SALMON RECOVERY FUNDING BOARD

Washington State Salmon Recovery Funding Board

Reach-Scale Effectiveness Monitoring Program

2008 Annual Progress Report

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ACRONYMS AND ABBREVIATIONS

AIS	Artificially Placed In-Stream Structure
BA	before after
BACI	Before After Control Impact
CCNRD	Chelan County Natural Resource Department
cm	centimeter
dbh	diameter at breast height
Ecology	Washington State Department of Ecology
ELJ	engineered log jam
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GIS	Geographic Information System
GPS	global positioning system
km	kilometer
LCFEG	Lower Columbia Fish Enhancement Group
LWD	large woody debris
m	meter
m^2	square meter
MMI	Multimetric Index
MP	milepost
NOAA	National Oceanic and Atmospheric Administration
OWEB	Oregon Watershed Enhancement Board
PUD	Public Utility District
RM	river mile
SPSSEG	South Puget Sound Salmon Enhancement Group
SRFB	Salmon Recovery Funding Board
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WRIA	Watershed Resource Inventory Area
YTAHP	Yakima Tributary Access and Habitat Program

EXECUTIVE SUMMARY

The Washington State Salmon Recovery Funding Board (SRFB) was created by the state legislature in 1999 to provide grants and loans for salmon habitat projects and salmon recovery activities. The SRFB has funded more than 1,126 projects and spent more than $336 million in state and federal funds toward salmon recovery. There is a need for the SRFB, as well as state and federal governments, to track the effectiveness of projects implemented under this funding. Additionally, regional coordination across monitoring programs is sought to increase data compatibility, improve management decisions across jurisdictions, and better utilize monitoring resources. Furthermore, monitoring data on the effectiveness of projects provides information to project sponsors that can be used to improve communication about restoration approaches and improve future designs. While it is not economically feasible to monitor the long-term success of every project, a subset of projects can be effectively monitored, both within a state and across the region.

Using this concept, the SRFB funded the Reach-Scale Effectiveness Monitoring Program in 2004 and began a Coordinated Monitoring Program with the Oregon Watershed Enhancement Board in 2006. Implementation of the SRFB program included first separating all projects into nine monitoring categories, and then selecting a subset of projects from each of these categories to monitor. The Coordinated Monitoring Program is currently focused on one of the categories, Livestock Exclusion Projects, in both Oregon and Washington. The results from both programs provide information about the probable effectiveness of other projects in the same category and the relative effectiveness between categories. Monitoring for the Reach-Scale Effectiveness Monitoring Program began in spring 2004 and has continued through 2008. This report contains monitoring results for this five year period. Monitoring for the Coordinated Monitoring Program began in 2006 and continued in 2008.

Monitoring categories included the following: fish passage, in-stream habitat, riparian plantings, livestock exclusions, constrained channels, channel connectivity, spawning gravel, diversion screening restoration, and habitat preservation. The intent of the monitoring was to test whether habitat targeted for restoration had been improved or preserved, and for some categories, whether local stream reach salmon and steelhead abundance had increased. Where structures were part of habitat improvement, engineering specifications were also tested for effectiveness in meeting design criteria over time. This effort also served as implementation monitoring for these projects.

Seven categories of habitat restoration projects were evaluated using a Before After Control Impact experimental design (Stewart-Oaten et al. 1986). Each project is monitored before implementation and after implementation on a rotating schedule depending on project type. Monitoring duration for each category ranges from five years post-implementation to 12 years post-implementation.

Field sampling indicators and techniques were adapted from U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (Peck et al. 2003) with specific protocols developed to detect changes in habitat, fish populations, or ecological status expected to result from project implementation. Protocols were tied to specific objectives associated with each monitoring category. Data were recorded in the field using digital data forms, and later uploaded into an office centralized database.

The field data were summarized using summary statistics developed for each project type. These summary statistics or project results were entered into the PRISM database maintained by the SRFB to track SRFB-funded restoration projects across the state. A one-sided paired *t*-test or a Wilcoxon paired-sample test was used to test for changes between control and impact reaches in the baseline year and subsequent sampling events (Year 1, Year 2, Year 3) for those projects that had been implemented. For Habitat Protection Projects, summary statistics were analyzed for differences between the baseline year and Year 3 using a paired *t*-test.

Initial results show that Fish Passage Projects are increasing juvenile densities for coho, steelhead and Chinook adult densities for coho and chum. In-Stream Habitat projects are significantly improving geomorphology by increasing mean vertical pool profile area and mean residual depth as well as the volume of large woody debris in the reach in the first year after construction. These increases have been maintained through the third year after construction. Riparian Planting Projects show a significant increase in the presence of three layers of vegetation in the first year after planting, but these improvements were not maintained in the third year of monitoring. Livestock Exclusion Projects are effectively decreasing bank erosion in the first year after construction; however, these decreases have not been maintained in the third year of monitoring. Channel Connectivity Projects are significantly increasing mean vertical pool profile area and mean residual depth in the first year after construction, but the mean vertical pool profile improvements were not significant in the third year of monitoring. In all cases, the percentage increase in the variable was more than 20 percent over baseline. Indications of change and observed trends are preliminary and need to be viewed both within the context of the project and the longer-term perspective that will be developed over the life of the monitoring program as the full list of projects in each category is implemented.

1 INTRODUCTION

The Washington State Salmon Recovery Funding Board (SRFB) was created by the Washington State Legislature in 1999 to provide grants and loans for salmon habitat projects and salmon recovery activities. The SRFB has funded more than 1,126 projects and spent more than $336 million in state and federal funds toward salmon recovery.

The Washington Comprehensive Monitoring Strategy was written in 2002 to identify monitoring efforts that were occurring in the state and to develop a strategy to coordinate these efforts through state-wide programs. In 2003, the SRFB funded a survey of restoration project sponsors to determine what, if any, monitoring was being done after projects had been implemented. The responses from the survey indicated that project sponsors were implementing a wide variety of monitoring efforts from compliance monitoring, required by the funding agreement, to full-scale monitoring programs that assess physical habitat and fish response to restoration.

The inconsistency of these monitoring efforts indicated a need for a coordinated effectiveness monitoring program to independently evaluate the success of funded restoration projects. A repeatable, standardized approach for this evaluation was needed to provide accountability for the expenditures of the state and federal legislatures to further salmon recovery, as well as to help determine the cost-effectiveness of different project categories so that future restoration dollars could be most efficiently spent.

In order to determine the relative effectiveness of project categories, the SRFB approved funding for the Reach-Scale Effectiveness Monitoring Program in 2004. Funding for the Reach-Scale Effectiveness Monitoring Program includes funding from the Pacific Coast Salmon Recovery Fund, a federal funding source for salmon recovery in the Pacific Northwest. This funding is distributed to states with habitat for Pacific salmon including Washington, Oregon, California, Alaska, and Idaho. These states are developing state-wide effectiveness monitoring programs to report back to Congress on the success of restoration efforts. Expanding coordination of these monitoring efforts in the Pacific Northwest will give federal legislators needed information for future funding decisions for salmon habitat restoration. Comparable data collected across the region will also provide better information to aid resource managers in making decisions regarding listed salmon species, many of which have habitat that ranges across state lines. In addition, results of a monitoring program could be shared with project sponsors to help improve communication about successful restoration approaches and lessons learned, and the best ways to approach project designs.

Successful coordination between Washington and Oregon has been included as a part of this monitoring program. For one of the monitoring categories, Livestock Exclusion Projects, the projects monitored occurred in both Oregon and Washington, and the funding for monitoring and reporting was provided jointly by both states. These data have been combined for analysis in this report, resulting in a regional representation of the effectiveness of this project type. This coordination has resulted in a larger sample size, allowing for more robust data analysis at a reduced cost to both states. Additional efforts in coordination of monitoring are under development.

Both the Reach-Scale Effectiveness Monitoring Program and the Coordinated Monitoring Program provide numerous benefits that support project sponsors. Data collected as part of the program allow project results to be compared because a consistent set of protocols are used for all projects monitored. Communication about the results of the program helps to spread information about approaches to restoration that are being used in different areas of Washington State and the region. Dissemination of this information helps project sponsors working in different areas of the state learn what approaches are working in other areas of the state. This information can be used to improve future project designs and implement more successful salmon recovery efforts, as well as improving information sharing among project sponsors and resource managers. By sharing project information through annual reports and publicly available data, project sponsors and other planning entities can learn from what has already been done across the region and adapt their efforts toward success.

This Annual Progress Report summarizes the data collected during the 2004–2008 field seasons. It includes a description of objectives and data collection methods for each monitoring category, results from the 2004–2008 field seasons, a description of each project site sampled, data analysis, economic analysis, and recommendations for future monitoring and reporting. These data represent the pre-project implementation, (or "before") data for projects not yet implemented, and the post-project implementation (or "after") data for implemented projects. This report contains both preliminary findings that will serve as baseline data for future years of data collection, as well as initial responses of physical and biological parameters from projects implemented each year starting in 2004. Initial response trends for some projects have been detected from three years of post-project implementation data, but for other projects it will take longer to detect changes. Physical and biological responses need to be viewed both in the context of the project, as well as the longer-term perspective that will be developed over the life of the program.

2 DESCRIPTION OF MONITORING CATEGORIES

Due to the large number of projects (more than 1,126) that have been funded by the SRFB, it was not economically feasible to monitor every project for effectiveness. Projects are grouped into monitoring categories with the intent of drawing conclusions about the effectiveness of the project types, and to extrapolate those conclusions to other similar projects. The current monitoring categories are described in the following paragraphs.

2.1 FISH PASSAGE PROJECTS

Fish Passage Projects include bridges, culvert improvements, dam removals, debris removals, diversion dam passage, fishways, weirs, and water management. The objective for Fish Passage Projects is to increase access to areas blocked by human-caused impediments (Crawford 2008a).

2.2 IN-STREAM HABITAT PROJECTS

In-Stream Habitat Projects include channel reconfiguration, installed deflectors, log and rock control weirs, roughened channels, and wood debris placements. The objective for In-Stream Habitat Projects is to increase in-stream cover, spawning, and resting areas by constructing artificial in-stream structures. The basic assumption is that creating more diverse pools, riffles, and hiding cover will result in an increase in local fish abundance (Crawford 2008b).

2.3 RIPARIAN PLANTING PROJECTS

Riparian Planting Projects include efforts to increase vegetation in the vicinity of salmon habitat. The objective of Riparian Planting Projects is to restore natural streamside vegetation to the streambank and riparian corridors. The assumption is that riparian vegetation increases shade to the stream, leading to cooler temperatures that are more beneficial for salmon. Riparian vegetation also reduces erosion and sedimentation, which can have negative effects on salmon habitat (Crawford 2008c).

2.4 LIVESTOCK EXCLUSION PROJECTS

Livestock Exclusion Projects include fencing to exclude livestock from riparian areas. The objective of livestock exclusion fencing is to exclude livestock from the riparian area of the stream where they can cause severe damage to streambanks and vegetation, increasing erosion and sedimentation. By excluding livestock, these adverse impacts can be avoided and restoration can occur (Crawford 2008d).

2.5 CONSTRAINED CHANNEL PROJECTS

Constrained Channel Projects include dike removal/setback, riprap removal, road removal/setback, and fill removal. The objective of Constrained Channel Projects is to restore the natural flood-flow channel capacity so that gravel, large wood, normal stream morphology, and fish habitat can be restored (Crawford 2008e).

2.6 CHANNEL CONNECTIVITY PROJECTS

Channel Connectivity Projects include reconnecting side channels, off-channel habitat creation or restoration, and wetland restoration. The objective of Channel Connectivity Projects is to restore lost channels and side channel rearing areas, and to dissipate the destructive effects of flood flows on habitat (Crawford 2008f).

2.7 SPAWNING GRAVEL PROJECTS

Spawning Gravel Projects include in-stream placement of spawning gravel. The objective of Spawning Gravel Projects is to improve spawning habitat capabilities within the restoration area by placing gravel in the stream. The assumption is that in some systems spawning areas are a limiting factor in producing salmon, and placing gravel in the stream should improve spawning success and increase local juvenile and adult fish abundance (Crawford 2008g).

2.8 DIVERSION SCREENING PROJECTS

Diversion Screening Projects include properly screening irrigation diversion dams, water treatment plants, pipes, ditches, headgates, and hydropower penstocks. The objective of Diversion Screening Projects is to prevent passage of salmon into areas where they may be stranded or subjected to increased mortality such as irrigated fields, turbines, treatment plants, factories, and other water uses. Salmon survival for a watershed can be improved by screening and otherwise protecting fish from diversions (Crawford 2008h).

2.9 ESTUARY PROTECTION PROJECTS

This category of projects was originally planned to be included in the program. However, other nearshore monitoring groups were developing protocols to address this habitat type. To avoid duplicating efforts, this project category was removed from the sample design, leaving an open category between Diversion Screening Projects and Habitat Protection Projects. A few estuary projects were included in the Habitat Protection Category using a limited protocol.

2.10 HABITAT PROTECTION PROJECTS

Habitat Protection Projects include habitat protection at the parcel scale without further restoration actions. The goals of these projects include: 1) protect identified blocks of critical habitat for a given listed salmon species, which protects the species at risk from further decline; 2) protect property that is providing key linkages connecting fragmented habitats; and 3) protect property used to enhance existing habitat and to offset poor habitat elsewhere in the watershed (Crawford and Arnett 2008). These projects are monitored to determine if high quality habitat is present at the protected sites or if the protected habitat is naturally improving without restoration.

