total of 167 m of stream restoration was completed in the 2013 restoration season on Lost Shoe Creek (LS4) through the removal of debris jams and sediment wedges. The restoration crew removed 52 m^3 of SWD and repositioned 64 pieces of LWD and removed 24 root-wads from the creek channel.

Due to the amount of fines within the creek system at the conclusion of in-stream work, no spawning gravel was added to Lost Shoe Creek this year. Spawning gravel is added after fines have been washed from the creek. Please see attached CWFS Spawning Gravel Placement Standard Operating Procedure for more information (Appendix III).

Riparian Monitoring

Riparian monitoring plots, established in 2010, were assessed to determine survival rate, health and growth rate of planted conifers as well as the amount of surrounding competing vegetation. Routine monitoring will occur after the completion of a riparian project until it is no longer deemed necessary. At any time if the information collected indicates additional treatment, there may be another restoration project. Photos were taken before and after brushing from permanently established photo points.

Table 3. Seedling survival and growth rates for planted western redcedar and Sitka spruce.

	Redcedar	Sitka Spruce
Total	100	98
Average height when planted	32.2 cm	35.5 cm
Average height in 2013	66.4 cm	91.6 cm
Average height increase	40.7 cm	66.0 cm
Number of dead trees	9	10
Seedling survival rate	91%	90%

After two growing seasons seedling survival was 91% for western redcedar (9% mortality – only 2 of the 9 dead trees were previously identified in 2010 as being in poor to fair condition). Although the survival rate for the Sitka spruce (*Picea sitchensis*) seedlings was slightly lower, at 89.8%, the results are still good (Table 3). At the time of planting the spruce were slightly taller than the redcedar by 3.3 cm. The net gain on the spruce after two growing seasons is 66.0 cm in total compared to 40.7 cm for the cedar. Trees planted in sunnier locations also fared better than those in shaded conditions. Brushing is recommended for a minimum of 2 more growing seasons to ensure the seedlings surpass the height of salmonberry shrubs and can effectively out-complete the underbrush for light, nutrients and water.

Riparian Maintenance

The restoration crew brushed competing shrubs around the planted western redcedar and Sitka spruce seedlings on Lost Shoe Creek. Salmonberry shrubs can grow well over 2 m in height and can effectively out-compete conifers for sunlight, hindering conifer growth. The crew brushed the 2007 and 2010 planting sites completing an estimated 4.5 ha out of the 9 ha total. Protective deer browse cones were

also removed from mature western redcedar trees. The cones were left in place on trees that still required protection from deer grazing.

Riparian Restoration

Volunteer days were held to assist with riparian restoration efforts at the Lost Shoe Creek off-channel. Volunteer planting days were combined with interpretative talks providing a hands on opportunity to learn about ecosystem restoration efforts, the project objectives and partnering organizations. With assistance of crew members the volunteers planted 156 Sitka spruce and western redcedar conifers. A total of 190 native shrubs including salal, salmonberry (*Rubus spectabilis*), red huckleberry, red elderberry (*Sambucus racemosa*), false azalea (*Menziesia ferruginea*), oval-leaved blueberry (*Vaccinium ovalifolium*), thimbleberry (*Rubus parviflorus*), Nootka rose (*Rosa nutkana*), false lily-of-the-valley (*Maianthemum dilatatum*), deer fern, lady fern (*Athyrium filix femina*) and sword fern (*Polystichum munitum*) were planted.

Poulin & Simmons completed a riparian restoration prescription for the Lost Shoe Creek watershed in PRNPR in 2001. Using the prescription restoration ecologist Jessica Hutchinson (MSc) developed a site level prescription for LS2A. Three riparian vegetation types were treated: RVT2 conifer-dominated sites with high stocking densities, reduced conifer diameter and crown development; RVT3 deciduous dominated sites with a suppressed conifer understory; and RVT4 sites deciduous dominated sites that lack a conifer understory.

Riparian Vegetation Type 2

Riparian Vegetation Type 2 sites are characterized by the high-density of conifers trees resulting from forestry tree planting operations and the additional natural re-growth of western hemlock, western redcedar, and Sitka spruce. When trees are tightly packed together they do not have enough space to grow healthy root systems, trucks or canopies. High-density conifer sites form a single canopy layer or a closed canopy that limits the availability of light reaching the forest floor. A closed-canopy decreases the amount of sunlight in the understory and significantly reduces the diversity and density of vegetation (Figure 16). Understory vegetation is extremely important for riparian ecosystems. Plants regulate ground water levels, stabilize creek banks, prevent erosion and help control water temperatures by providing

Figure 16. Dense second-growth forest lacking understory vegetation.

stream-side shade and cover. They are also an important food source for both terrestrial wildlife and aquatic organisms. The lack of vegetation in second-growth forests affects the entire ecosystem and can potentially impact all levels of the food chain in the terrestrial and aquatic environments. In 2013/2014 riparian restoration treatments were carried out in a total of 1.3 ha of RVT2 conifer-dominated sites (Figure 17). Riparian restoration techniques, such as patch openings and variable thinning were used to accelerate the development of old growth characteristics. Thinning dense conifer forests can accelerate a tree's diameter growth rates and increase biodiversity from the tops of trees down to the forest floor. The objectives for the riparian restoration treatments in the Lost Shoe Creek RVT2 sites are to accelerate the development old-growth characteristics such as diverse understory vegetation and large live crowns and to increase forest complexity by adding standing dead trees, multiple canopy layers, and a component of decaying wood on the forest floor. The limbs were removed from the felled trees, gathered and placed in discrete coarse woody debris piles to allow for maximum sun exposure on the forest floor. The felled trees were left intact to provide habitat for wildlife and a moist elevated substrate for re-generating conifer seedlings and shrubs.

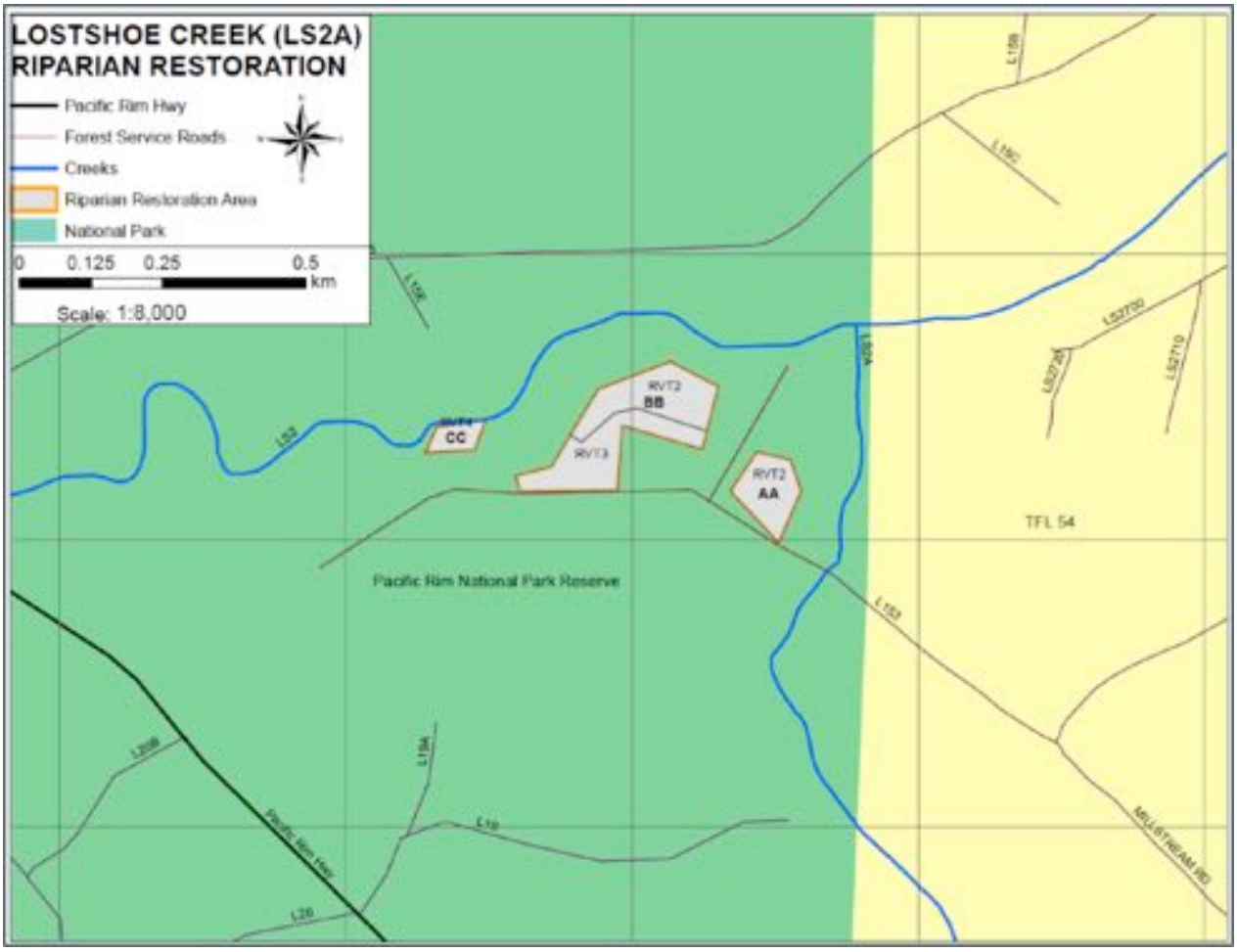

Figure 17 . The Lost Shoe Creek riparian restoration polygons and riparian vegetation types.

Riparian Vegetation Type 3 and 4

The riparian corridor on Lost Shoe Creek was historically a conifer dominated forest composed of western redcedar, Sitka spruce and western hemlock 250 - 1000+ years in age. Disturbance from logging activities resulted in the regeneration of an almost entirely pure deciduous red alder stand. The 1937 aerial photographs, analysed by forest ecology specialist Dr. Audrey Pearson, confirmed that red alder was only a minor component of the old-growth stand before logging (Pearson, 2007). It is now, however, the dominant stand type accounting for over 66% of the riparian corridor on Lost Shoe Creek (Poulin & Simmons, 2001).

Red alder is a pioneering tree species that establishes after heavy disturbance. It thrives in areas of full sun and exposed mineral soils. Logging roads, landslides or disturbed alluvial streams like Lost Shoe Creek provide the habitat conditions necessary for the proliferation of red alder.

Figure 18. The red alder's shallow roots systems are easily eroded and topple into Lost Shoe Creek.

Red alder provides many early benefits to harvested or degraded riparian areas. Its rapid growth rates provide a source of erosion control in its early growth stages (Hughes, 2007). A bacterium on the trees' roots converts atmospheric nitrogen, fixing nitrogen into the soils and improving the fertility of the soil. The organic litter from the trees also benefits aquatic and terrestrial organisms supplying a source of food and shelter. These fast growing trees also provide shade helping to regulate water temperatures during the drier summer months.