3 PROCEDURES COMMON TO ALL MONITORING CATEGORIES

3.1 SITE SELECTION

For each monitoring category, projects were selected randomly for monitoring from the list of all of the projects funded by the annually awarded grants in that category. The target number of projects to be monitored in each category was 10, for a total of 90 projects sampled over the duration of the program. There are currently 84 projects that are actively being monitored. For some categories, there were delays in implementation of some of the projects. To help ensure that the sample size goal was attained, additional projects were added to over-sample in these categories. In other categories, the goal of 10 projects available to monitor has not been met. Once the list of projects to be monitored was generated, project sponsors were contacted during the planning process.

Prior to monitoring, preparation for the field season included acquiring permission to access all monitoring sites, obtaining sampling permits, updating the digital data collection system, and determining suitable locations for control reaches for the Before After Control Impact (BACI) Design Projects. See Appendix A for a project list.

3.2 ACCESS

Permission was obtained to access each project site from the landowner(s) before starting seasonal fieldwork. Access issues were prioritized so that those sites that needed to be sampled first were the initial focus (e.g., sites with near-term implementation dates, specific seasonal requirements, or sites that required spawner surveys that take several months).

Project sponsors also provided valuable information and assistance in determining potential control sites for BACI Design Projects. These reaches were often on adjacent properties and permission to access the control site over time was also gained, if possible, during this initial contact. Potential control sites were examined to determine if they were suitable as controls.

3.3 PERMITS

State and federal permits were obtained prior to sampling. The permits that have been obtained over the life of the program include the following: 1) Scientific Collection Permit from Washington State Department of Fish and Wildlife (WDFW), and 2) Endangered Species Act (ESA) incidental take permits (Section 10A 1[a]) from National Oceanic and Atmospheric Administration (NOAA) Fisheries (for waters with listed salmon and steelhead) and/or from U.S. Fish and Wildlife Service (USFWS; for waters with bull trout).

3.4 DIGITAL DATA COLLECTION

Data were recorded using Trimble GeoExplorer® hand-held computers and global positioning system (GPS) units. Electronic field forms for each monitoring task were built either in Visual Basic CE® or Microsoft Excel® software. Field data were downloaded to field laptops, electronically and visually checked for completeness, and sent to a permanent centralized database maintained at Tetra Tech EC., Inc. Digital files for each project include a project site map, digital data collection forms for hand-held data loggers, photos of the transects in the control and impact reaches, and database structures to house the field data collected and to calculate the appropriate summary statistics. These summary statistics were entered into the SRFB PRISM database used to track SRFB-funded restoration projects. With each year of monitoring, data are added to the PRISM database to track habitat and fish response through time. Analysis reports were run in PRISM to apply the *t*-test to project categories with adequate "before" and "after" data.

As the monitoring program progresses, improvements will need to be made to effectively manage a growing quantity of data. The database used to house monitoring data is currently being updated to maximize efficiency and to improve the existing code used in calculating summary statistics. Increased database capabilities will allow for more and different types of queries to be run, so that data can be more quickly accessed to respond to queries from project sponsors and others. Additionally, the capacity of the database will be expanded, making it slightly less portable. Procedures will be implemented to ensure seamless data transfer and only one master copy will be maintained. Other copies will be field replicates to allow for quality assurance/quality control evaluation in the field. Focus will also be placed on improving the process used to calculate statistics, such that added metrics can be calculated within the database, and so that calculations can be performed for multiple species. Documentation for variables created and procedures performed within the database will be improved and included as part of the data structure. Furthermore, files that are currently not linked to the database will be linked to streamline data access.

3.5 BACI DESIGNS

A BACI Design Project uses a control and an impact reach that are both sampled prior to project implementation and after implementation (Stewart-Oaten et al. 1986). Changes in the control reach provide an estimate of changes in environmental conditions, while changes in the impact reach estimate environmental changes as well as change due to the restoration action.

Seven of the nine monitoring categories have BACI sample designs. For these seven project types, control and impact reaches were established and documented. Whenever a project is sampled, the same control and impact reaches will be revisited to track the change in parameters through time. For each project site, the "X" site, or site used to locate the sample reach, was located using a GPS unit, and control and impact reaches were located in reference to the "X" site. For Fish Passage Projects, the "X" site was the location of projects with a structure of interest (e.g., the fish passage barrier). For other project categories, the "X" site was the center of the sample reach. Each reach was selected in accordance with the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) protocols as summarized in the Washington SRFB Effectiveness Monitoring Protocols (Crawford 2004 a-h; Crawford and Arnett 2004). Within each reach, 11 equally spaced sampling transects, labeled A through K, were established and flagged. Total length of the sample reach was based on 40 times the average wetted width of the channel. Permanent rebar stakes were placed at Transects A, F, and K to facilitate relocating the sample reach (Figure 3-1).

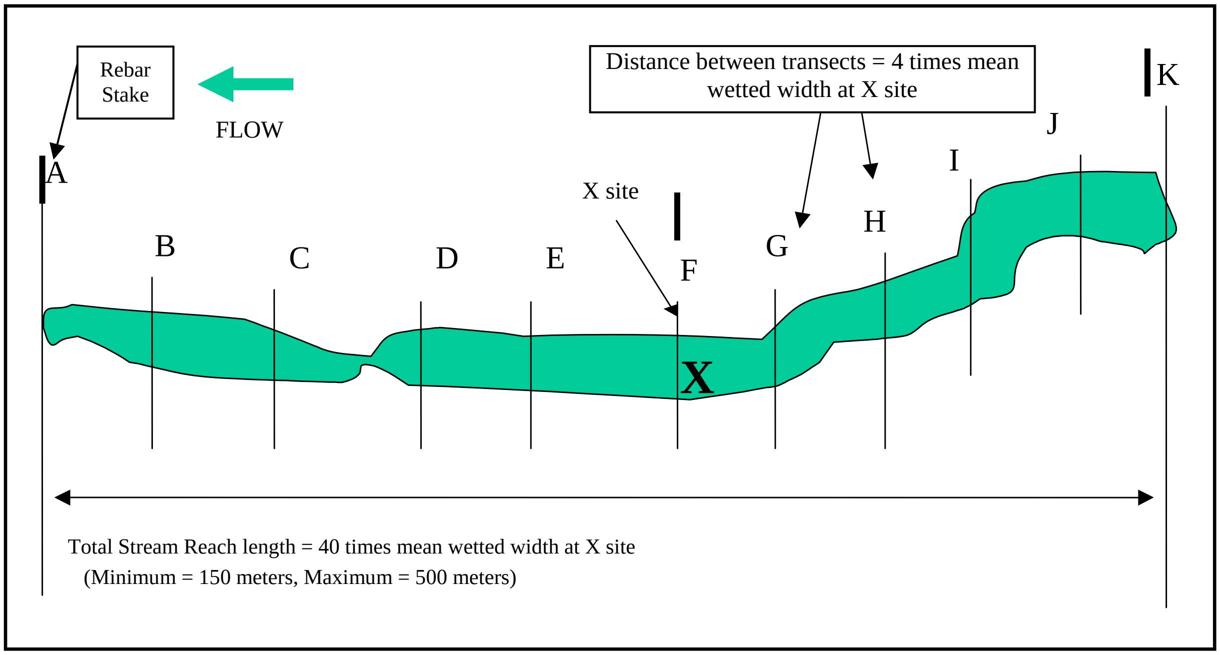


Figure 3-1. Layout of Sampled Project Reach

Transect F was located in the center of the sample reach and served as the “X” site for project categories that were not fish passage barriers. GPS points were recorded for each sample reach at Transects A, F, and K where the rebar stakes were placed. Photos were taken of the view upstream and downstream at Transects A, F, and K to help relocate each transect. Additionally, a map was drawn for each sample reach, showing the locations of each transect, rebar stakes, and reach-scale landmarks to help relocate the sample reach. The combination of the GPS points, rebar stakes, a reach description, photos, and a reach map was deemed sufficient documentation to relocate the sample reaches in subsequent sampling efforts.

3.6 PROTOCOL IMPROVEMENTS

Since the monitoring program was implemented in 2004, many lessons have been learned in applying the protocols in the field. Field procedures have been modified to meet the objectives of the monitoring program and collect the necessary data for each project category. In 2008, the monitoring protocols were updated to more accurately reflect the field procedures followed. The revised protocols include clarification of definitions, interpretation of items that were somewhat vague, and the addition of digital data forms where they were previously lacking. Data analysis procedures were also described as part of the protocol revision process, laying out the steps followed to develop and calculate summary statistics for each protocol. The updated protocols can be found at www.rco.wa.gov/srfb/docs.htm#monitoring under Reach-Scale Effectiveness Protocols (Revised 2008).

4 METHODS AND RESULTS

Detailed protocols for each monitoring category are available in Crawford (2008 a-h) and Crawford and Arnett (2008). The protocols include goals and objectives for each category, detailed field collection descriptions, summary statistics and data analysis procedures. The following sections summarize results from each monitoring category including the summary statistics for each project site sampled.

The first section summarizes the methods and results for monitoring categories that use the BACI design with a control and impact reach. The second section discusses projects that are assessed based on a function without a control. The third section summarizes the methods for the Habitat Protection Projects, which do not have a control reach. In these projects, the monitoring goal is to track changes in ecological health through time.

4.1 BACI DESIGN PROJECTS

BACI design projects involve monitoring of a control reach and an impact reach prior to project implementation and following implementation. BACI design projects monitored in 2008 included Fish Passage, In-stream Habitat, Riparian Planting, Livestock Exclusion, Constrained Channels, Channel Connectivity, and Spawning Gravel.

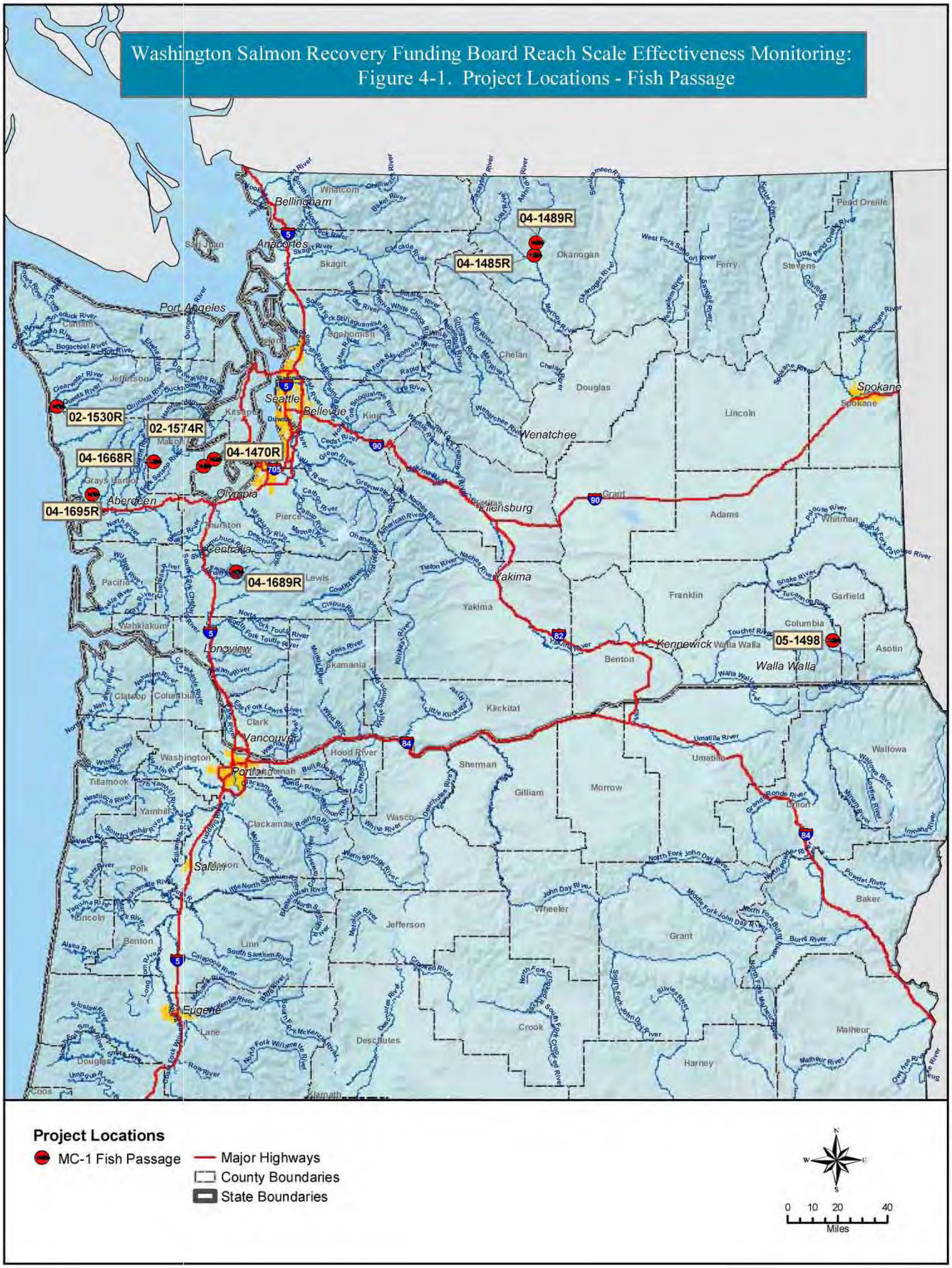
4.1.1 Fish Passage Projects

4.1.1.1 Protocol Description

In 2008, four Fish Passage Projects were monitored of the nine active projects in the program. Effectiveness monitoring of Fish Passage Projects included monitoring design specifications, juvenile salmonid abundance, and spawner/redd counts. Design specifications were determined for each project and compared to “as-built” conditions. Passage requirements were also measured at each project. Fish Passage Project monitoring required a BACI design with the control reach located below, and impact reach located above, the fish passage structure. Spawner surveys were part of the monitoring activity; therefore, these reaches were selected to include appropriate spawning habitat. The “X” point for these projects was the fish passage structure itself.

Figure 4-1 shows the locations of all of the Fish Passage Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects included in the program.

MC-1 Fish Passage



MC-1 Fish Passage

Design Specifications

Crawford (2008a) identifies the approach for monitoring fish passage structure (e.g., culvert or dam) function based on the species of salmonid for which the fish passage structure was designed. Measurable design criteria from project sponsor plans were identified for projects that were implemented. Many of the design criteria measured are taken from the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW 2000). Each project was given a percent score based on the number of design features that were in compliance with the plans, as compared to the total number of design features selected for measurement. After the Fish Passage Projects are built, design specifications monitoring is conducted at the first low-flow opportunity (typically when juvenile salmon surveys are being conducted). The project will be considered to be effective if 80 percent of the design criteria are met over 5 years.

Juvenile Salmonid Abundance

Crawford (2008a) identifies the methods (snorkeling and electrofishing) used to assess juvenile fish abundance. Because snorkel surveys are less intrusive and destructive than electrofishing (Murphy and Willis 1996), they were used whenever appropriate. Snorkel surveys were used at all Fish Passage Project sites sampled during the 2008 field season. Surveys were generally conducted during the low-flow period in the summer.

Snorkel surveys, depending on stream size, used one to four snorkelers. Snorkelers counted all fish observed, focusing on salmonids (juvenile coho salmon, Chinook salmon, chum salmon, pink salmon, rainbow trout/steelhead, bull trout, and cutthroat trout). Just prior to the snorkel survey, the reach was ranked for turbidity using criteria described in Crawford (2008a). The reach surface area was determined using Crawford (2008a). The length of the reach was measured and 21 stream widths were measured at even intervals along the reach. The average reach width was multiplied by the reach length to calculate surface area. For each study reach, the density of fish (fish/m^2) observed for Chinook salmon, coho salmon, rainbow trout/steelhead, and bull trout was calculated. Sampling for juvenile salmonid abundance occurred during the low-flow period or other appropriate period for each project location. Fish Passage Projects will be considered effective if there is a significant difference between the impact and control reaches for the mean value in juvenile salmonid densities in the impact reaches by Year 5.

Spawner and Redd Abundance

Spawner and redd surveys were conducted every 7 to 10 days in both the impact and control reaches, beginning with the earliest anticipated spawning date for the target species, and continuing until the end of the normal spawning period for that species (Crawford 2008a). Surveys were conducted on foot to count spawners and redds. Redd locations and carcasses were marked and, when possible, data on gender, length, and adipose fin presence were recorded for carcasses. Fish Passage Projects will be considered effective if there is a significant difference between impact and control reaches for the mean value in spawner or redd densities by Year 5.

4.1.1.2 Results/Data Summaries/Decision Criteria

Table 4-1 identifies the summary statistics reported for each Fish Passage Project. As mentioned above, spawner surveys focused on target species, so only adult and redd data for the target species are reported for each project.

4.1.1.3 Project-Specific Summaries

Projects that involve structural modifications to improve fish passage are monitored prior to implementation of the project (Year 0) and for a period of five years following implementation. Post-project monitoring is conducted at the control site and impact site during Year 1, 2, and 5. Summary data for each Fish Passage Project are presented below. Projects sampled prior to 2008 have multiple years of data. New projects for 2008 only have baseline data. This may vary if project implementation was delayed or incomplete during 2008 or previous years.

Table 4-1. Decision Criteria and Statistical Test Type for Fish Passage Projects

Monitoring Parameter	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Passage Structure	Passage design criteria met	Yes/No	None	≥ 80% of each project design is intact to rate a Yes
Juvenile Fish Abundance	Chinook salmon juvenile abundance	$\#/m^2$	paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Coho salmon juvenile abundance	$\#/m^2$	paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Steelhead parr abundance	$\#/m^2$	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
Adult Fish Abundance (Total number of spawners or redds observed over all surveys divided by the length of the sample reach in km. Only one target species was monitored for each project.)	Chinook salmon redds or Chinook salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Coho salmon redds or coho salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Steelhead redds or coho salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Bull trout redds or bull trout spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Pink salmon redds or pink salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Chum salmon redds or chum salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5
	Sockeye salmon redds or sockeye salmon spawner abundance	#/km	BACI paired *t*-test	Alpha =0.10 for one-sided test. Detect an increase between impact and control by Year 5

Source: Crawford 2008a

02-1530 Salmon River Tributary 21-0143 Culvert Barrier

The Salmon River Tributary Project involved the replacement of a partial fish barrier culvert on a tributary to the Salmon River. The barrier consisted of a 72-inch culvert located approximately 110 feet above the Salmon River at river mile (RM) 13.4. The undersized culvert was a partial barrier to adult salmonid migration and a full barrier to juvenile passage. High velocities and a 1.37-meter culvert outfall drop contributed to the barrier. The culvert was identified in a U.S. Forest Service (USFS) culvert inventory as a high priority for replacement. Removal and replacement of this culvert with an adequately sized culvert provided unimpeded access to 0.8 miles of spawning and rearing habitat for coho salmon, steelhead, and cutthroat trout.

Pool depth check at downstream end of culvert at outfall before construction (2004)

Downstream end of culvert at outflow after construction (2005)

Project Location

This project is located in Grays Harbor County, on a tributary to the Salmon River, within Quinault Indian Nation land. The culvert is located where Forest Road 2120 crosses the tributary. The impact reach (150 meters [m]) is upstream of the culvert and the control reach (150 m) includes both the tributary and a portion of the Middle Fork Salmon River.

Project Objective

The objective of this project was to replace a 1.8-meter culvert that was acting as a partial fish barrier on Watershed Resource Inventory Area (WRIA) #21-0143 tributary, 33.5 meters above the Middle Fork Salmon River confluence. The culvert had a 1.37-meter outfall drop and high velocities, which created a partial barrier to adult salmon migration and a full barrier to juvenile passage. The project was intended to provide access to 1,287 meters of spawning and rearing habitat for coho salmon, steelhead, and cutthroat trout. The target species for this project is coho salmon. The project is sponsored by the Quinault Indian Nation and is located on their property. Bill Conway of the Quinault Indian Nation and Rich McConnell of the U.S. Department of Agriculture Forest Service are the primary contacts.

Project Data

Figures 4-2 and 4-3 show the trends through time of the impact data minus the control data for each year for juvenile fish density, coho spawner density and coho redd density. Table 4-2 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Salmon River Tributary Project.

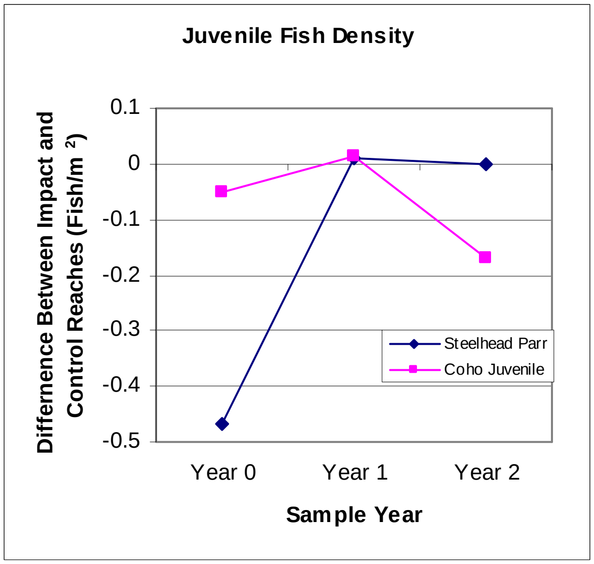


Figure 4-2. Juvenile Fish Density in the Salmon River Trib

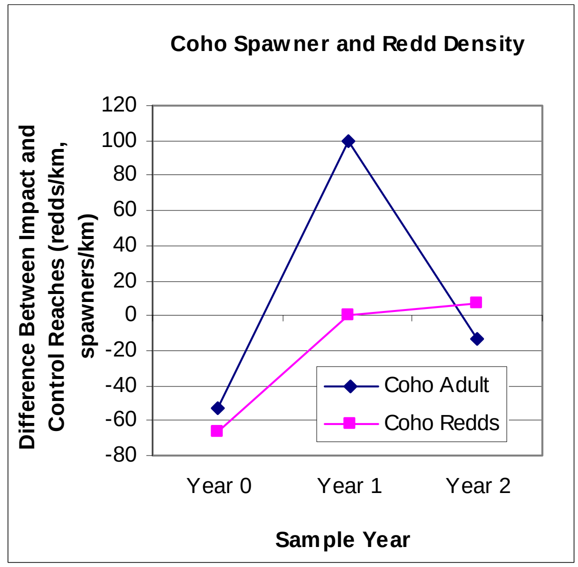


Figure 4-3. Spawner and Redd Density in the Salmon River Trib

Table 4-2. Summary Statistics for Pre- and Post-Installation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 2 (2006)	
	Control	Impact	Control	Impact	Control	Impact
Fish Data						
Steelhead Parr (fish/m^2)	0.4852	0.0189	0.0099	0.0211	0	0
Coho Juvenile (fish/m^2)	0.0499	0	0.0231	0.0364	0.3512	0.1827
Coho Adult (fish/km)	53	0	73	173	20	7
Coho Redds (redds/km)	67	0	7	7	0	7
Data collected July 20, 2004 and fall and winter 2005 (Year 0); fall 2005 and March 15, 2006 (Year 1); and June 14, 2006 and fall and winter 2006 (Year 2).						

The new culvert was inspected to determine compliance with both the design specifications and MC-1 protocol. The following parameters were measured: culvert length, culvert span, material thickness, proportion of the culvert buried, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Following project implementation in 2005, monitoring showed coho adult spawners and redds in the impact reach. Although the numbers were lower in 2006, they still exceeded those of 2004. Steelhead parr increased in the impact reach following project implementation in 2005, but were not seen in 2006. Coho juvenile numbers increased in the impact reach following project implementation in both 2005 and 2006. Monitoring was not conducted at the Salmon River Tributary site in 2007 or 2008. Year 5 monitoring is scheduled for 2009.

02-1574 Melaney Creek Fish Passage Project

Melaney Creek flows over a distance of about 3 miles between the outlet of Spencer Lake until the confluence with Oakland Bay. Approximately 0.50 miles upstream of Oakland Bay, a major culvert barrier existed under Agate Road. The Melaney Creek Fish Passage Project included the replacement of the previously existing fish-barrier culvert with a 22-foot wide by 100-foot long concrete box culvert. The box culvert is bottomless, or stream simulating, in that it allows for stream functions such as large woody debris (LWD) recruitment and organic material transfer to occur. The project was designed to allow better upstream access to approximately 2.5 miles of functional habitat for coho, steelhead, chum, and cutthroat trout. The available habitat is considered to be functional and intact. In addition to the culvert replacement, the project sponsor, South Puget Sound Salmon Enhancement Group, proposed to revegetate the riparian area and place LWD to increase habitat diversity in the system.


Culvert prior to implementation (2004)


Culvert following project implementation (2007)

Project Location

The Melaney Creek Fish Passage Project is located on Melaney Creek, which flows from Spencer Lake to Oakland Bay, and is within WRIA 14. The project site is situated near the City of Shelton, in Mason County, Washington. The culvert that was replaced as part of this project is on Agate Road and is owned and maintained by Mason County.

Project Objective

The intent of this project was to improve the road/stream crossing at Agate Road for anadromous and resident fish by replacing a culvert that blocked fish passage with a stream simulation structure that provides access to additional habitat, allows for natural stream function, and improves the habitat complexity of the stream. Upstream habitat with low stream gradient, high canopy cover, a mixture of gravel and fines, and stable stream flow was made available to fish of all life history stages, including spawning adults and rearing juveniles. Removal of this culvert was designed to provide unimpeded access for fish from productive Oakland Bay estuaries to Spencer Lake. The target species for this project was coho salmon. The contact person for this project is Lance Wineka.

Project Data

Figures 4-4 and 4-5 show the trends through time of the impact data minus the control data for each year for juvenile fish density, coho spawner and redd density, and chum spawner and redd density. Table 4-3 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Melaney Creek Fish Passage Project. The project was implemented in 2006.