Red alder do not have strong root systems and can be easily eroded causing the tree to topple over into the stream causing severe bank erosion and sediment input to the stream (Figure 18). The rapid decay rates of red alder also limit its function as a source of large woody debris for stream ecosystems. Conifers decay at a slower rate and their large root wads and large trunks slow creek velocity and regulate the transport of small woody debris, sediment and spawning gravel. Red alder can provide a short-term source of instream cover, scour and organic matter but the rapid decay of red alder restricts its physical and biological function over the long term. For these reasons riparian restoration treatments are recommended to help restore the ecological processes associated with large conifers and stream systems.

Figure 19. The red alder has effectively shaded and prevented conifer regeneration in this RVT4 site on Lost Shoe Creek.

The Riparian Vegetation Type 3 sites on Lost Shoe Creek were thinned to release suppressed understory conifers. A total of 0.8 hectares of RVT3 restoration was completed in 2014 (Figure 17). The objective was to release understory Sitka spruce and western redcedar trees from competition while retaining enough alder to remain as a dominant component of the forest composition. Individual alder were felled within a 3 m to 10 m radius of selected conifers. Where possible, alder was felled above the lower live limbs to allow coppicing, retention of live roots, and source of coarse woody debris.

In Riparian Vegetation Type 4 sites the deciduous-dominated forests lack a conifer understory (Figure 19). The objective was to thin overstory red alder while retaining the largest and healthiest alders that have large live crowns or signs of wildlife use. The RVT4 sites were thinned to roughly 100 to 400 stems per hectare. Conifer seedlings will be planted in July 2014 to create a mixed deciduous-conifer stand. A total of 0.2 ha of red alder was thinned in RVT4 sites (Figure 17). The felled alder trees were left intact, limbs were removed if they were pressing shrubs and conifers or blocking wildlife trails.

Wildlife Monitoring

Blue-listed species, the Red-legged frog *(Rana aurora*) egg masses, juveniles and adults as well as Northwestern salamander (*Ambystoma gracile*) egg masses and adults were observed at LS2A and the off-channel habitat (Figure 20). Signs of black bear (*Ursus americnus*) activity (scat and grubbed skunk cabbage) were also seen on the Swan Lake Safety trail.

Figure 20. An adult red-legged frog found on LS2A.

Coho Creek Restoration Project

Fish Monitoring

Smolt Trap Monitoring

Coho Creek Smolt Trap

The smolt trap was monitored daily beginning on May 11 and ending on May 31, with the exception of May 13-17 and May 29 and 30 when either trap maintenance was required (baffles needed) or when creek water levels were too high, causing water to flow around the panels. The total fish counted through the trap during operation was 34. The total coho smolts were 17, with 10 of the smolts dying during high flow periods from excessive water velocity in the trap. On May 17, baffles were built to better regulate flow to the trap and prevent fish mortality. The trap also collected 5 coastal cutthroat trout and 12 sculpin (thought to be the Coastrange sculpin, although, only the rays of the anal fins were counted on 4 fish). If the smolt trap on Coho Creek is installed again in 2014 it should be checked several times a day during rain events to clear debris from the galvanized mesh and ensure the safety of all fish in the trap.

Stream Monitoring

Water Quality Monitoring

During restoration activities water temperature and dissolved oxygen concentrations were monitored and recorded throughout the duration of the stream restoration project to ensure in-stream work did not occur when water temperature exceeded the maximum allowable 20°C (at this temperature fish become severely stressed) or that suspended sediment levels were not harmful (Table 4).

Table 4. Water quality point sample data taken during restoration activities, ensuring work stops once water temperature exceeds 20°C.

Coho Creek Location	Date (m-d-y)	DO (mg/L)	% Sat	Temp (C°)
0+435 m	07/23/2013	8.2	81	14.1
0+435 m	07/24/2013	8.2	81	14.1
0+435 m	07/30/2013	8.2	81	13.6
0+350 m	07/23/2013	7.7	75	12.8
0+350 m	07/24/2013	7.7	75	12.8
0+350 m	07/30/2013	7.0	68	12.4
0+298 m	07/23/2013	8.6	84	13.2
0+298 m	07/24/2013	8.6	82	12.5
0+298 m	07/30/2013	8.2	79	12.4
0+195 m	07/23/2013	9.8	95	12.6
0+195 m	07/24/2013	9.7	93	12.2
0+195 m	07/30/2013	9.6	91	12.0

Gant Charts

Restoration was completed on Coho Creek in 2012/13. The primary objective was to improve fish access by removing debris jams and SWD build-up that impeded fish passage upstream. The other objective was to flush sediment and allochthonous material downstream by removing SWD. The build-up of SWD was causing sedimentation, filling in pools and covering natural spawning grounds with fines. In total 53 m^3 of SWD was removed from the creek and 65 LWD were repositioned in the stream.

The 2012/13 restoration sites were evaluated using the methods outlined in Koning et al. (1998) (Appendix VIII). Each in-stream structure was assessed for specific physical and biological attributes, and given an overall rating from 1 to 4 for condition, stability, and maintenance. The 2012/13 restoration sites on Coho Creek from Station 0+323 to 0+522 m were evaluated in March 2014 (Appendix VIII). The sites all received near perfect scores of 3 or 4 out of 4 for biological and overall objectives. Maintenance work is required from station 0+323 to 0+485 m. LWD should be added to these sites to increase in-stream cover and to scour pools. Additionally, vegetation should be planted at Jam 10 from station 0+368 to 0+384 m to stabilize creek banks and regulate runoff. The necessary maintenance work will be undertaken for these sites in July 2014.

The 2013/2014 restoration sites on Coho Creek from 0+100 to 0+385 m will be evaluated in March 2015, after 1 year of high winter flows (Appendix IX).

Stream Maintenance

The 2012/13-restoration work on Coho Creek was evaluated using the Gant Charts in March 2013 (see KWRP Report 2012/2013). Maintenance was required on sites from station 0+297 to 0+545 m. Maintenance was completed at station 0+297 m. Three LWD were repositioned to improve fish access and to provide additional stream cover. From station 0+323 to 0+385 m a total of 12 LWD were repositioned to improve drainage and flush sediment. An A-frame structure was constructed to scour a pool and provide instream cover (Figure 21). The LWD were also repositioned in-stream to provide additional cover and aquatic habitat. Additional maintenance work was also required on the 2011/2012 restoration sites from station 0+100 to 0+297 m (see KWRP Report 2011/2012).
At station 0+100 m 4 LWD were repositioned to improve scour and flush sediment. At station 0+140 m 5 m^3 of SWD and 6 LWD were removed and repositioned to improve fish access and

Figure 21. The restoration crew constructs an A-frame structure to scour a pool on Coho Creek.

stream cover respectively. From station 0+200 to 0+248 m 5 root wads and 4 m^3 of SWD were removed from the centre of the creek channel to improve drainage and flush sediments from spawning gravel. Two LWD were repositioned at this site to provide additional stream cover. In total 285 m of maintenance was completed in 2013/2014. A total of 11 root wads were removed from the creek channel, 51 LWD were repositioned, 63 m of 3/8" cable used for anchoring, and 28 m^3 of SWD was removed.

The maintenance work completed on Coho Creek in 2013 was largely assisted by the in-kind contribution of crew members from Creative Salmon Ltd. The Creative Salmon crew worked for 2 days helping to move LWD and remove SWD and root wads. This opportunity allowed CWFS crew to mentor Creative Salmon employees and gave the Creative Salmon employees a chance to learn about wild salmon habitat, providing a positive experience for all.

The 2013 restoration sites will continue to be monitored to ensure the project objectives have been achieved and to evaluate effectiveness of restoration methods. Restoration maintenance work is still required from station 0+385 to 0+545 m and should be carried out in the summer of 2014.

Riparian Maintenance

Riparian restoration on Coho Creek was completed in 2010 following the prescriptions written by CWFS Planning Biologist Warren Warttig (RPBio) and restoration ecologist Jessica Hutchinson (MSc) (2010). In 2012/13 only maintenance work was completed in the watershed. A total of 0.5 ha of RVT4 was brushed. Competing shrubs were removed around the planted Sitka spruce and western redcedar seedlings. Brushing allows the conifers to have unlimited access to sunlight and remain free of competing vegetation for the entire growing season. Protective deer browse cones were also removed from mature western redcedar trees. The cones were left in place on trees that still require the protection from deer grazing.

Sandhill Creek Restoration Project

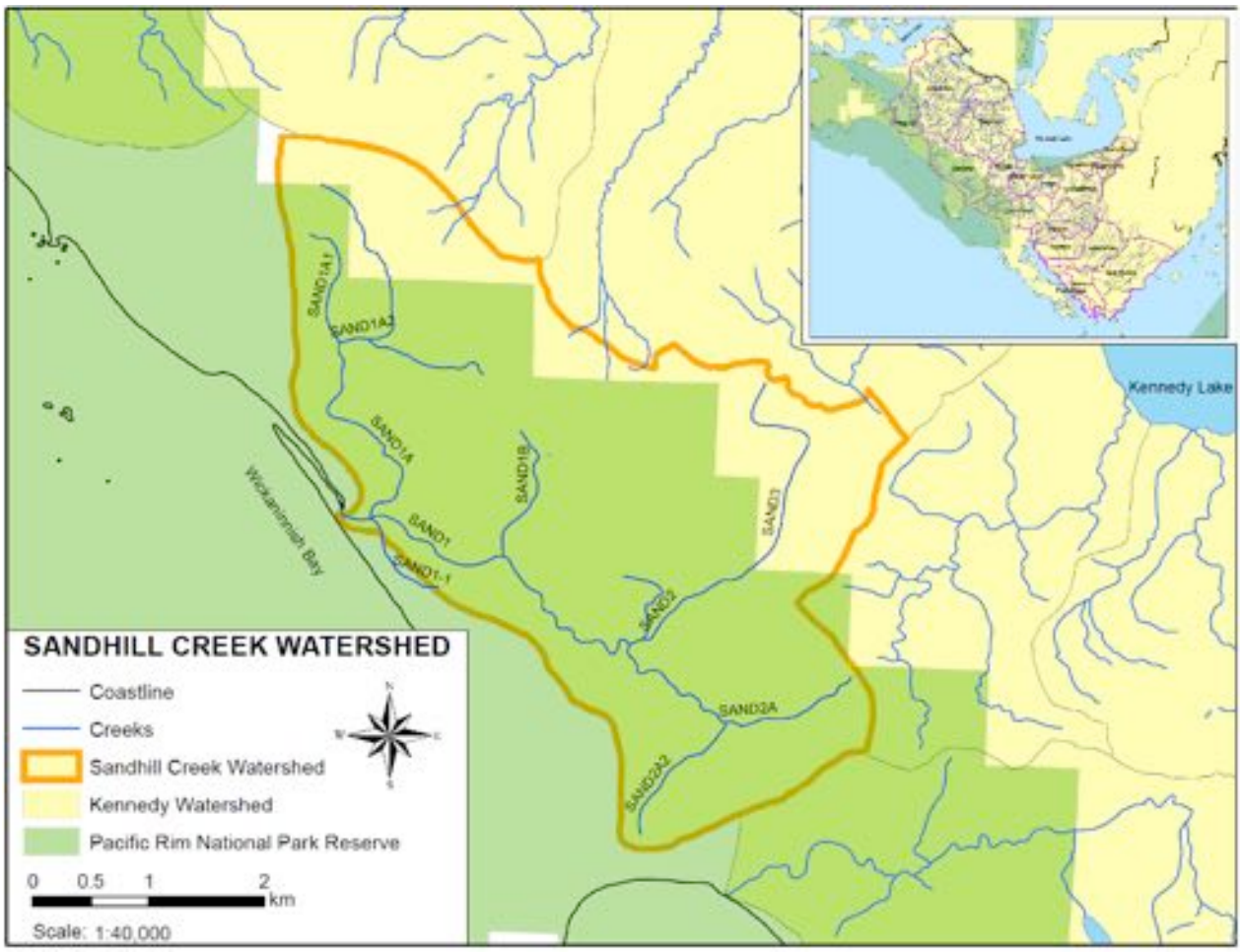

Figure 22. The Sandhill Creek Watershed lies primarily within the boundaries of PRNPR.

Assessment and Restoration Plan

Sandhill Creek lies primarily within Pacific Rim National Park Reserve (PRNPR), and generally flows in a northwesterly direction exiting into the Pacific Ocean (Figure 22). The sub-basin has total catchment area of 1,693 ha. The length of the mainstem and tributaries totals 24.9 km. The sub-basin, like much of the Kennedy Flats Watershed, was extensively logged mid-century. The riparian habitat was significantly altered and the streams degraded largely by the unregulated harvesting practices of that time. Highway 4 and a network of logging roads segment creek channels and impede fish access and degrade the quality of the aquatic habitat.

A riparian assessment and prescription was completed in February 2014 at the request of PRNPR. The assessment provides site level recommendations and prescriptions for restoration to mitigate the long-term damage to fish and wildlife habitat. The assessment and prescription are focused on reach SAND2 of Sandhill Creek. The assessment is part of a larger restoration plan for the ecological integrity of the entire Kennedy Flats Watershed.

Figure 23. Restoration treatments are prescribed for riparian areas with sub-standard habitat conditions.

The prescribed treatments are for previously harvested areas with sub-standard riparian structural conditions (Figure 23). The overall objective of the prescribed treatments is to accelerate the recovery of old-growth structural elements in second-growth riparian forests.

The addition of large woody debris to Sandhill Creek is recommended to improve stream habitat conditions. Large woody debris frequency was observed to be **Moderate** to **Low** in SAND2. Stream restoration was completed in this reach in 1999 and 2000 but additional work is needed. When new logs become available as a result of riparian restoration efforts, the felled trees should be added to increase in-stream habitat complexity. Examples of restoration structures built or added to provide cover or scour include cover logs, bundles, and A-frame spurs.

The quality and quantity of spawning habitat was observed to be **Low** within the Sandhill Creek assessment area. The addition of spawning gravel and the construction of spawning platforms is recommended for designated locations on Sandhill Creek where conditions are appropriate. Riparian and stream restoration in the Sandhill Creek Watershed are planned for the summer of 2014.

Conference Creek Watershed Restoration Project

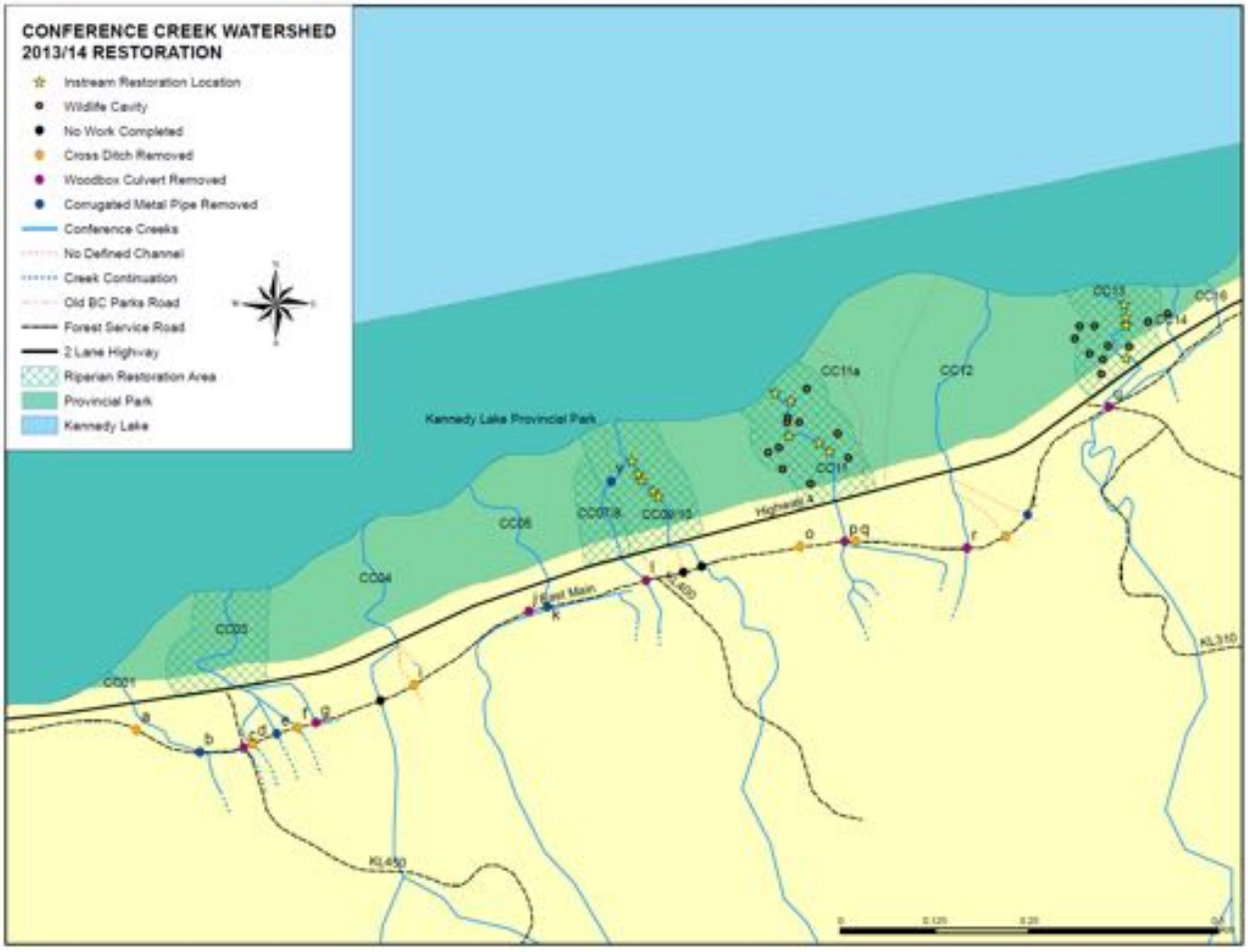

Figure 24. Conference Creek Watershed is located adjacent Kennedy Lake and is bisected by Highway 4 and the East Main.

Assessment and Restoration Plan

The Conference Creek Watershed (CCW) is a sub-basin adjacent to the larger Kennedy Flats Watershed and is located in Tla-o-qui-aht First Nation traditional territory. The CCW is also a part of the Haa'uukmin Tribal Park and the Kennedy Lake Provincial Park (Figure 24). The majority of the CCW is within the boundaries of Tree Farm License (TFL) 54 held by Ma-Mook Natural Resources Ltd. and managed by Iisaak, with a small portion along the southeast boundary falling within TFL 57, which is also managed by Iisaak.

Historically, the CCW supported healthy cutthroat trout and coho populations and surface and subsurface flows into Kennedy Lake from these drainages maintained valuable shore spawning habitat

for sockeye salmon. Unfortunately, these species are in decline, due in part to habitat degradation from road construction, logging and mining practices. This loss has had a significant impact on recreational and cultural fishing opportunities within the CCW.

In 2013, the Central Westcoast Forest Society completed an assessment of the Conference Creek Watershed to identify potentially impaired habitat and physical limitations to terrestrial species and salmonid production. This assessment gathered site-specific habitat information to diagnose the nature of impairment as well as to provide the detailed information needed to plan the appropriate habitat rehabilitation project. A comprehensive restoration plan was developed for the watershed. The plan includes in-stream, riparian and road restoration site-level prescriptions. Funding for this project was generously provided by the Habitat Conservation Trust Fund, Department of Fisheries and Oceans Recreational Fisheries Conservation Partnerships Program, and the Ministry of Transportation and Infrastructure.

Fish Monitoring

Juvenile Fish Trapping

Gee traps were set in the Conference Creek Watershed in Creeks 1 to 14. Six traps were set in total on each creek and two traps were set each between Kennedy Lake and Highway 4, between Highway 4 and East Main and upstream East Main on September 6 and 7, 2013. In total 52 cutthroat trout and 18 coho were caught (Table 5). Creeks in the Conference Creek watershed will continue to be monitored to assess the production and distribution of salmonids in the system after restoration efforts.

Table 5. The results from juvenile fish sampling on LS2A in 2013.

Creek Number	Sampling Location	Cutthroat	Coho
1	Lake to Highway 4	2	0
1	Highway 4 to East Main	8	5
1	Above East Main	10	1
4	Lake to Highway 4	10	7
5/6	Lake to Highway 4	3	0
7/8	Lake to Highway 4	4	0
9/10	Lake to Highway 4	1	2
11	Highway 4 to East Main	1	0
13	Lake to Highway 4	6	1
13	Highway 4 to East Main	6	0
14	Lake to Highway 4	1	2

Stream Monitoring

Water Quality Monitoring

During restoration activities water temperature and dissolved oxygen concentrations were monitored and recorded throughout the duration of the stream restoration project to ensure in-stream work did not occur when water temperature exceeded the maximum allowable 20°C (at this temperature fish become severely stressed) or that suspended sediment levels were not harmful (Table 6).

Table 6. Water quality point sample data taken during restoration activities, ensuring work stops once water temperature exceeds 20°C.