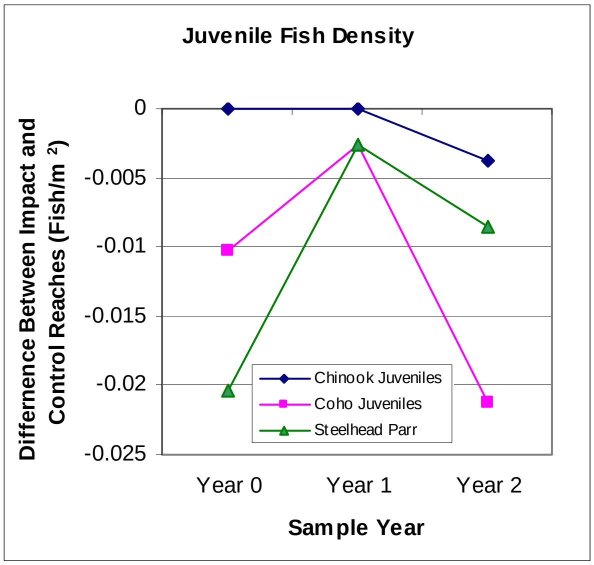


Figure 4-4. Juvenile Fish Density in Melaney Creek

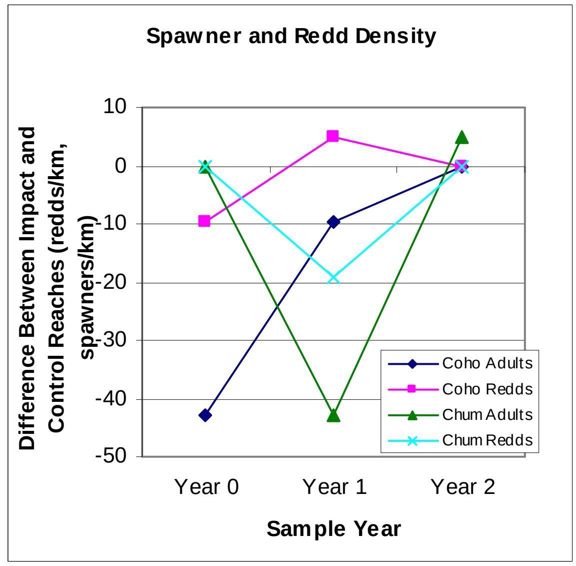


Figure 4-5. Spawner and Redd Density in the Melaney Creek

Table 4-3. Summary Statistics for Pre- and Post-Installation (Year 0, Year 1, and Year 2) Monitoring

	Year 0 (2004)		Year 1 (2006)		Year 2 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Fish Data						
Chinook Juveniles (fish/m^2)	0	0	0	0	0.0038	0
Coho Juveniles (fish/m^2)	0.0102	0	0.0026	0	0.0340	0.0128
Steelhead Parr (fish/m^2)	0.0276	0.0072	0.0026	0	0.0101	0.0016
Coho Adults (fish/km)	48	5	14	5	0	0
Coho Redds (redds/km)	10	0	0	5	0	0
Chum Adults (fish/km)	0	0	143	100	0	5
Chum Redds (redds/km)	0	0	19.04	0	0	0
Data collected July 20, 2006 and fall 2004 (Year 0), September 21, 2006 and fall 2006 (Year 1), and July 26-27, 2007 and fall 2007 (Year 2)						

The new culvert was inspected to determine compliance with both the design specifications and protocols. The following parameters were measured: culvert length, culvert span, material thickness, proportion of the culvert buried, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Data collected at the Melaney Creek project site indicate that fish passage is occurring at the structure for both juvenile and adult salmonids. In both the control reach and the impact reach juvenile densities for both coho and steelhead decreased from 2004 to 2006 and then increased in 2007. The changes were more extreme in the control reach. For adults, spawning was observed by chum in both reaches in 2006 at relatively high densities (Table 4-2). High flows in 2007 appear to have caused some bank erosion in the impact reach, but there has been no significant damage to the structure. Monitoring was not conducted at Melaney Creek in 2008 and Year 5 monitoring is planned for 2010.

04-1470 Hiawatha Fish Passage

Hiawatha Creek Fish Passage project is located 600 meters upstream of the estuary in Pickering Passage near Allyn, WA. Hiawata Creek is a small drainage that supports chum, coho, coastal cutthroat, and resident fish. The upper wetland headwaters provide rich rearing opportunities, while the lower stream reach provides spawning opportunities. At this project site, the original concrete culvert was undersized and failing. Due to high flow events, a large outfall drop, and the small diameter of the culvert, the downstream channel had become severely degraded, and downcut, with limited rearing habitat and loss of floodplain connection. The disconnection from the floodplain limited the recruitment of LWD in this portion of the creek. The Hiawatha Fish Passage project included the replacement of the existing culvert to improve fish passage. The new culvert has a significantly wider span, natural stream bottom, and does not present a velocity or outfall barrier. Additionally, LWD was installed in the downstream channel to assist in facilitating natural channel formation and providing additional habitat complexity.

Downstream end of culvert prior to project (2005)

Culvert following project implementation (2008)

Project Location

This project is located in Mason County on Hiawata Creek, 600 meters upstream of the estuary in Pickering Passage, between Allyn and Shelton, Washington. The project site is located off of Island View Drive in Grapeview, Washington. The impact reach is above the culvert and the control reach is below the culvert. South Puget Sound Salmon Enhancement Group (SPSSEG) sponsors this project and Eli Asher serves as the primary contact. Lands within the project area are owned by Mason County.

Project Objective

The objective of this project was to improve access to spawning habitat for chum salmon by replacing an existing undersized concrete culvert with a 20’ wide aluminum arch culvert. Additional objectives include improving the spawning habitat downstream of the culvert by installing LWD to further facilitate salmon spawning and rearing opportunities. The target species for this project is chum salmon.

Project Data

Figures 4-6 and 4-7 summarize the data collected during Year 0 and Year 1 monitoring of the Hiawatha Fish Passage Project. Table 4-4 shows fish data collected to date at this project site. A second year of baseline data was able to be collected at this site due to delays in project implementation.

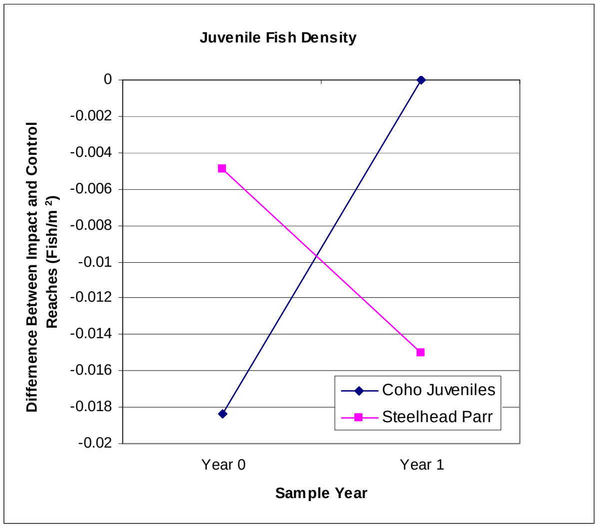


Figure 4-6. Juvenile Fish Density at Hiawata

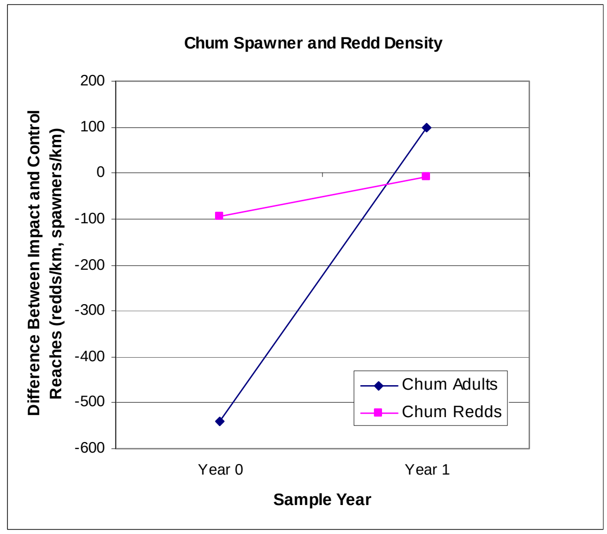


Figure 4-7. Spawner and Redd Density at Hiawata

Table 4-4. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 0*, and Year 1) Monitoring

Variable	Year 0 (2005)		Year 0* (2006)		Year 1 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Fish Data						
Coho Juveniles (fish/m^2)	0.0082	0	0.0272	0.0088	0	0
Steelhead Parr (fish/m^2)	0.0218	0	0.0049	0	0.0150	0
Coho Adults (fish/km)	0	0	73	0	0	0
Coho Redds (redds/km)	0	0	0	0	0	0
Chum Adults (fish/km)	0	0	2,647	0	127	227
Chum Redds (redds/km)	0	0	253	0	20	13

Data collected on August 22, 2005 and fall 2005 (Year 0); June 19, 2006 and fall 2006 (Year 0*); and October 14, 2008 and fall 2008 (Year 1).
Year 0 indicates second year baseline data.

The new structure was inspected to determine compliance with both the design specifications and protocols to determine fish passage. The following parameters were measured: water velocity, gradient, structure length, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance and fish passage was confirmed.

Summary

Upon initial assessment of the new culvert, all flow through the culvert was noted as subsurface. As a result the culvert did not meet the minimum depth criteria. However, once flow was established through the culvert, it met all criteria and was determined to be in compliance with the design criteria.

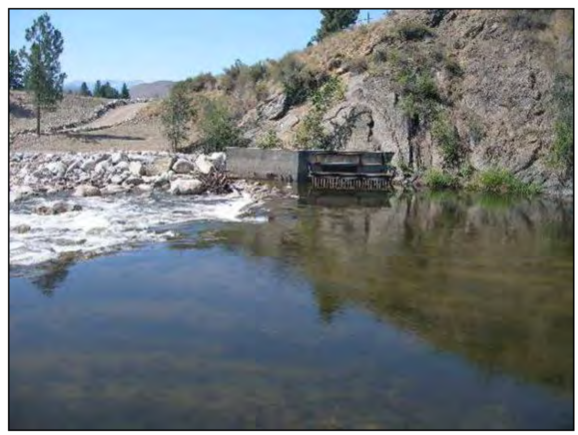
MC-1 Fish Passage

In Year 1, adult chum spawners and redds were documented in the impact reach for the first time since monitoring of this site began in 2005, confirming that the new culvert is passable to adult fish. Adult spawners and redds were also observed in the control reach. Comparison of the juvenile fish data in Figure 4-6 shows increased use following construction by coho salmon in the impact reach and decreased use by steelhead parr.

04-1485 Fulton Dam Barrier Removal Project

The Chewuch Basin Council is working with state and federal agencies to address adverse impacts to passage, spawning, and rearing in the lower 8 miles of the Chewuch River, a tributary to the Methow River. Some of these impacts are tied to the operation of irrigation ditches, such as the Fulton Ditch. Removal of the passage barriers and increasing river flows were identified as priorities in the draft Habitat Conservation Plan under development for the Chewuch Basin. Irrigation improvements have made water delivery more efficient over the past four years but have done little to address passage limitations. The Fulton River Ditch Company operates a diversion that is used for irrigation in the Methow Valley. This diversion has historically relied on a rock dam at RM 0.7 on the Chewuch River, which was identified as a partial passage barrier for listed species. In 2007, the dam was re-constructed as a natural channel providing improved passage for listed species at all flow levels while maintaining irrigation viability and water supply to Fulton Ditch. Improvements included installing a headgate control, roughening of the natural channel, and construction of a low-flow channel for fish passage. Species present in the Chewuch River and targeted by this project include spring Chinook salmon, bull trout, and summer steelhead.

Fulton Dam site in 2005 with rock dam(Year 0)



Fulton Dam site in Year 2 (2008)

Project Location

The Fulton Dam Project is in the Chewuch River (WRIA 48) in Okanogan County. The Fulton Dam work site is located behind the Winthrop Forest Service Field Office in Winthrop, Washington. The impact site is located upstream from Fulton Dam near Windhaven Resort and the control site is located immediately downstream from Fulton Dam.

Project Objective

The project was designed to provide a naturalized river bed that would still maintain water flow and irrigation rights to the Fulton River Ditch Company diversion, but would not restrict fish passage over the crest of the structure. Before construction, Chinook were limited in their access to the area above the dam by an inadequate fish passage structure, although pre-project surveys illustrate that some passage occurred. Removal of the existing dam at RM 0.7

provided improved fish passage at all flows to the lower 8 miles of the Chewuch River. The project approach included removal of the existing dam and construction of a roughened natural channel ramp that allows fish to cross anywhere in the channel. The new ramp has a more gradual gradient drop and low velocity areas for fish to rest as they move upstream. The new diversion structure also improved the function of the diversion for the Fulton River Ditch Company, as the new structure requires less maintenance, without any reduction in irrigation capacity. The project sponsor is the Chewuch Basin Council and the project contact is Chris Johnson of the Methow Salmon Recovery Foundation. The landowner is John Larsen.

Project Data

Figures 4-8 and 4-9 show the trends through time of the impact data minus the control data for each year for juvenile fish density, Chinook spawner and redd density. Table 4-5 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Fulton Dam Project.

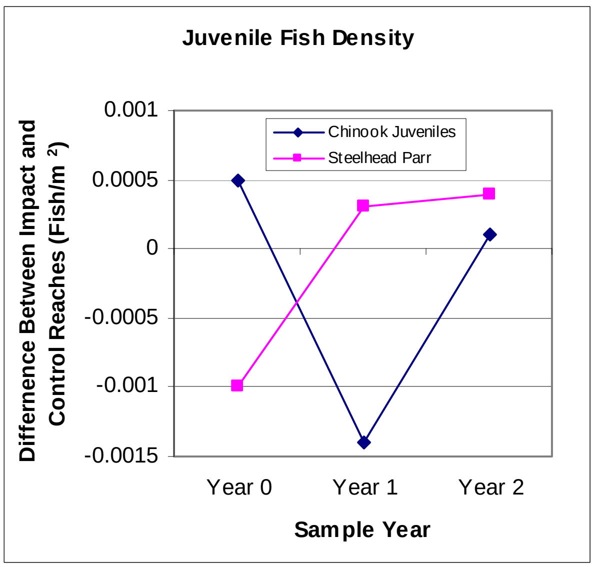


Figure 4-8. Juvenile Fish Density in the Chewuch River

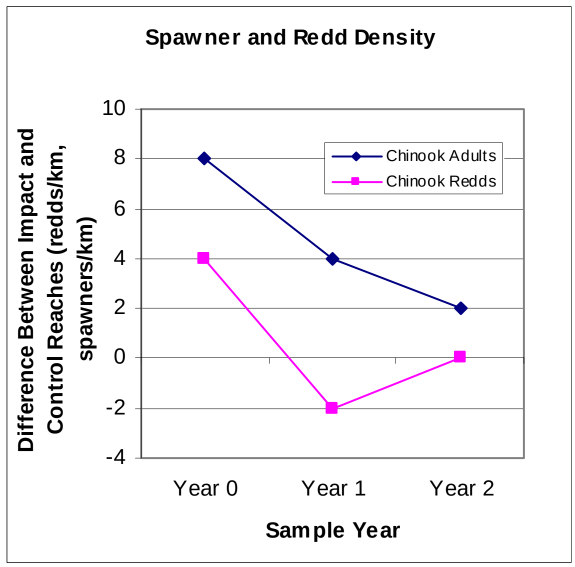


Figure 4-9. Spawner and Redd Density in the Chewuch River

Table 4-5. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2005)		Year 1 (2007)		Year 2 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Fish Data						
Chinook Juveniles (fish/m^2)	0	0.0005	0.0014	0	0	0.0001
Steelhead Parr (fish/m^2)	0.0036	0.0026	0.0007	0.0010	0.0030	0.0034
Chinook Adults (fish/km)	8	16	4	8	0	2
Chinook Redds (redds/km)	0	4	2	0	0	0
Data collected July 14 through October 10, 2005 (Year 0); July 22 through September 22, 2006 (Year 0*); and July 19, 2007 through September 27, 2007 (Year 1).						

MC-1 Fish Passage

The new structure was inspected to determine compliance with both the design specifications and protocols. The following parameters were measured: water velocity, gradient, structure length, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Pre-project data at this site show use by Chinook spawners and steelhead parr in both the control and impact reaches. Spawner density in both the control and impact reaches has decreased between Year 0 and Year 2. Chinook juveniles were also using the impact reach above the structure before the project was implemented, indicating Fulton Dam was not a full barrier to passage. Following implementation, steelhead parr were still found in both the control and impact reaches, and Chinook juvenile densities increased in Year 2 following a sharp decrease in Year 1.

04-1489 Chewuch Dam Barrier Removal Project

The Chewuch Canal is operated by the Chewuch Canal Company and provides irrigation water to the Methow Valley. Water supply for the canal is provided by an outflow structure behind a concrete dam at RM 8.0 on the Chewuch River. As shown in the photo below, the original dam construction which provided marginal fish passage through a denile, which was used by Douglas County Public Utility District (PUD) for fish trapping and collection. Since this denile was no longer needed by the PUD, and to improve fish passage and fish exclusion from the outflow, a project was developed to re-construct the dam and build a roughened channel that would provide better passage than the denile. Removal of this barrier increased access to the upper 30 miles of the Chewuch River. Species targeted by this effort include Chinook salmon, bull trout, and steelhead, which are all listed as endangered or threatened under the ESA.

Chewuch Dam prior to implementation (2005)

Chewuch Dam following implementation (2007)

Project Location

The Chewuch Dam Project is located in the Methow subbasin (WRIA 48) in Okanogan County. The dam is located approximately 8.0 miles north of Winthrop on the East Chewuch Road (Okanogan County Road 9137). The landowner of the project area is the WDFW and access to the dam and the impact reach is provided through their property (behind agricultural buildings). The control reach is located downstream from the project near the Windhaven Resort on USFS property.

Project Objective

The goals of the project were to provide improved passage for listed species at all flow levels while maintaining irrigation viability. Additionally, the existing dam and headworks were renovated to meet current fish passage and exclusion standards. The Chewuch Basin Council is working with state and federal agencies to address adverse impacts to passage, spawning, and rearing in the lower 8 miles of the Chewuch River. The project created a roughened channel for passage at the dam, prevents adult fish from spawning in the inlet of the canal, an involved the installation of a headgate to prevent unregulated flows down the inlet canal. Additionally, the dam crest was built 12 inches higher to eliminate the need for flashboards except during extreme low flows. The project sponsor is the Chewuch Basin Council and the project contact is Chris Johnson of the Methow Salmon Recovery Foundation.

Project Data

Figures 4-10 and 4-11 summarize the data collected during Year 0, Year 1, Year 2, and Year 3 monitoring of the Chewuch Dam Barrier Removal Project. Table 4-6 shows all of the fish data collected to date at this site.

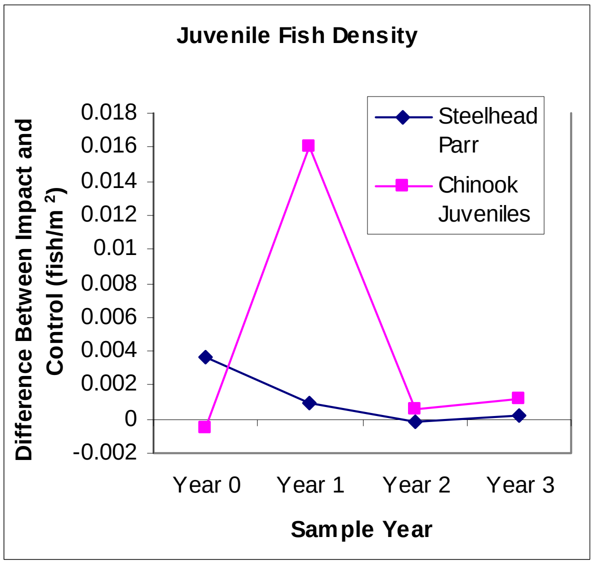


Figure 4-10. Juvenile Fish Density at Chewuch Dam

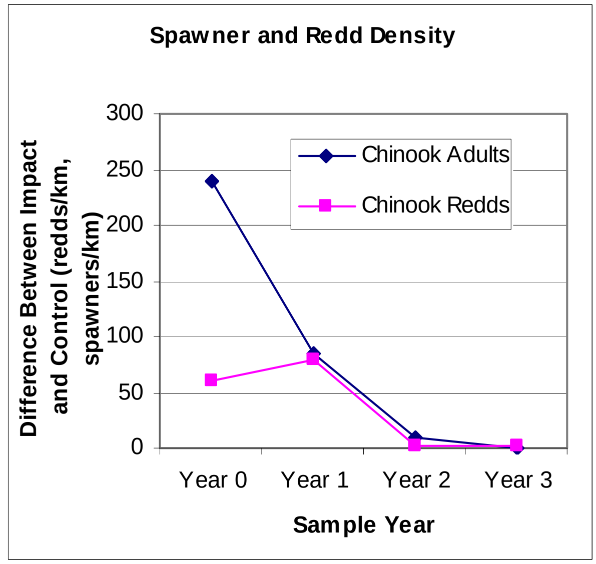


Figure 4-11. Spawner and Redd Density at Chewuch Dam

Table 4-6. Summary Statistics for Pre- and Post-Installation (Year 0, Year 2, and Year 3) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 2 (2007)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact	Control	Impact
Steelhead Parr (fish/m^2)	0.0026	0.0062	0.0011	0.0023	0.0010	0.0009	0.0001	0.0003
Chinook Juveniles (fish/m^2)	0.0005	0	0.0085	0.0246	0	0.0006	0.0034	0.0046
Chinook Adults (fish/km)	16	256	8	92	2	12	2	2
Chinook Redds (redds/km)	4	64	0	80	0	2	0	2
Data collected July 16, 2005 through September 30, 2005 (Year 0), July 21, 2006 through September 30, 2006 (Year 1), July 18, 2007 through September 27, 2007 (Year 2), and July 23, 2008 through September 27, 2008 (Year 3).								

The new structure was inspected to determine compliance with both the design specifications and fish passage protocols. The following parameters were measured: water velocity, gradient, structure length, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Juvenile fish density in the impact reach (minus the control reach) (Figure 4-10) shows a peak in density in Year 1, and then a sharp decrease in Years 2 and 3. Steelhead parr density did not increase significantly in Year 1 and remained low in Year 2 and 3. Adult spring Chinook abundance was slightly lower in Year 3 than in Year 2 (Figure 4-11); however, redd counts remained the same. Adult Chinook abundance and redd counts were both significantly lower in Year 2 and Year 3 than in Year 0 or Year 1. This suggests that overall spring Chinook escapement back to the Chewuch watershed may have been dramatically reduced in 2007 and 2008.

04-1668 Beeville Road at Milepost (MP) 2.09

The Beeville Road Project included the replacement of a stream crossing, including two compressed, oval culverts, on the Beeville Road in western Mason County, Washington. One of the culverts was perched approximately two feet higher than the other culvert and only allowed the stream to flow through it during high water events. The other, larger, culvert was a fish passage barrier due to gradient. The crossing was rated as 33 percent passable for 6-inch trout by the Mason Conservation District. The Beeville Road project involved the installation of an 18-foot wide oval aluminum culvert meeting WDFW's "No Slope" design criteria. The artificial streambed in the new culvert was designed with a slope of 2 percent. This crossing was the lowermost remaining fish passage barrier on a County road as Petersen Creek flows to the East Fork of the Satsop River. The 765-acre watershed above the crossing is owned primarily by Green Diamond Resource Company and managed under a Habitat Conservation Plan. Fish use in the stream includes chum, coho, and coastal and resident cutthroat trout.


Beeville Road culverts pre-implementation (2005)


New culvert post project implementation (2007)

Project Location

This project is located in Mason County, just outside of the town of Matlock, on Mason County property. The crossing is 2.09 miles north of Matlock on Beeville Road. The road crossing is located on Petersen Creek, a tributary to the East Fork Satsop River.

Project Objective

The objective of this project was to replace two culverts to correct perching of one and high gradient in the other to improve fish passage to the upper watershed. The project opened 6,102 meters of habitat containing 9,009 square meters of spawning and 10,494 square meters of rearing habitat. The species of interest was coho salmon; however, chum, steelhead, and cutthroat were targeted for this restoration action as well. This project was sponsored by Mason County Public Works and Rick Hirshberg is the primary contact person.

Project Data

Figure 4-12 shows the trends through time of the impact data minus the control data for each year for juvenile fish density. Table 4-7 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Beeville Road Fish Passage Project.

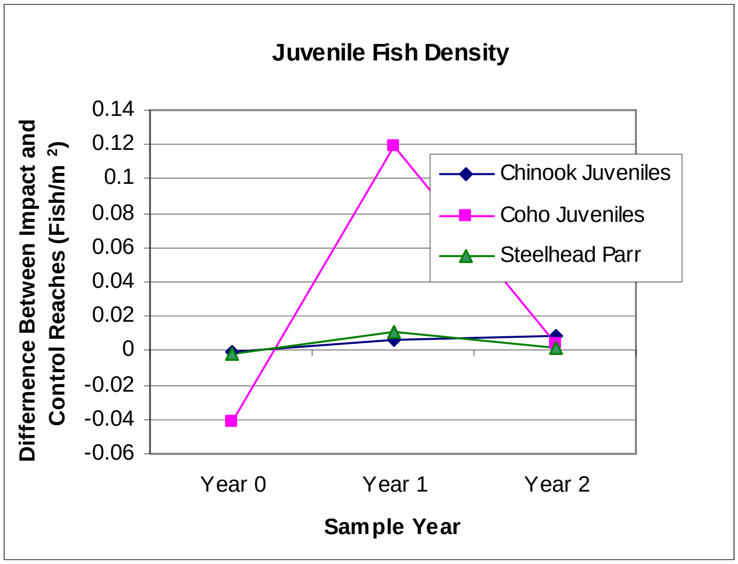


Figure 4-12. Juvenile Fish Density in Peterson Creek

Table 4-7. Summary Statistics for Pre- and Post-Installation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 2 (2007)	
	Control	Impact	Control	Impact	Control	Impact
Fish Data						
Chinook Juveniles (fish/m^2)	0.0012	0	0	0.0067	0.0014	0.0105
Coho Juveniles (fish/m^2)	0.0617	0.0202	0.0292	0.1481	0.1025	0.1064
Steelhead Parr (fish/m^2)	0.0024	0	0.0029	0.0135	0.0152	0.0174
Coho Adults (fish/km)	0	0	0	0	0	0
Coho Redds (redds/km)	0	0	0	0	0	0
Chum Adults (fish/km)	0	0	0	0	0	0
Chum Redds (redds/km)	0	0	0	0	0	0
Data collected May 5, 2005 and fall of 2005 (Year 0); August 23, 2006 and fall of 2006 (Year 1); and May 8, 2007 fall of 2007 (Year 2).						

The new culvert was inspected to determine compliance with both the design specifications and protocol requirements. The following parameters were measured: culvert length, culvert span, material thickness, proportion of the culvert buried, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Data collected at the Beeville Road Fish Passage Project indicate increases in juvenile densities for Chinook, coho, and steelhead in the first year after construction as compared to a control reach (see Figures 4-7 through 4-9). In Year 2, coho juvenile density decreased, but the density of chinook and steelhead parrs continued to increase. No coho spawners or redds have been observed at this site, but in Year 2 (2007) a chum spawner was observed in the impact reach, indicating that the culvert is passable for spawning fish. Monitoring was not conducted at Beeville in 2008 and Year 5 monitoring is planned for 2010.

04-1689 Lucas Creek Barrier Correction Project

At the Lucas Creek Project site, an 82-inch by 65-inch by 48-foot-long arch culvert with a slope of 4.1 percent crossed the road at MP 5.173, and was a velocity barrier under most flow conditions to migrating adult anadromous fish. A 1-foot drop at the outlet presented a 100 percent barrier to juvenile upstream migration. This project included the installation of a new culvert, additional streambed gravel, grade controls, installation of LWD, and streamside plantings to restore fish passage to 2.8 stream miles of Lucas Creek. Salmonid species documented below the barrier include Chinook, coho, steelhead, resident and sea run cutthroat trout, and rainbow trout.