Conference Creek Watershed Location		Date (m-d-y)	DO (mg/L)	% Sat	Temp (C^o)
Creek 3	Downstream sediment trap – where constructed channels	09/04/2013	8.9	87	12.5
Creek 3	Upstream sediment trap	09/04/2013	8.4	81	12.3
Creek 3	Below Highway 4 culvert	09/04/2013	9.3	92	13.3
Creek 11	Near lake – downstream restoration site	09/04/2013	10.2	95	11.4
Creek 11	Near lake – upstream restoration site	09/04/2013	10.2	95	11.1
Creek 9	Downstream restoration site	09/10/2013	9.8	93	11.7
Creek 9	Upstream restoration site	09/10/2013	10	94	11.2
Creek 13	Upstream restoration site	09/11/2013	10.5	97	10.7
Creek 13	Downstream restoration site	09/11/2013	10.7	99	10.2
KL400	Upstream restoration site	09/12/2013	9.7	94	12.6
KL400	Downstream restoration site	09/12/2013	10.1	94	10.9
Creek 1	At creek outflow – prior to in-stream work	09/15/2013	8.9	91	14.2
Creek 1	At creek outflow – after channel construction	09/15/2013	9.1	89	13

Road Deactivation

All stream restoration work was carried out during the appropriate fish window (July 15 – September 15), starting on September 3 and ending on September 15th. A Bobcat 337 excavator removed collapsed wood box culverts (WBC) and corrugated metal pipes (CMP) along the East Main logging road and along an old access road to Kennedy Lake, KL450. During road pullback, the machine operator roughed up the logging road to create a heterogeneous surface to encourage re-vegetation. An environmental technician was on-site throughout road deactivation and during the removal of drainage structures to implement sediment control and erosion practices to protect downstream fish and fish habitat. Road deactivation followed the Fisheries Reconnaissance and Prescriptions for the East Main Deactivation

Project (Clough, 1998) and the Kennedy Watershed Restoration Plan (2001), in addition to observations made during the In-stream Habitat Assessment.

Deactivation of East Main and KL400 included the removal of 7 wood and 9 metal culverts impeding fish access, construction of 7 cross-ditches and roughing up of 1,612 m of road during pullback, reconnecting 8 creeks to upstream fish habitat. Approximately 143 m^2 of stream habitat was restored on East Main and KL400 and 25 pieces of large woody debris and 104 boulders were placed instream at restored stream crossings. Along East Main, 392 conifer trees (a mixture of Western redcedar, Sitka spruce, and Western hemlock) were planted and ten volunteers assisted in tree planting on two volunteer days. During road deactivation 5 historic channels were reconnected. The excavator restored the historic hydrology by redirecting flows from ditches or the centre of the road back to their historic channels. A total 170 m^2 of channel was constructed with 79 LWD and 6 boulders placed in-stream to provide cover, scour and pools. Pool complexes were added to provide cover and rearing habitat for juvenile salmonids. To re-vegetate stream banks 120 indigenous conifer seedlings were planted and the exposed berms were grass seeded.

CWFS has received additional funding from the Department of Fisheries and Oceans Recreational Fisheries Conservation Partnerships Program and the Ministry of Transportation and Infrastructure to remove hung/collapsed culverts on Highway 4 to reconnect fish habitat. This work will be carried out in the 2014-2015 field season.

Stream Restoration

A Level I and Level II Fisheries Habitat Assessment was completed that included an in-stream and riparian restoration prescriptions. This assessment identified physical limitations to salmonid production, provided baseline data for future monitoring research, and allowed CWFS to prioritize restoration opportunities and develop site-specific restoration prescriptions.

Fish habitat in the CCW is bisected by Highway 4 and the East Main logging road. Historic channels, which would have once had productive aquatic ecosystems, are no longer accessible due to hung or collapsed culverts (Figure 25). Creeks have been rerouted, dewatered and replaced with featureless ditches. The goals of the CCW stream restoration project was to rehabilitate spawning and rearing habitat, remove fish barriers and impediments, and increase habitat productivity.

A total of 1,025 m2 of stream was restored downstream of Highway 4. The restoration crew repositioned 32 pieces of large woody debris in the stream. LWD has a critical ecological function for salmonids and can increase salmonid abundance in a system (Rosenfeld, J.S. et al. 2000; Fausch, K. D., and T. G. Northcote. 1992; Roni, P. and T.P. Quinn, 2001). LWD was repositioned to address three functions: cover, bank protection, and scour. The crew also removed 41.95 m3 of small woody debris to improve drainage and flush sediment. Spawning gravel was not added but should be added in subsequent years after sufficient sediment has flushed downstream and once creek flows and in-stream conditions have stabilized.

Figure 25. Hung and collapsed culverts impeding fish passage across Highway 4.

Riparian Restoration

The riparian assessment prescribed restoration treatments for 23.66 ha in the CCW. The riparian vegetation type (RVT) classification system was used to differentiate common stand conditions and to design restoration prescriptions for areas with similar stand characteristics. Prescribed riparian treatments were designed to accelerate natural seral stage development by accelerating conifer succession, increasing structural complexity, and species diversity and composition.

Riparian Vegetation Type 2

Riparian restoration techniques, such as patch openings and variable thinning, were used to accelerate the development of old growth characteristics in 6.82 hectares of overstocked conifer sites, riparian vegetation type 2. Thinning dense conifer forests can accelerate the diameter growth rate of trees, increasing biodiversity from the tops of trees down to the forest floor. The fallers removed smaller diameter trees around brush patches, retaining the larger healthier trees. Off-site Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) were targeted during the thinning

treatments with a higher retention of western redcedar (*Thuja plicata*) and Sitka spruce (*Picea sitchensis).*

All felled trees were limbed to allow for maximum sun exposure on the forest floor. Limbs were stacked in discrete coarse woody debris piles making sure that any slash from thinning process did not block existing game trails, angler trails, and was above the high water mark. In these sites coarse woody debris (CWD) can be a limiting factor for terrestrial species diversity. The CWD piles will provide critical habitat for both plants and animals, providing food, water and shelter. The moisture held in CWD is also important for terrestrial amphibians and invertebrates. All large wood was left intact to provide future habitat for wildlife and for regenerating coniferous seedlings. A total of 100 CWD piles were constructed.

Western hemlock and red alder were girdled to encourage standing dead wood (snag) creation. Girdling helps establish a more heterogeneous canopy structure and a greater diversity of habitats. It will also allow for a more gradual increase in light as the crown dies back or as the tree breaks and naturally decays. Snags are an important characteristic of coastal forests, influencing structural heterogeneity and offering diverse habitat for forest biota (Clayoquot Sound Scientific Panel, 1995). The amount of standing dead wood is a relevant indicator of forest biodiversity (Batera et al., 2007). Girdling these trees makes them more susceptible to invertebrates and fungus, which will increase use by primary cavity excavators such as the pileated woodpecker (*Dryocopus pileatus*), and in turn provide habitat for secondary cavity users, like the blue-listed Vancouver Island northern pygmy owl (*Glaucidium gnoma*). Western hemlock and red alder were targeted, as they are the preferred species by primary cavity nesters and foraging birds in the area.

Riparian Vegetation Type 3 and 4

An additional 0.28 ha of red alder dominated sites with a suppressed conifer understory (RVT 4), and 0.36 ha of red alder with a good conifer understory (RVT 3) was also thinned. The objective in these sites was to thin the overstory deciduous trees to release suppressed conifers, to establish a mixed deciduous-conifer stand. The largest diameter alders with good branching and live crowns were retained. Individual trees were selected for removal that would benefit the health and vigour of retained conifers and deciduous trees. Due to the ecological benefits of red alder it remains a dominant component of the forest composition post-restoration.

Wildlife Cavity Creation

Once the area had been thinned, 20 wildlife cavities were created in downed wood to create denning habitat for small mammals and amphibians and to increase the diversity of decay rates in CWD. The dens are protected from the rain by slanted covers, and the entries are designed to stay dry and add protection from predators. Five cavities or slots were constructed to provide roosting habitat for bats. Seven larger cavities for small mammals were constructed and 8 wandering (*Aneides vagrans*) and red-back salamander (*Plethodon cinereus*) cavities were also constructed (Figures 26 and 27). The cavities help advance decay rates by increasing the surface area that traps water and fungal spores. This will provide foraging habitat for invertebrates and their predators.

Figure 26. A cavity cut into a felled red alder will increase decay rates and provide near-term habitat for amphibians.

Figure 27. This cavity has grooves cut into it and a lid fitted overtop to provide moist habitat wandering and red-backed salamanders.

Toquaht Restoration Project

Figure 28. Twin Rivers Watershed is located in the Toquaht First Nations traditional territory in Barkley Sound.

Assessment and Reconnaissance

Twin Rivers is a sub-basin adjacent to the Kennedy Watershed and is located in the northwest portion of Barkley Sound (Figure 28). These rivers are within the traditional territory of the Toquaht First Nation and are approximately 10 kilometres from the village of Macoah and around 20 kilometres from Ucluelet.

Twin Rivers was significantly altered by logging. Restoration of this watershed is part of a long-term community strategy to rehabilitate wild salmon populations in the area. Twin Rivers very recently supported healthy salmon populations with previous escapement records showing a yearly average of 2,000 fish with a high of 11,000 coho and chum returning to the system (DFO, 1979). Unfortunately

these numbers have drastically declined in recent years with zero chum returning to Twin Rivers East for 2 consecutive years now (R. Smith, pers. comm.).

Previous assessments and restoration activities in the watershed were reviewed and a reconnaissance of Twin Rivers West was completed on July 17th, 2013. Twelve debris jams and a collapsed wooden bridge were found in the mainstem throughout 1,800 m section of the lower river. Reduced flow rates have caused the deposition of sediment, also known as aggradation, filling in the thalwag and pools, decreasing stream depths and smothering of spawning beds. Where the channel is choked with sediment it cannot handle the quantity of water during high flows and floods the riparian zone thereby slowing the recovery of the riparian vegetation and overhead canopy cover. During summer low flows, the water is often subsurface and water temperatures may rise to levels threatening to fish health.

Stream Monitoring

Water Quality Monitoring

During restoration activities water temperature and dissolved oxygen concentrations were monitored and recorded throughout the duration of the stream restoration project to ensure in-stream work did not occur when water temperature exceeded the maximum allowable 20°C (at this temperature fish become severely stressed) or that suspended sediment levels were not harmful (Table 7).

Table 7. Water quality point sample data taken during restoration activities, ensuring work stops once water temperature exceeds 20°C.

Twin Rivers Location		Date (m-d-y)	DO (mg/L)	% Sat	Temp (C°)
Twin Rvr #8	DS Site 2	08/21/2013	9.6	95	13.5
Twin Rvr #4	10:30 am	08/22/2013	7.6	79	15.6
Twin Rvr #4	1:45 pm	08/22/2013	8.1	84	15.9
Twin Rvr #4	2:05 pm	08/22/2013	7.8	81	15.3
Twin Rvr #6	10:00 am	08/26/2013	9.9	96	12.5
Twin Rvr #6	Site 7	08/26/2013	9.6	95	12.9
Twin Rvr #6	Site 4	08/27/2013	9.3	95	14.1
Twin Rvr #6	Site 4	08/27/2013	9.8	95	12.6

Stream Restoration

The reconnaissance identified immediate opportunities for restoration in the Twin Rivers Watershed in 2013. The sites were easily accessible road crossings from the Barkley Main. In total 14 people from the communities of Tofino, Ucluelet and Macoah helped to restore habitat in the Twin Rivers Watershed. They successfully completed 490 m (approximately 1,225 m^2) of stream habitat. The crew removed 41 m^3 of small woody debris and repositioned 75 pieces of LWD into structures to improve one or more of the following attributes: cover, scour, bank protection, and hydrologic functions, all of which are important components of healthy stream ecosystems. Spawning gravel was placed at 4 sites, resulting in approximately 50 m^2 of spawning area (Figure 29).

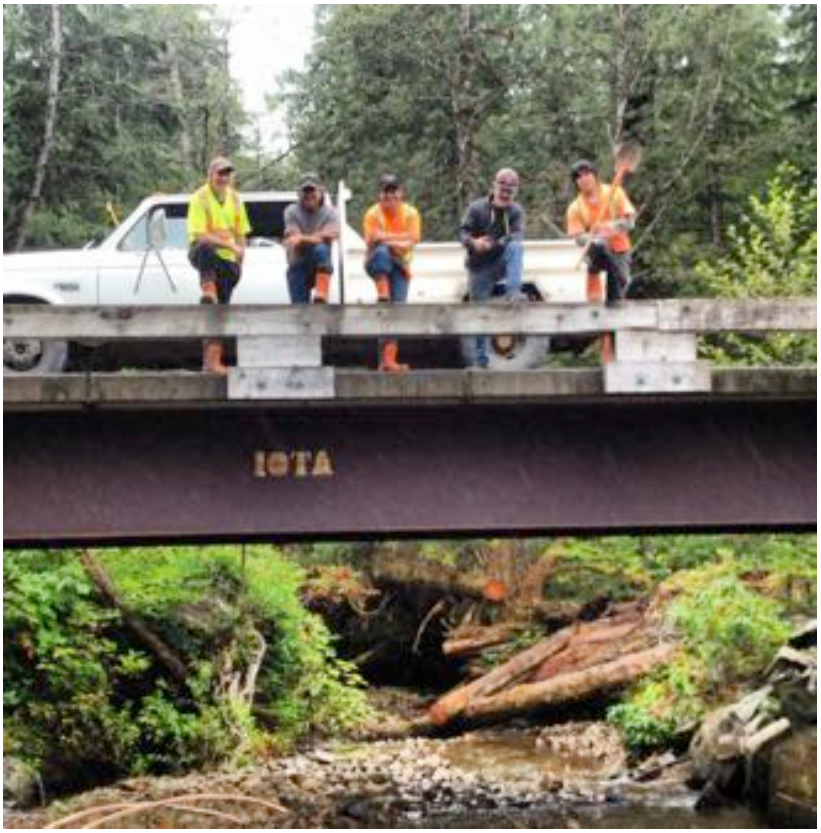

Figure 29. Twin Rivers restoration crew standing on the bridge above an A-frame they constructed and spawning gravel they placed.

Restoration is this watershed will continue in 2014 with funding provided by Pacific Salmon Foundation, Environment Canada EcoAction Community Funding Program, and the Schein Foundation.

Community Outreach and Education

Fundraiser

The 3rd annual Salmon to Sea Fundraiser was successful with $6,275 raised to put towards salmon habitat restoration in the Clayoquot and Barkley Sounds. On April 20th, 130 people from the region filled the ballroom at Black Rock Oceanfront Resort in Ucluelet to show their support for CWFS restoration efforts. The event was an excellent opportunity to showcase CWFS work with a screening of the latest film (http://clayoquot.org/about/films) *Restoring the Atleo River* and access to reports and project information.

Interpretative Walks

The Walk in the Forest Trail is a 600 m stretch of boardwalk and bark mulch trail that is located 1 km before the Tofino-Ucluelet junction on Highway 4. Since 2010, Central Westcoast Forest Society has renovated and extended the Walk in the Forest Trail by 100 m and built a 3x4 m viewing platform that overlooks Lost Shoe Creek. In May 2012, Parks Canada installed new interpretative signs that speak to restoration ecology and the efforts of Pacific Rim National Park Reserve (PRNPR) and CWFS to restore degraded habitat. In April 2013, thanks to funding provided by Parks Canada a bear-proof garbage can was installed at the trail head. The garbage can is an excellent addition and has helped keep the trail clean and garbage free. Maintenance work was completed on the trail thanks to a minor works contract with the Ministry of Forest Lands and Natural Resource Operations.

Interpretative walks were held throughout the year on the trail, at the adjacent off-channel habitat on Lost Shoe Creek and at Coho Creek. The interpretative walks are popular among local school groups, community members and visitors to the region. The walks are an excellent means to communicate information about coastal temperate rainforests, sensitive riparian ecosystems and the importance of habitat restoration. The walks also provide an opportunity to communicate the efforts made by Parks Canada and Central Westcoast Forest Society to restore local streams and forests.

Film

Wyatt Visuals and Burke Electric Media created an educational film in 2013/14 about Central Westcoast Forest Society and the Ahousaht First Nations' restoration project in the Atleo RIver Watershed. Vimeo, a New York based company that provides high quality online video hosting, picked the film as a Staff Pick. The film received excellent reviews and has now been viewed by more than 49,000 people worldwide.

Labour

Crew members worked on the 2013/2014 restoration project from May 2013 to March 31, 2014. The restoration project provided employment for 14 local workers from Tofino, Ucluelet and the Toquaht, Ahousaht, Yu?lu?il?ath, and Tla-o-qui-aht First Nations communities.

Budget

Project funds and expenditures incurred during the project season were directed through CWFS accounts and managed accordingly; this included worker payroll, management payroll, consultant fees, direct expenses, and equipment rentals. The funds were allocated based on the contribution agreements and contracts with the different project funders (Table 8).

Table 8. The Budget Break down for KWRP 2013/14 and list of Funding Contributions

Budget Breakdown for KWRP 2013/14	
Cost of goods and shipping	**$14,877.90**
Cost of Services (wages & subcontractors)	**$161,098.29**
Cost of Equipment	**$9,436.17**
Admin & other	**$22,065.24**
Total	**$ 207,477.60**
Funding Contribution Breakdown	
Recreation Sites and Trails BC	$ 2,000.00
Alberni-Clayoquot Regional District	$ 3,500.00
Pacific Salmon Foundation	$ 20,985.00
Parks Canada	$ 40,000.00
Schein Foundation	$ 4,800.00
Donations	$ 358.00
Shell FuellingChange	$ 10,000.00
Environment Canada EcoAction	$ 20,000.00
TD Friends of the Environment	$ 15,000.00
Department of Fisheries and Oceans Recreational Fisheries Conservation	$ 37,933.00
Habitat Conservation Trust Fund	$ 42,569.00
Ministry of Transportation and Infrastructure	$ 8,500.00
Other	$ 1,802.60
Total Budget	**$ 207,477.60**

Future Opportunities

Although over 81 km of 420 km fish bearing stream length have been restored since the start of the Kennedy Flats Restoration Project 20 years ago, there remain many high priority stream reaches and riparian areas that have yet to be restored. Further culvert replacements and road deactivations are also required in several watersheds. Many important streams and watersheds remain inaccessible to salmon due to collapsed culverts or debris jams acting as fish impediments. Central Westcoast Forest Society needs support from funding agencies to help rehabilitate these high priority salmon bearing streams and wildlife habitat.

Continued support is also needed to help with riparian restoration efforts in Clayoquot and Barkley Sounds. Riparian restoration is the foundation of many land management strategies yet it is significantly underfunded. Wildlife in British Columbia depends on riparian ecosystems for the diversity of habitat niches they provide. Please show your support for this integral work.

Recommendations for 2014/2015 Kennedy Watershed Restoration Project

- Install and monitor smolt traps on Lost Shoe Creek.
- Monitor the population and distribution of juvenile salmonids in LS2A.
- Complete in-stream restoration maintenance on Coho Creek, LS2A and the Lost Shoe Creek off-channel habitat.
- Complete riparian restoration on Coho Creek for polygon B, in RVT 2.
- Complete riparian restoration on Lost Shoe Creek RVT 2, RVT 3 and RVT 4 in particular tree topping, girdling, planting and constructing wildlife cavities in 2013/14 restoration sites.
- Complete in-stream restoration and construct spawning platforms on Sandhill Creek.
- Complete riparian restoration on Sandhill Creek.
- Remove barriers to fish passage in the Conference Creek Watershed.
- Complete stream and riparian restoration efforts in the Toquaht Nation’s territory.

Conclusion

Habitat restoration in the Kennedy Watershed continued this year thanks to generous contributions from Recreation Sites and Trails BC, Alberni-Clayoquot Regional District, Pacific Salmon Foundation, Parks Canada, Schein Foundation, Shell FuellingChange, Environment Canada EcoAction Community Funding Program, TD Friends of the Environment, Department of Fisheries and Oceans Recreational Fisheries Conservation Partnerships Program, Habitat Conservation Trust Fund, and the Ministry of Transportation and Infrastructure. The project also received invaluable in-kind support from the Toquaht, Tla-o-qui-aht and Yuułuʔiłʔatḥ First Nations and from, Gibson Brothers Contracting Ltd., Clayoquot Biosphere Trust, Creative Salmon Ltd. and Iisaak Forest Resources Ltd.

Thanks to the restoration efforts of Central Westcoast Forest Society salmon have once again returned to LS2A for the first time in 40 years! Reconnecting and restoring this habitat means that wild Pacific salmon now have an additional 838 m of stream channel and access to 4 ha of wetland to use for spawning and rearing. The impact this habitat will have on salmon production within the watershed will be assessed through continued monitoring efforts by PRNPR and CWFS. This project is an excellent example of the dedication, collaboration and support needed to sustain wild salmon for the generations to come.

Since this project began in 1994, CWFS has restored 81 of 420 km of fish bearing streams, 72 ha of riparian forest (of over 500 ha) have been restored, 48 ha of slide area (of 54 ha) have been bioengineered, and 247 km of logging road has been deactivated and revegetated. As restoration progresses in the Kennedy Flats Watershed, qualitative monitoring seems to indicate improvement in overall stream conditions and health of the riparian forests.

Despite these efforts many high priority stream reaches have yet to be restored. Further culvert replacements and road deactivations are also needed in several sub-basins. A strong focus on effectiveness monitoring, regular maintenance and additional assessments of work completed by CWFS, will increase our Society's capacity and success. Many important streams and watersheds remain inaccessible to salmon due to collapsed culverts or debris jams acting as fish impediments. Central Westcoast Forest Society needs support from funding agencies to help rehabilitate these high priority salmon bearing streams.

Over the past 19 years the local community has benefited from the employment and training provided by the Kennedy Watershed Restoration Project. Partnerships have not only been encouraged but have developed between various community and stakeholder groups during this time. 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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Appendices

Appendix I: KWRP Large Woody Debris (LWD) Placement SOP
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 have one function.
- 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 from the benthic substrate.
- Restoration involves maintenance; our sites must be re-visited to ensure the structures 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 the CWFS).
- 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: KWRP Monitoring Methodology during In-Stream Work SOP

• Monitor environmental conditions (temperature, turbidity) at work sites.
• If fish are present and work-site stream temperature exceeds 20°C either:
    1. Limit substrate disturbance to prevent release of trapped gases and sediment.
    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 or suspended sediment.