Culvert prior to implementation (2005)

Culvert post-implementation (2007)

Project Location

The project is located on Lucas Creek, a tributary to the Newaukum River, which flows into the Chehalis River. The site is within WRIA 23, in Lewis County, Washington. The land at the site is owned partly by Weyerhaeuser Company and in part by Lewis County.

Project Objective

The objectives of this project included replacing an existing culvert with a fish-passable structure, installing designed streambed gravel, implementing grade controls, and placing LWD and streamside plantings to help restore fish passage to 2.8 miles of Lucas Creek. Lewis County Public Works sponsored this project and Rod Lakey serves as the primary contact.

Project Data

Figures 4-13 and 4-14 show the trends through time of the impact data minus the control data for each year for juvenile fish density, and Chinook spawner and redd density. Table 4-8 summarizes the data collected during Year 0, Year 1 and Year 2 monitoring of the Lucas Creek Barrier Correction Project.

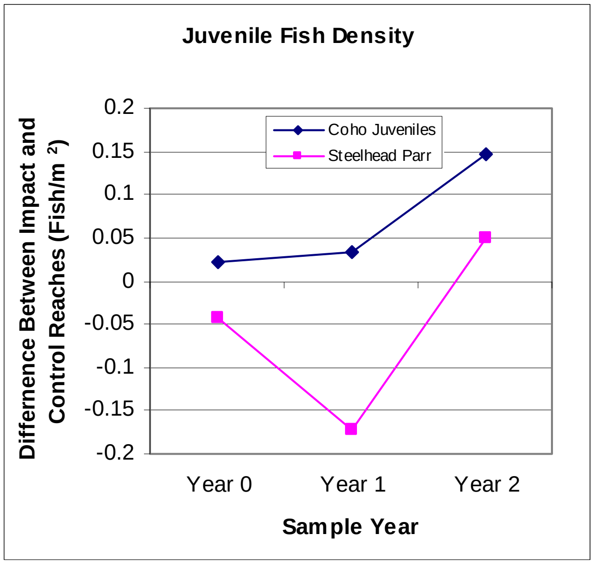


Figure 4-13. Juvenile Fish Density in Lucas Creek

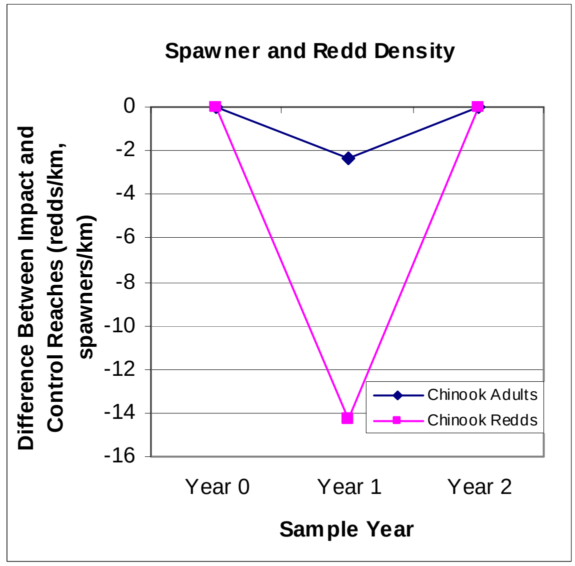


Figure 4-14. Spawner and Redd Density in Lucas Creek

Table 4-8. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 2) Monitoring

	Year 0 (2005)		Year 1 (2006)		Year 2 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Fish Data						
Coho Juveniles (fish/m^2)	0	0.0217	0	0.0334	0.1620	0.3084
Steelhead Parr (fish/m^2)	0.0871	0.0449	0.2221	0.0509	0.0222	0.0722
Coho Adults (fish/km)	0	0	0	0	0	0
Coho Redds (redds/km)	0	0	0	0	0	0
Chinook Adults (fish/km)	0	0	5	2	0	0
Chinook Redds (redds/km)	0	0	14	0	0	0
Data collected September 13, 2005 through January 31, 2006 (Year 0); October 6, 2006 and fall 2006 (Year 1); and September 14, 2007 and fall 2007 (Year 2)						

The new culvert was inspected to determine compliance with both the design specifications and MC-1 protocol. The following parameters were measured: culvert length, culvert span, material thickness, proportion of the culvert buried, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

This project consists of a modification to a road culvert to improve fish passage, primarily for coho salmon. Evaluation of this project includes both juvenile (snorkel surveys) and adult (redd count surveys) fish surveys. During the first three years of monitoring, juvenile coho have been observed both upstream and downstream from the culvert both prior to and after project implementation. These data suggest that this section of Lucas Creek serves as an important rearing area and passage corridor for coho salmon. Chinook adults were observed in Year 1 immediately following a high water event. Although suitable coho spawning habitat does exist in both the impact and control reaches, these areas do not appear to be used for spawning. It is suspected that escapement of coho through this area is fairly low and that most of the spawning occurs somewhere upstream from the impact reach. Monitoring was not conducted at Lucas Creek in 2008 and Year 5 monitoring is planned for 2010.

04-1695 Dekay Road Fish Barrier

This project replaced culverts that were primarily juvenile fish barriers at three crossings of Polson Creek, a 6,233-meter long tributary of the West Fork Hoquiam River. Two of the existing culverts were replaced with bottomless box culverts and the third with a concrete bridge. This allowed the stream to regain normal function and provided access to all fish species and life stages. Polson Creek has excellent coho salmon and cutthroat trout spawning and rearing habitat. The mainstem Hoquiam River has documented use by Chinook salmon and steelhead. Polson Creek was identified as having good riparian cover, adequate LWD, and wetland habitat. The target species for this project is coho salmon.

Impact reach prior to implementation (2005)

Impact reach post-implementation (2007)

Project Location

This project is located in Grays Harbor County on Polson Creek. Survey reaches are upstream and downstream of this stream crossing on Dekay Road, west of Highway 101, on Grays Harbor County property.

Project Objective

The objective of this project was to replace culverts on Polson Creek, which are currently fish passage barriers to provide access to 13,471 square meters of rearing habitat, and 3,624 square meters of spawning habitat for anadromous coho salmon, Chinook salmon, and sea-run cutthroat. This project was sponsored by the Chehalis Basis Fisheries Task Force and Lonny Crumley is the project contact.

Project Data

Figures 4-15 and 4-16 show the trends through time of the impact data minus the control data for each year for juvenile fish density, and coho and Chinook spawner and redd density. Table 4-9 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Dekay Road Fish Barrier Project.

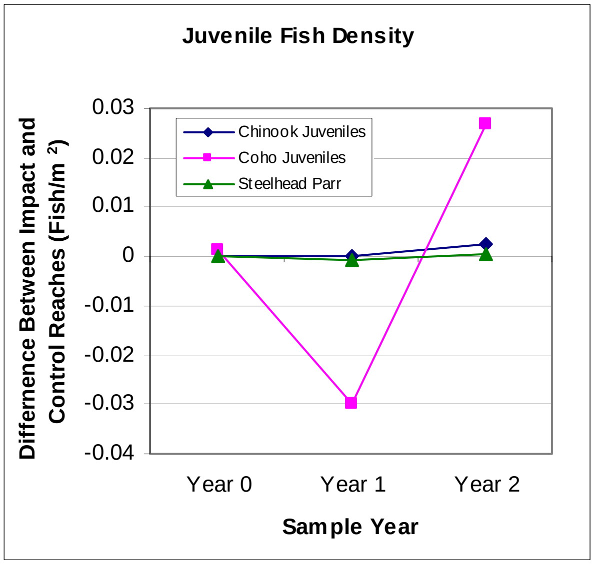


Figure 4-15. Juvenile Fish Density in Polson Creek

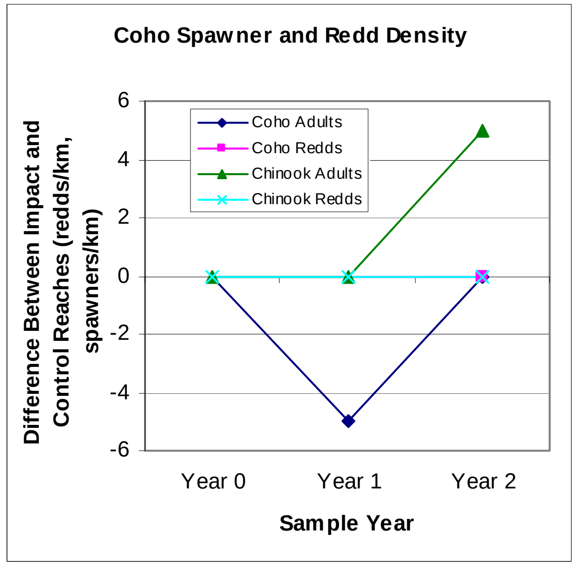


Figure 4-16. Spawner and Redd Density in Polson Creek

Table 4-9. Summary Statistics for Pre- and Post-Installation (Year 0, Year 1, and Year 2) Monitoring

	Year 0 (2005)		Year 1 (2006)		Year 2 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Fish Data						
Chinook Juveniles (fish/m^2)	0	0	0	0	0.0025	0.0050
Coho Juveniles (fish/m^2)	0.0100	0.0112	0.0533	0.0236	0.0050	0.0318
Steelhead Parr (fish/m^2)	0	0	0.0013	0.0007	0.0025	0.0030
Coho Adults (fish/km)	0	0	5	0	0	0
Coho Redds (redds/km)	0	0	0	0	0	0
Chinook Adults (fish/km)	0	0	0	0	0	5
Chinook Redds (redds/km)	0	0	0	0	0	0
Data collected May 15, 2005 and fall 2005 (Year 0); August 29, 2006 and fall 2006 (Year 1); and May 7, 2007 and fall 2007 (Year 2).						

The new culvert was inspected to determine compliance with both the design specifications and MC-1 protocol. The following parameters were measured: culvert length, culvert span, material thickness, proportion of the culvert buried, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Data collected at the Dekay Road Fish Passage Project indicate generally increasing densities for Chinook, coho, and steelhead parrs by Year 2. For all three species, densities in the impact reach are higher than the control reach in Year 2. Spawning use has been limited in all three years at the site with a few Chinook observed in the impact reach in Year 2. The culvert remains functional after two years of high flows. Monitoring was not conducted at Dekay Road in 2008 and Year 5 monitoring is planned for 2010.

05-1498 Curl Lake Intake Fish Barrier Removal Project

The Curl Lake Intake Project included the removal of a partial barrier for fish passage on the Tucannon River in SE Washington and incorporated LWD in and around the pool below the existing weir. The project design was to install a sloped channel with a pool above the existing weir, lower the weir by one foot, and construct a riffle crest/roughened channel downstream from the weir-pool. The constructed riffle downstream of the weir-pool raised the water level in the pool. The project was designed to benefit steelhead, Chinook, and bull trout.

Curl Lake Intake Structure before barrier removal (2006)

Curl Lake Intake Structure after barrier removal (2008).

Project Location

The Curl Lake Intake Project is located in the Tucannon subbasin (WRIA 35), in Columbia County. The project was constructed on the Tucannon River, a tributary to the Snake River, within the Wooten State Wildlife Area. The impact site is located just upstream from the intake structure and the control site is located just downstream, both on lands owned by WDFW.

Project Objective

The objective of this project was to increase access to areas where passage was impeded by a weir structure, thus connecting isolated freshwater in-stream habitat to increase the range and distribution of salmon. WDFW sponsored this project and Steve Rodgers serves as the primary contact person.

Project Data

Figures 4-17 and 4-18 show the trends through time of the impact data minus the control data for each year for juvenile fish density and Chinook spawner and redd density. Table 4-10 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Curl Lake Project.

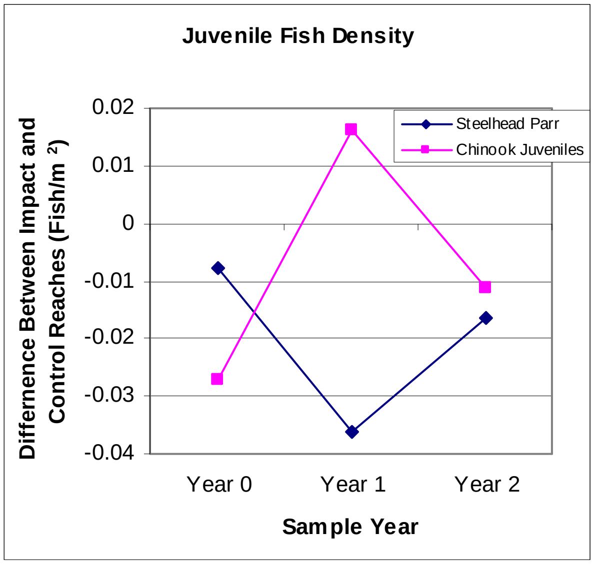


Figure 4-17. Juvenile Fish Density in the Tucannon River

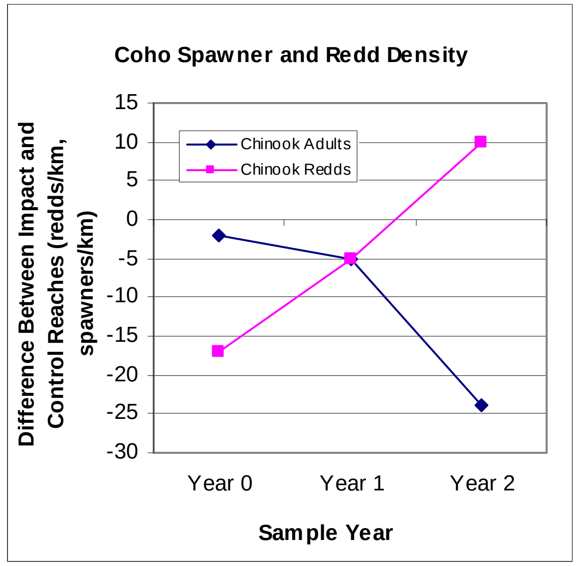


Figure 4-18. Spawner and Redd Density in the Tucannon River

Table 4-10. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)		Year 2 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Fish Data						
Steelhead Parr (fish/m^2)	0.0408	0.0329	0.1004	0.0643	0.0659	0.0496
Chinook Juveniles (fish/m^2)	0.0514	0.0244	0.0349	0.0510	0.0231	0.0120
Chinook Adults (fish/km)	2	0	10	5	62	38
Chinook Redds (redds/km)	17	0	5	0	14	24
Data collected July 14, 2006 through November 11, 2006 (Year 0); August 18, 2007 through October 29, 2007 (Year 1); and August 19 through October 30, 2008 (Year 2).						