• 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 mortality) 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

Gravel:

- Washed (Clean) round rock,
- Rock size should be a mixture ranging from +/- 20% of larger sand sized to 1⁄4 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, riffle crests, or glides with fast moving water
- 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 summer 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 with 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 peak flows normally associated with 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. i.e. 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 the gravel wider than the low flow margins along each bank and ensure a thalweg by spreading it in a shallow vie with a rake or with boots.

D. Clough & W. Warttig

Appendix IV: KWRP Native Tree and Vegetation Planting SOP

Damage

Any trees or plants found to be mouldy, dry, frozen or damaged in any way should be reported to supervisor.

1. When planting trees and plants, care should be taken to avoid root stripping, scarring, bending or damage to the seedlings.
2. Many problems with survival can be traced back to improper handling techniques.
   - Roots dry out rapidly when exposed to sun or wind
   - When temperatures fluctuate rapidly or when the tree beings to "respire" or grow in the container it can draw down the energy reserves available for survival and growth after planting.
   - Physical damage, crushing, dropping and tearing roots limit survival after planting.

Cluster Planting Spot Selection

Cluster planting is tighter spacing than normal, which allows for brush spaces to develop. We do this to try to avoid the stem-exclusion phase (or what some call the nudum phase)

1. Plant in the most suitable spot available to favour survival, erosion stabilization and growth.
2. Target size of a cluster is a 4 m to 5 m diameter area.
3. Recommended density is 6-7 trees/plants per cluster.
4. Spacing between trees/plants should be a maximum of 2.5 m and a minimum of 1m.
5. The wider spacing between the clusters maximizes the area brushed and better allows trees to manage brush as their crowns spread.
6. Ensure adequate amount of mineral soil or a mixture of mineral soil and well decomposed organic material, depending on the species of tree or plant.
7. Avoid spots shaded by inanimate objects such as stumps, windfalls, rocks, or depressions in ground.
8. Utilize high stumps for planting or on prepared spots as instructed by supervisor.
9. Install deer browse protection devises where needed

Planting Quality

1. **Screefing**- for conifer seedlings all organic debris and competing roots should be removed within 1 to 1.5 m diameter.
2. **Planting hole**- the planting hole shall prepared so that the entire root system of the tree may be fully accommodated in its natural position.
3. **Root Placement**- each tree or shrub shall be placed in the planting hole with the roots in a near neutral arrangement and at a depth that after filling and tamping, the soil comes to the root collar line where no roots are exposed nor any needles or branches are covered with soil. The roots shall not be doubled up, twisted, tangles or bunched and with containerized seedlings the top of the "plug" must be covered. The plug shall not be flattened in the planting hole, or damaged by the planting implement.
4. **Tree alignment**- Tree or shurb should be planted so that the roots and stem are aligned along a vertical axis.
5. **Firmness-** soil shall be filled in and compacted around the roots with no air pockets. Soil shall be compacted firmly enough so that the tree will not pull loose with a gentle tug. Organic debris shall not be used for filling around the roots.

Appendix V: KWRP Invasive Plant Species SOP, Prevention and Reporting

Prevention:

- All crew members should be able to recognize the native plants that they see
- Ensure vehicles, personal gear and equipment are clean of invasive plants and seed
- Thoroughly wash equipment and gear in warm water before moving to a new watershed or sub-basin
- Minimize soil disturbance in all construction and maintenance activities
- Re-vegetate disturbed areas as soon after disturbance as possible.
- Promote the establishment of a healthy plant community
- Limit the movement of weed-infested soil or gravel
- Use certified weed-free seed mixes or vegetation in disturbed areas to provide competition for any new weeds

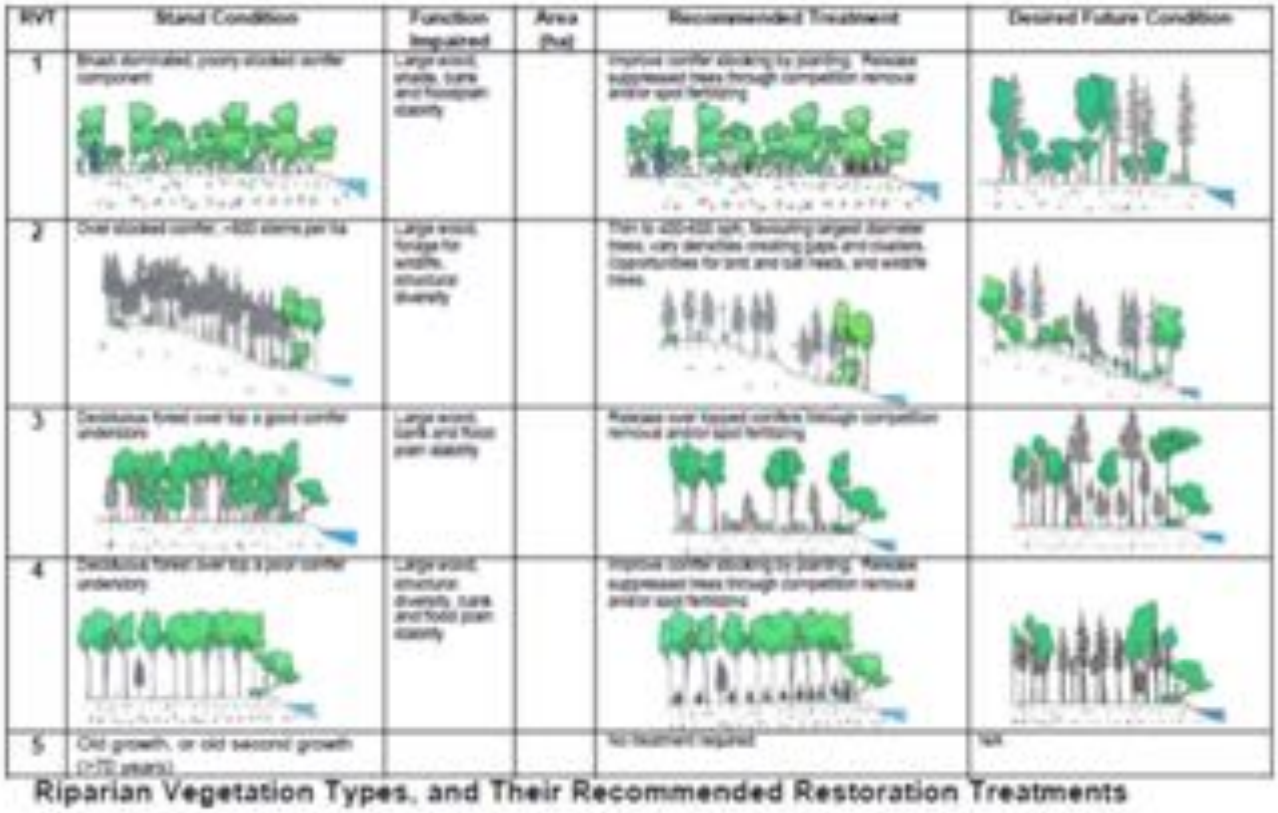
Reporting:

- Report unidentifiable or invasive plants to your Supervisor:

Reporting Protocol:

Date:	Name:
Location – Sub-basin	Plant Species:
GPS / UTMs:	Site Characteristics - Slope %, aspect
Site description:	Comments – Frequency, distribution
Picture # and Camera:	

All recorded information should be forwarded to info@bcinvasives.ca

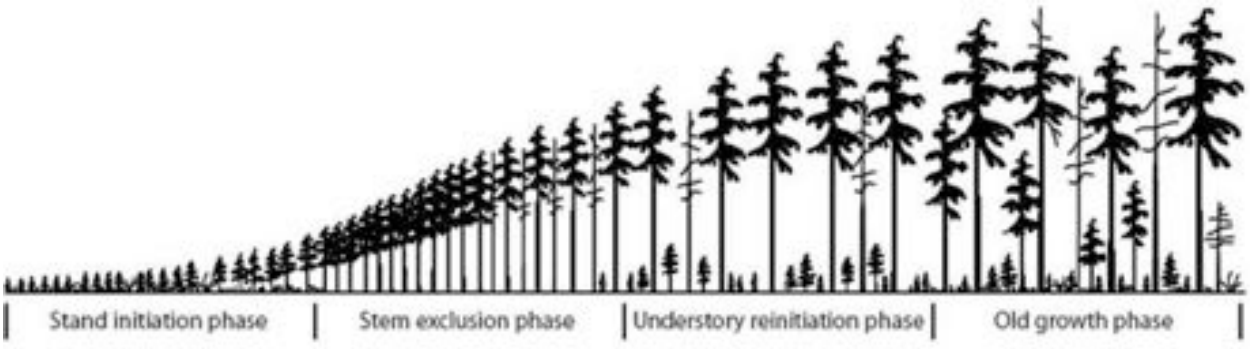


RVT	Stand Condition	Function Impaired	Area (ha)	Recommended Treatment	Desired Future Condition
1	Shrub dominated, poorly stocked conifer component	Large wood, shade, bank and floodplain stability		Improve conifer stocking by planting. Release suppressed trees through competition removal and/or spot fertilizing	
2	Over stocked conifer, >800 stems per ha	Large wood, forage for wildlife, structural diversity		Thin to 400-600 sph, favouring largest diameter trees, vary densities creating gaps and clusters. Opportunities for bird and bat nests, and wildlife trees.	
3	Deciduous forest over top a good conifer understory	Large wood, bank and flood plain stability		Release over topped conifers through competition removal and/or spot fertilizing	
4	Deciduous forest over top a poor conifer understory	Large wood, structural diversity, bank and flood plain stability		Improve conifer stocking by planting. Release suppressed trees through competition removal and/or spot fertilizing	
5	Old growth, or old second growth (>??? years)			No treatment required	NA

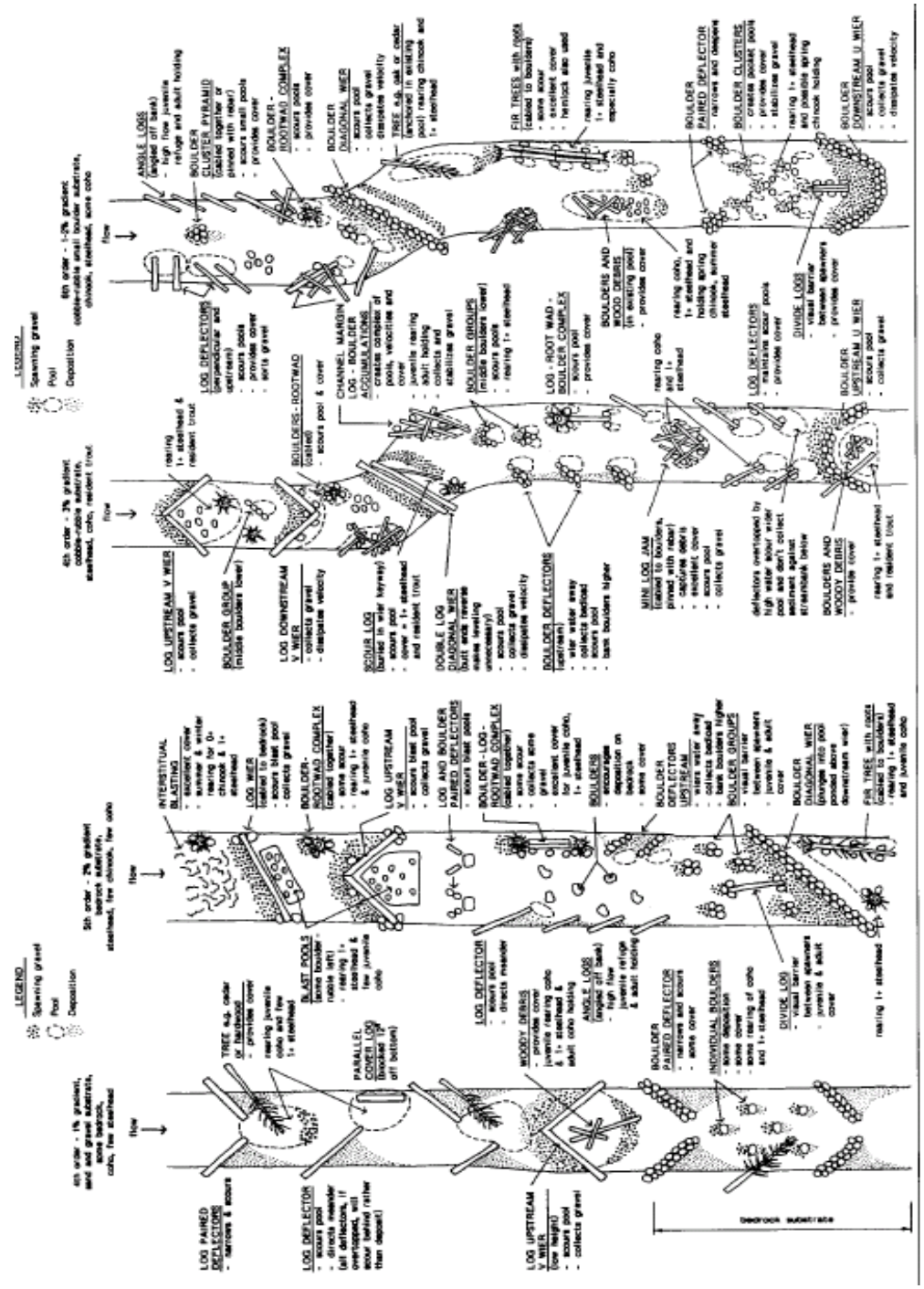
Riparian Vegetation Types, and Their Recommended Restoration Treatments

Appendix VI: Riparian Vegetation Types

Schematic of Seral Stage Development



Appendix VII: Example diagrams of in-stream log structures (Slaney and Zaldokas, 1997).

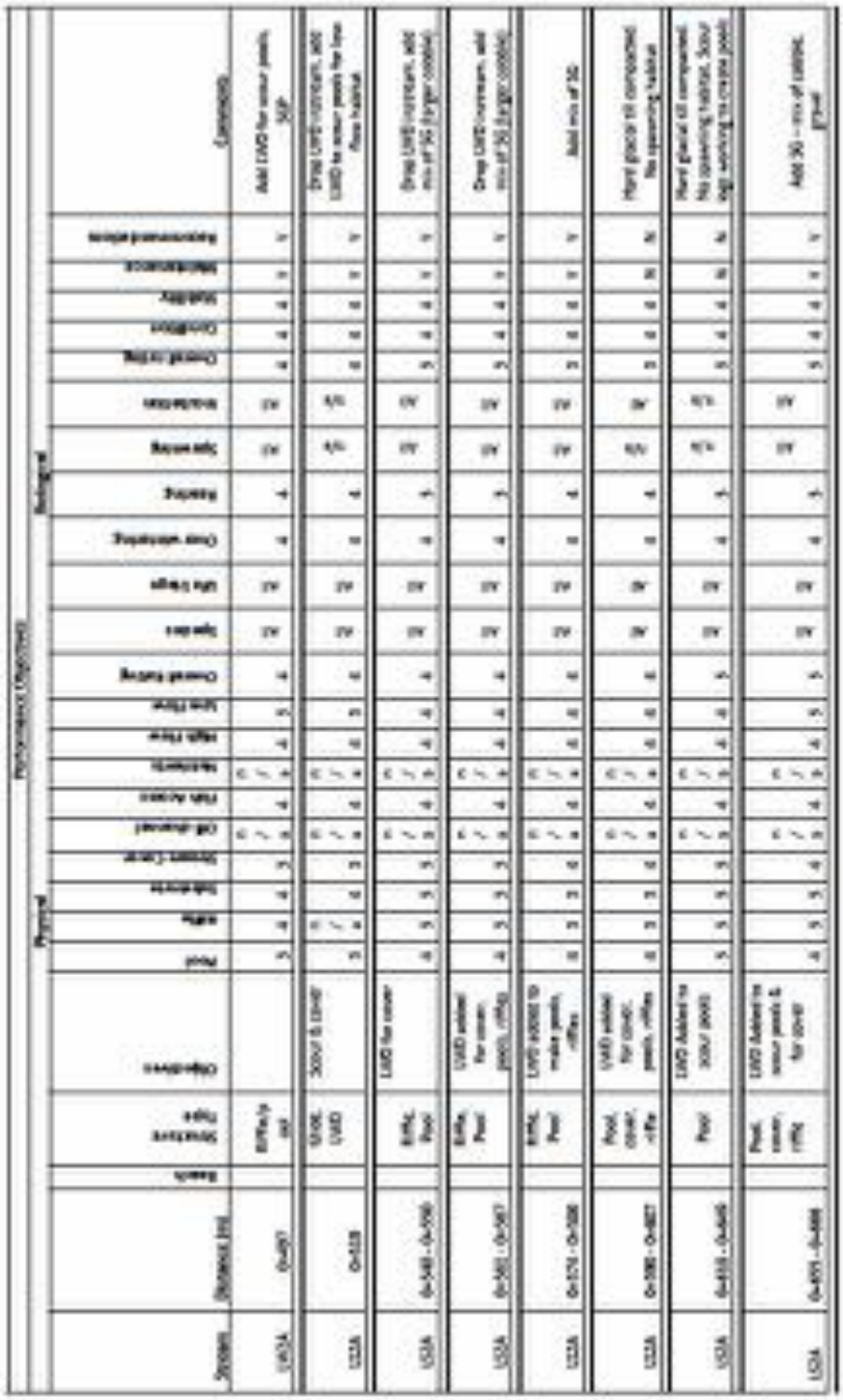


Appendix VIII: Monitoring 2012/2013 Restoration Sites

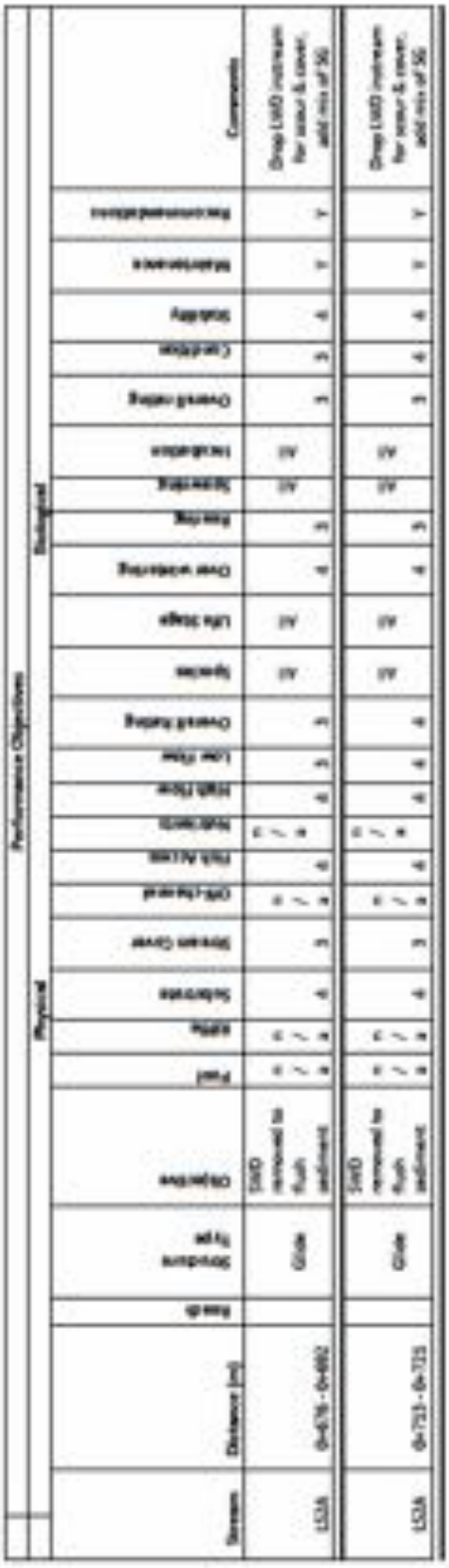
Routine Monitoring Form: KWRP Coho Creek 2012/2013 Restoration Sites

Routine Monitoring Form: KWRP Coho Creek 2012/2013 Restoration Sites (continued)

Routine Monitoring Form: KWRP Lost Shoe Creek, LS2A 2012/2013 Restoration Sites



Routine Monitoring Form: KWRP Lost Shoe Creek, LS2A 2012/2013 Restoration Sites (Continued)