The new structure was inspected to determine compliance with both the design specifications and protocols. The following parameters were measured: water velocity, gradient, structure length, maximum water depth, and hydraulic drop. All attributes measured were found to be in compliance.

Summary

Data collected at the Curl Lake Intake Project indicate a mixed response for juvenile and spawner densities in the first few years after construction. Juvenile Chinook densities increased in the impact reach as compared to the control reach after construction in Year 1, but then decreased in Year 2. Steelhead parr decreased relative to a control reach in Year 1, but then increased in Year 2. Chinook adults increased substantially in Year 2 in both the control and impact reaches, although the rate of increase was greater in the control than in the impact reach, so, by comparison, the impact reach did not perform as well as the control. Chinook redds were observed in the impact reach in Year 2, while none where observed in the impact reach in previous years. Due to variability in fish response, multiple years of data are needed to clarify trends caused by project effects.

4.1.2 In-Stream Habitat Projects

4.1.2.1 Protocol Description

In-Stream Habitat

The 2008 monitoring included 7 In-stream Habitat Projects out of 11 active projects. Effectiveness monitoring of In-stream Habitat Projects includes quantifying and measuring in-stream structures, juvenile salmonid abundance, and stream morphology. In-stream Habitat Project monitoring requires a BACI sample design where the impact reach includes the in-stream structures, and the control reach is a representative reach generally located upstream of the in-stream structures.

Figure 4-19 shows the locations of all of the In-Stream Habitat Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects included in the program.

Quantifying In-stream Structures

Crawford (2008b) provides a three-step procedure for quantifying in-stream structures after implementation in Year 1. After implementation, the number of pieces placed is inventoried and their location recorded using a GPS unit. If all of the pieces remain in place, the effectiveness rating is 100 percent. A project will be rated effective if at least 80 percent of structures remain in place over 10 years. Quantification of in-stream structures will be conducted periodically following implementation. The number of structures remaining can be compared with flow levels experienced by the project to determine structure stability.

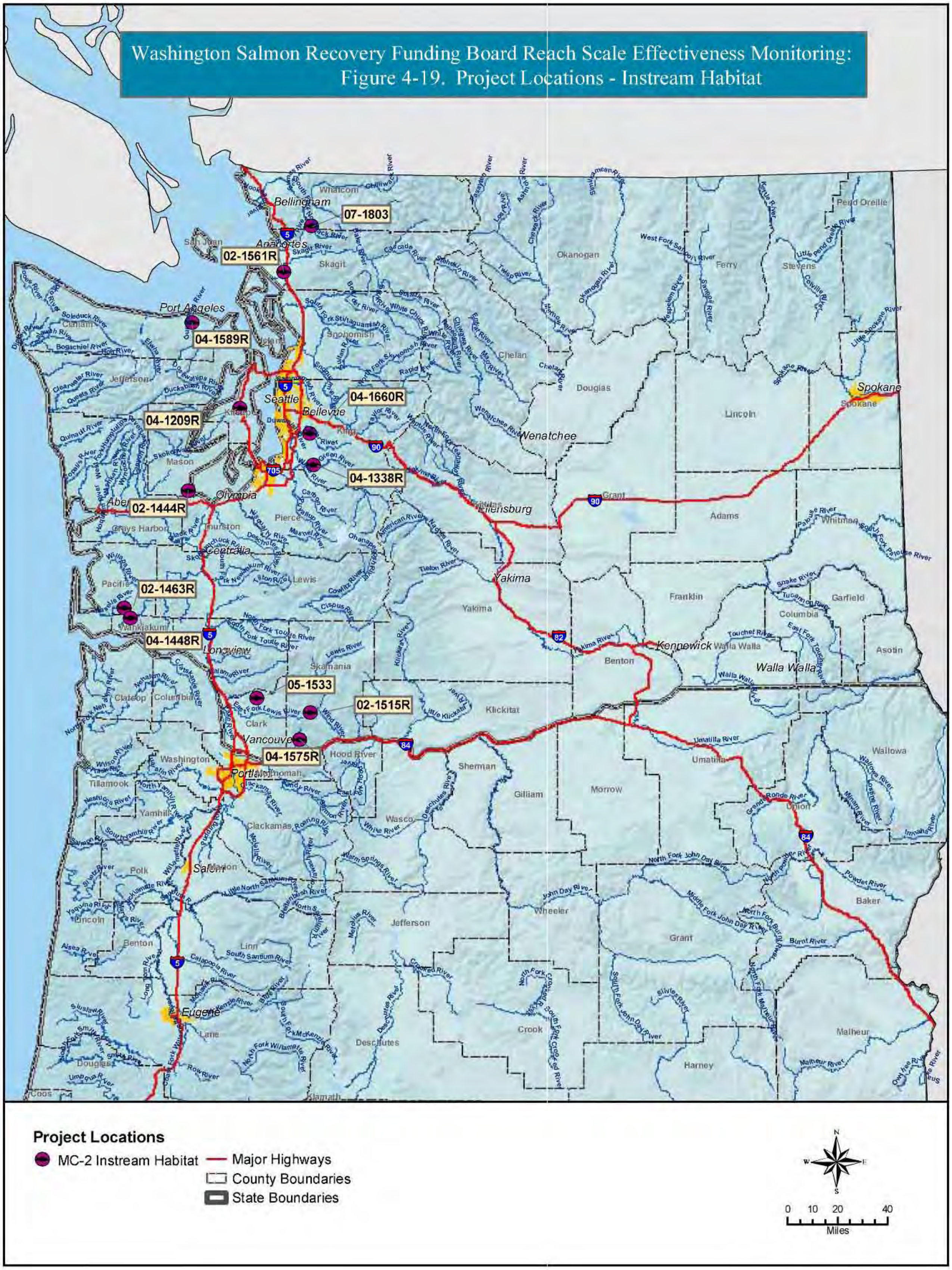
Juvenile Salmonid Abundance

Juvenile salmon abundance was assessed using the same general procedures identified in Section 4.1.1.1. However, when a stream is too turbid for snorkeling, electrofishing may be used for the juvenile survey. Electrofishing is conducted with the removal method (Crawford 2004b [revised 2008]), using up to three passes with block nets in place. After each pass, fish are identified by species, and their length is measured. Following electrofishing, all fish are returned to the study reach after identification and enumeration. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in juvenile salmonid densities in the impact reaches by Year 10 and if *t*-test results are statistically significant.

Stream Morphology

Crawford (2008b) was used to measure changes in stream morphology associated with habitat restoration projects using a thalweg profile. The profile consisted of a longitudinal survey of depth, habitat class, fine sediment deposits, slope, and off-channel habitat at equally spaced intervals along the sample reach. Wetted width and substrate were measured at 21 transects consisting of the 11 lettered transects (A through K) and the midpoint station between each lettered transect.

MC-2 In-Stream Habitat



If a significant side channel was present, transects for the side channel were measured as well. For the substrate assessment, substrate particles were classified into the appropriate size classes by measuring the intermediate axis of the particle from five stations across the channel at each transect. In-Stream Structure Projects will be considered effective if there is a 20 percent increase in mean residual vertical profile area and mean residual depth after 10 years. Mean residual vertical profile area (Mean Residual Pool Vertical Profile Area, Table 4-2) and mean residual depth (Mean Residual Depth, Table 4-2) are measures of the amount of pool refuge and the level of pool quality provided for fish within the sample reach. Data analysis methods are discussed further in Chapter 5.0. Stream morphology, substrate, LWD, residual depth, riparian vegetation, and shading were monitored during the low-flow period. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in mean residual vertical pool profile area and mean residual depth in the impact reaches by Year 10 and if *t*-test results are statistically significant.

Substrate

Crawford (2008b) was used to measure the change in the percentage of fines and embeddedness in control and impact reaches. Substrate was assessed during the summer low-flow period when turbidity and visibility were optimum for making observations. For the 21 transects established in the thalweg profile, substrate size class was estimated for 105 particles at five equally spaced points across each transect.

Large Woody Debris

Crawford (2008b) was used to measure LWD. Pieces of LWD were counted by size class during summer low flow at the same time as other in-stream measurements. Details on size classes can be found in Crawford (2004b [revised 2008]). Only pieces greater than 10 centimeters (cm) in diameter at the small end and more than 1.5 meters in length were included in the tally. Counts for pieces within bankfull channel and those that bridged the bankfull channel were kept separate. However, data are reported as the log of the volume of wood counted in both the channel and the bankfull cross-section. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in Log_{10} of the volume of LWD in the impact reaches by Year 10 and if *t*-test results are statistically significant.

Slope Measurements

Crawford (2008b) identifies the method for measuring the water surface slope and the direction of flow that are used to calculate residual pool depth. A hand level was used to measure slope because it was found to be reliable in brush and inclement weather. The upstream team member, standing at water level, sighted on a stadia rod held by the downstream team member at water level and recorded the height at which the bubble was level between each of the 21 transects identified in the reach layout and used in the thalweg profile. The difference in the height recorded as seen through the level and the eye-level height of the observer was the "rise," and the distance between the team members was the "run" in calculating the water surface slope. The upstream team member also sighted back to the rod with a bearing compass and recorded the bearing of the stream flow in the downstream direction. If the team members could not see each other between transects, intermediate slope readings were taken. The distance over which each slope reading was taken was recorded and a weighted average slope calculated.

4.1.2.2 Results/Data Summaries/Decision Criteria

Table 4-11 shows the summary statistics reported for Artificially Placed In-Stream Structure (AIS) Projects. The location and number of in-stream structures will be recorded when the structures have been placed in Year 1.

4.1.2.3 Project-Specific Summaries

Projects that involve the placement of In-Stream Structures are monitored prior to implementation of the project (Year 0) and for a period of ten years following implementation. Post-project monitoring is conducted at the control site and impact site during Years 1, 3, 5, and 10. Summary statistics for In-Stream Structure Projects are presented below. Projects have one year of baseline data, or one year of baseline and one or two years of post-project data depending on the status of implementation.

Table 4-11. Decision Criteria and Statistical Test Type for Artificially Placed In-Stream Habitat Projects

Monitoring Parameter	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Structure	Measure of the number of in-stream structures within the study reach	#	None. Count of intact structures	Greater than or equal to 80% of projects are intact by Year 10. Intact means that 50% of material of each AIS present is in place within the impact reach.
Stream Morphology	Mean residual pool vertical profile area	m^2/reach	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10.
	Mean residual pool area	m^2/100 m	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Log_{10} Volume of LWD	Log_{10} (m^3/100 m)	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
Juvenile Fish Abundance	Chinook salmon juvenile abundance	#/m^2	BACI paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Coho salmon juvenile abundance	#/m^2	BACI paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Steelhead parr abundance	#/m^2	BACI paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10

Source: Crawford 2008b

02-1444 Little Skookum Valley Creek, Phase II Riparian

The Little Skookum Valley Creek Salmon Enhancement Project was designed to improve stream habitat on Skookum Valley Creek for salmonids and other resident species. SPSSEG and partners have implemented LWD placement, construction of riparian fencing, and installation of riparian plantings as part of the project.

Prior to the implementation of the project, a 300-meter section of the creek was degraded due to lack of riparian cover, LWD, and excessive invasive plants. The source of future LWD recruitment has been dramatically reduced due to past human activities. In-stream salmon habitat complexity is important for salmonids that rear in local creeks, including coho, steelhead, and cutthroat, who need diverse stream habitat to reach their optimal production.

The Skookum Creek watershed is targeted by WRIA 14 Lead Entity to develop future salmon projects. In conjunction with several other salmon restoration projects that have recently been completed in the Skookum Creek watershed by WDFW and Squaxin Island Tribe, this project has improved salmonid habitat conditions. This is consistent with the WRIA 14 Salmon Habitat Committee’s desire to utilize a watershed-based habitat approach for salmon recovery.

Skookum Valley Creek in 2004 (Year 0)

LWD placed in Skookum Valley Creek in 2008 (Year 3)

Project Location

This project is located on Skookum Valley Creek in Mason County and is sponsored by the Mason Conservation District and the SPSSEG. Skookum Valley Creek is a tributary to Skookum Creek at river mile 5. Both the impact and control reaches are located on private property, with the control reach located just upstream of the impact reach. The land owner at the project site is Rich Hirschberg and the project contact is Lance Wineka of the SPSSEG.

Project Objective

Due to past human activities, the stream lacks LWD and the riparian area along this section of creek lacks riparian cover. There is also excessive invasive plant cover (reed canary grass) along the banks. This project aimed to improve stream habitat for salmonids and other species by installing LWD, riparian fencing, and riparian plantings. As part of this project, seven pieces of LWD were installed in the creek. The target species for this project is coho salmon.