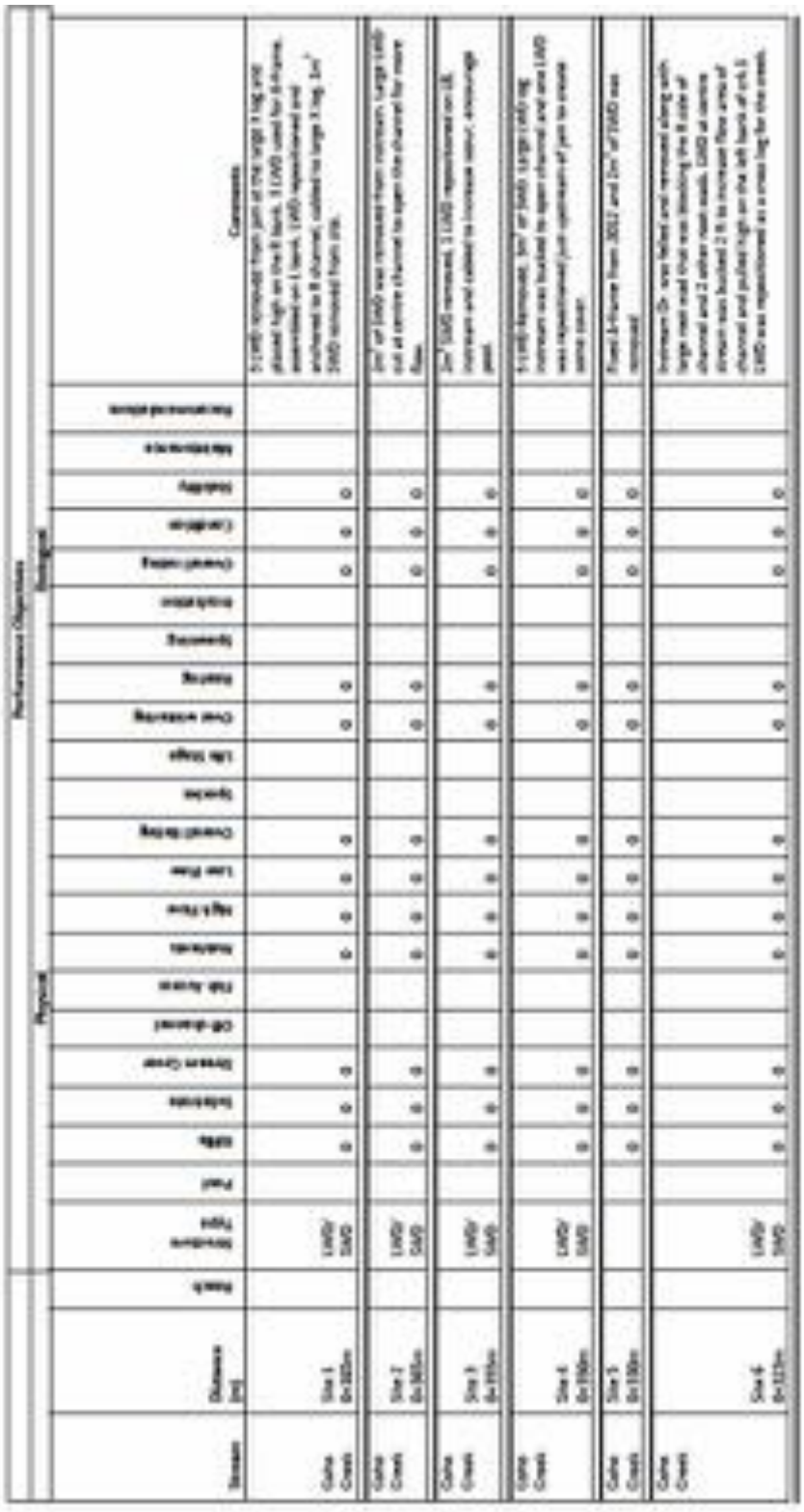


Routine Monitoring Form: KWRP Lost Shoe Creek, Off-channel 2012/2013 Restoration Sites

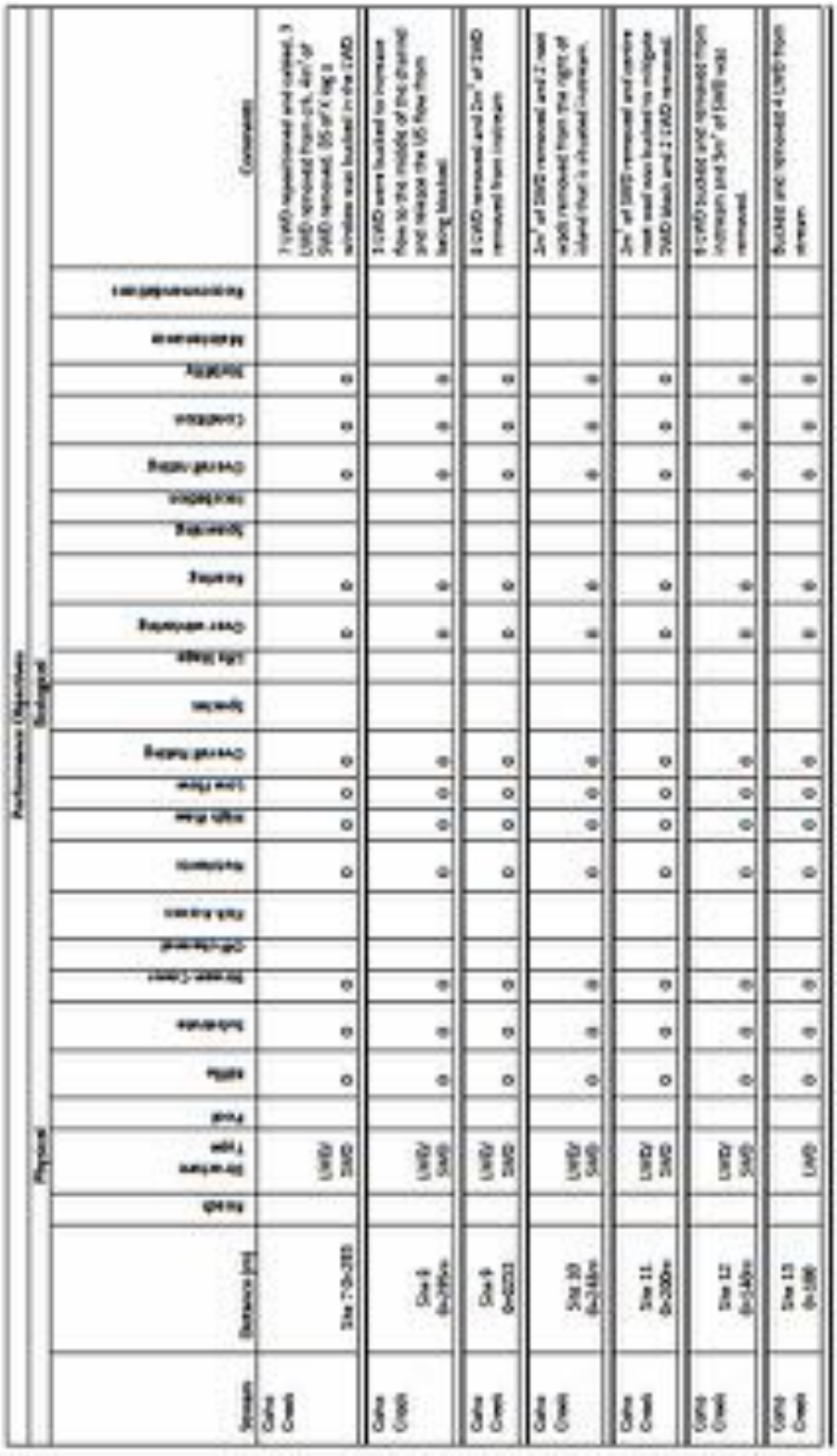
Routine Monitoring Form: KWRP Lost Shoe Creek, Off-channel 2012/2013 Restoration Sites (Continued)

Appendix IX: Monitoring 2013/2014 Restoration Sites

Routine Monitoring Form: KWRP Coho Creek 2013/2014 Restoration Sites



Routine Monitoring Form: KWRP Coho Creek 2013/2014 Restoration Sites (Continued)



Routine Monitoring Form: KWRP Lost Shoe Creek, LS4 2013/2014 Restoration Sites

Routine Monitoring Form: KWRP Conference Creek Watershed 2013/2014 Restoration Sites

					Performance Objectives																					
					Physical										Biological											
Stream	Distance (m)	Reach	Structure Type	Objectives	Pool	Riffle	Substrate	Stream Cover	Off-channel	Fish Access	Nutrients	High Flow	Low Flow	Overall Rating	Species	Life Stage	Over wintering	Rearing	Spawning	Incubation	Overall rating	Condition	Stability	Maintenance	Recommendations	Comments
Twin Rivers	Twin RVR4			LWD added for cover, pools, riffles, scour		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
Twin Rivers	Twin RVR6			LWD added for cover, pools, riffles, scour		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
Twin Rivers	Twin RVR7			LWD added for cover, pools, riffles, scour		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
Twin Rivers	Twin RVR8			LWD added for cover, pools, riffles, scour		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
Twin Rivers	Twin RVR1			LWD added for cover, pools, riffles, scour		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD

Routine Monitoring Form: KWRP Twin Rivers 2013/2014 Restoration Sites

					Performance Objectives																					
					Physical										Biological											
Stream	Distance (m)	Reach	Structure Type	Objectives	Pool	Riffle	Substrate	Stream Cover	Off-channel	Fish Access	Nutrients	High flow	Low flow	Overall Rating	Species	Life Stage	Over wintering	Rearing	Spawning	Incubation	Overall rating	Condition	Stability	Maintenance	Recommendations	Comments
CCW	Culvert Crk 1			SWD removed. Channel diversion.		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, channel diversion around fish barrier, WBC removed at East Main.
CCW	Culvert Crk 3			Channel creation and road crossing removal.		0	0	0			0	0	0	0			0	0			0	0	0			Three historic channels re-connected and road crossings removed on East Main.
CCW	Culvert Crk 5/6			SWD removed. Road crossings removed.		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
CCW	Culvert Crk 7/8			SWD removed. Road crossings removed.		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD
CCW	Culvert Crk 9/10			LWD added for cover, pools, riffles, scour. SWD removed. Road crossings removed.		0	0	0			0	0	0	0			0	0			0	0	0			Removed SWD, repositioned LWD, road crossings removed on East Main.
CCW	Culvert Crk 11			LWD added for cover, pools, riffles, scour. SWD removed. Road crossings removed.																						Removed SWD, repositioned LWD, road crossings removed on East Main.
CCW	Culvert Crk 12			Road crossings removed.																						Road crossings removed on East Main.
CCW	Culvert Crk 13			LWD added for cover, pools, riffles, scour. SWD removed. Road crossings removed.																						Removed SWD, repositioned LWD, road crossings removed on East Main.

Appendix IX Before and After Restoration Photos

Picture 1. Coho Creek before restoration looking upstream at Station 0+323 m

Picture 2. Coho Creek after restoration looking upstream at Station 0+323 m

Picture 3. LS4 before restoration looking upstream at station 4+646 m

Picture 4. LS4 after restoration looking upstream at station 4+646 m

Picture 5. LS4 before restoration looking downstream at station 4+656 m

Picture 6. LS4 after restoration looking downstream at station 4+656 m

Picture 7.Conference Creek #13 before restoration looking upstream at station 0+105 m

Picture 8. Conference Creek #13 after restoration looking upstream at station 0+105 m

Picture 9. Conference Creek #11 before restoration at station 0+140 m

Picture 10. Conference Creek #11 after restoration at station 0+140 m

Picture 11. Lost Shoe riparian before restoration in block AA

Picture 12. Lost Shoe riparian after restoration in block AA

Picture 13. Twin Rivers RVR1 *after*.

Picture 14. Twin Rivers RVR1 *before*.