Project Data

Figures 4-20 and 4-21 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-12 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Little Skookum Valley Project.

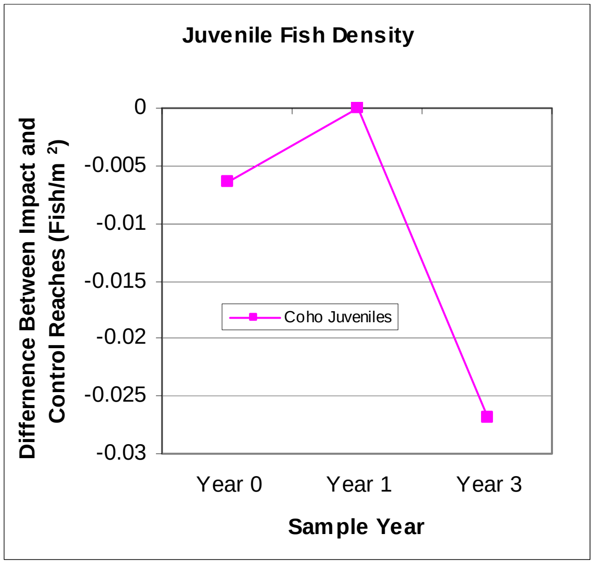


Figure 4-20. Juvenile Fish Density in Little Skookum Creek

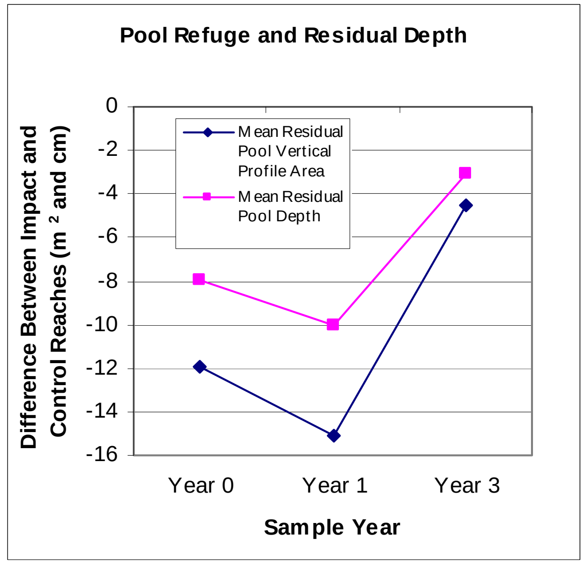


Figure 4-21. Pool Refuge and Residual Depth in Little Skookum Creek

Table 4-12. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2006)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	19.52	7.63	27.27	12.18	20.56	16.02
Mean Residual Pool Depth (cm)	13.01	5.08	18.18	8.12	13.71	10.68
Log10 of Volume of LWD (m^3)	-1.38	0	-1.16	0.24	-1.38	0.16
Fish Data						
Coho Juveniles (fish/m^2)	0.0485	0.0420	0	0	0.0268	0
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	7	N/A	6
Data collected June 30, 2004 (Year 0); August 21 - 22, 2006 (Year 1); and June 26 - 27, 2008 (Year 3).						

Summary

Implementation of this project was delayed in 2005, but was achieved in 2006. Post-implementation monitoring was conducted in 2006 and 2008. In 2008, the mean residual pool area and mean residual depth increased from the Year 1 survey in 2006. The number of AIS remaining in the impact reach decreased by one piece from seven pieces to six (85 percent remaining), thus resulting in a decrease in Log_{10} volume of LWD. During the Year 3 survey, no salmonids were identified in the impact reach; however, coho were found in the control reach. This is an increase over the number of salmonids found in the 2006 survey, but a decrease from 2004.

MC-2 In-Stream Habitat

02-1463 Salmon Creek Restoration Project

In the Pacific County Salmon Recovery Strategic Plan, Salmon Creek was noted as having low amounts of LWD and approximately 6,500 feet of creek were identified as lacking channel structure and sinuosity. An existing roadbed was located between the stream and an adjacent wetland, thus disconnecting the wetland from the stream channel. As a result, Salmon Creek was channelized over a distance of approximately 1,000 feet. In addition, the presence of the road caused confinement of the channel migration zone, which straightened the channel and increased scour over approximately 1,500 feet. The Salmon Creek Restoration Project included re-grading the channel migration zone to reconnect off-channel habitat and the placement of LWD within the stream, benefiting approximately 5,000 feet of stream. Road decommissioning activities were also conducted; however, those activities were not included as part of the SRFB-funded project.

Impact reach at Transect A in 2004 (Year 0)

Impact reach at Transect A in 2007 (Year 3)

Project Location

The Salmon Creek Project site is located on private land managed by The Campbell Group and on state lands managed by the Washington Department of Natural Resources (WDNR) in Pacific County, Washington. The project will occur within WRIA 24, in the Naselle River Basin. The sampling reaches are located on Salmon Creek within Township 11N Range 8W Southeast corner of Section 23 (Impact Reach) and Section 13 (Control Reach).

Project Objective

The Willapa Bay Fisheries Enhancement Group sponsored this project in conjunction with project partners, Campbell Group, WDNR, and Turnersville Horse Group, with the common goal of improving salmonid spawning and rearing habitat within Salmon Creek. The objective of this project was the placement of LWD throughout approximately 5,000 linear feet of Salmon Creek and other improvements to habitat for cutthroat trout, steelhead, coho salmon, Chinook salmon, and chum salmon. The contact person for this project is Ron Craig.

Project Data

Figures 4-22 and 4-23 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-13 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Salmon Creek Habitat Project.

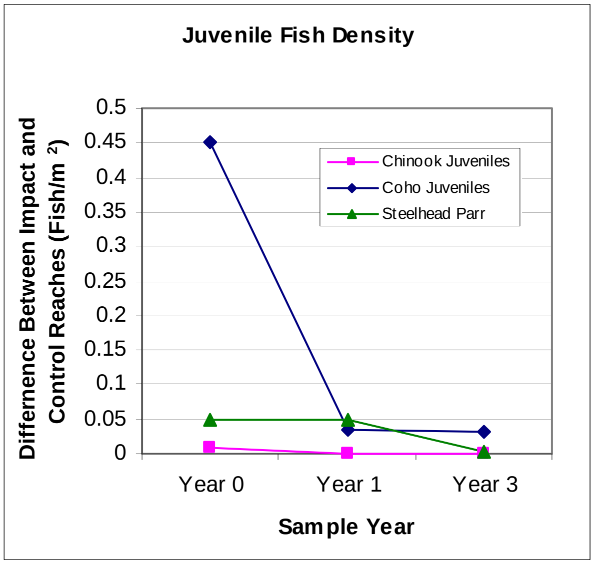


Figure 4-22. Juvenile Fish Density in Salmon Creek

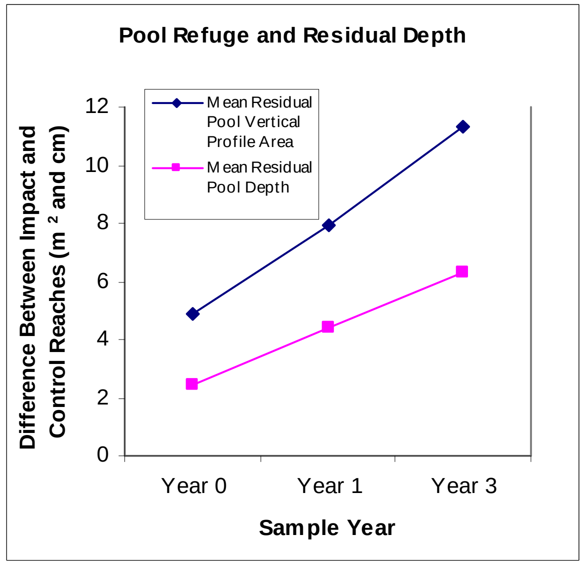


Figure 4-23. Pool Refuge and Residual Depth in Salmon Creek

Table 4-13. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	12.40	17.28	9.96	17.89	11.72	23.04
Mean Residual Pool Depth (cm)	7.18	9.60	5.56	9.99	6.51	12.80
Log10 of Volume of LWD (m^3)	1.13	0.41	1.03	1.40	1.16	1.28
Fish Data						
Chinook Juveniles (fish/m^2)	0	0.0096	0	0	0	0
Coho Juveniles (fish/m^2)	0.1793	0.6310	0.0825	0.1169	0.2737	0.3055
Steelhead Parr (fish/m^2)	0.0203	0.0684	0.0126	0.0622	0.0074	0.0112
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	13	N/A	12
Data collected from June 8-10, 2004 (Year 0); August 4-5, 2005 (Year 1); and May 21 - 24, 2007 (Year 3).						

Summary

One of 13 artificial structures was found to have dislodged and migrated downstream out of the impact reach. This was the only AIS that was not securely anchored. A second structure was initially noted as having migrated approximately 7 meters based upon GPS coordinates recorded in 2005 (Year 1) compared with those recorded again in 2007 (Year 3). However, this structure had been securely anchored into bedrock in Year 1 and the anchoring system was found to be still in place in Year 3, suggesting that precision variance in the GPS system and not actual movement of the AIS was responsible for the difference. Data collected at the Salmon Creek project site indicate structures are continuing to increase pool depth above baseline conditions in comparison to a control reach. Increases in localized fish abundance were observed for juvenile coho in both control and impact reaches in Year 3, so these changes may be tied to changes in environmental factors (see Table 4-13). Slight decreases in the density of steelhead parr were also noted in both reaches in Year 3. The level of environmental variation at this site may create a need for more monitoring events in order to detect significant change in juvenile fish densities. Monitoring was not conducted at Salmon Creek in 2008 and Year 5 data will be collected in 2009.

02-1515 Trout Creek Artificial In-Stream Structures

Trout Creek is a major tributary to the Wind River and is vital for the recovery of steelhead within the basin due to the quantity of spawning and rearing habitat it contains. The Trout Creek watershed has historically supported approximately 20 percent of the entire Wind River's run of wild steelhead. Upper Trout Creek and tributaries were logged in 1948, and in the 1970s, logjams were thought to be migration barriers and were removed eliminating natural water velocity modification and sediment storage and instigated channel incision. The cumulative effects are seen in little shade to the stream causing elevated water temperatures, bankfull channel width to depth ratios that are inappropriate, a high percentage of bank erosion, and low numbers of large woody debris in the stream. The Upper Trout Creek Rehabilitation Project is intended to improve habitat for wild steelhead by restoring riparian areas and channel stability in the Trout Creek drainage. Chinook salmon and cutthroat trout may benefit from this project as well.

Impact reach at Transect A looking upstream (2004)

Impact reach at Transect A looking upstream (2006)

Project Location

This project area is located in Skamania County within the Wind River Basin (WRIA 29) in the Trout Creek drainage. The sampling reaches are located on Crater Creek (tributary to Trout Creek) within Township 4N Range 6E Section 11 (Impact Reach) and Section 3 (Control Reach). The control reach is located approximately 1.4 miles upstream from the impact reach.

Project Objective

The objectives of this project are to restore riparian vegetation along Upper Trout Creek to eight trees/acre (> 31-inches diameter over 200 year growth period), thus increasing shade to the creek and increase bank stability. Additionally, the project is intended to reduce bankfull width to depth ratios and increase LWD within the creek. The Underwood Conservation District sponsors this project and the USFS is the land owner. Brian Bair and Bengt Coffin are the primary contacts.

MC-2 In-Stream Habitat

Project Data

Table 4-14 summarizes the data collected during Year 0 and Year 0* monitoring of the Trout Creek Project.

Table 4-14. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 0*) Monitoring

Variable	Year 0 (2004)		Year 0* (2006)	
	Control	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Mean Residual Pool Vertical Profile Area (m^2/reach)	15.58	19.25	8.05	21.18
Mean Residual Pool Depth (cm)	10.38	12.83	5.37	14.12
Log_{10} (Volume of LWD) (m^3/100m)	1.69	1.69	1.58	1.68
Fish Data				
Steelhead Parr (fish/m^2)	0	0.0047	0.0129	0.0066
In-Stream Structures				
AIS Present (#)	N/A	N/A	N/A	N/A

Data collected July 13–14, 2004 (Year 0) and August 17–19, 2006 (Year 0*).
* Year 0* indicates second year baseline data.

Summary

Project implementation was delayed and a second “baseline” survey was conducted in 2006. Stream flows were much lower in 2006 than in 2004, as evidenced by the photos above. Monitoring was not conducted in 2007 or 2008 because the project has not yet been implemented. Year 1 monitoring is scheduled for 2009.

02-1561 Edgewater Park Off-Channel Restoration

The Edgewater Park site is located on the west side of the Skagit River within the river's floodplain. From Sedro Woolley, downstream for over 22 miles, the natural processes of the river have been restrained between levees. At the park, the levee has been set back from the river. Historically, the south end of the park had been bisected by several off-channel sloughs. Over time, these sloughs have been partially filled at their north end. The remaining slough areas (34 acres) act as a refuge for wildlife and offer protection and shelter to salmon at various life stages during times of high water. A deposition bar at the south end makes passage out of the sloughs difficult as the river recedes, causing stranding. The Edgewater Park Off-Channel Restoration project involved the construction of the off-channel sloughs and reconnection of isolated habitat to the river, thus reestablishing a functioning off-channel slough system, which is a rare resource in the lower Skagit River.

Upstream end of predicted paleo-channel in 2004 (Year 0)

LWD placed in constructed channel (2005)

Project Location

This project is located on the Skagit River (WRIA 3), at Edgewater Park, in the City of Mount Vernon, Skagit County. The project site is located in the south end of the park on lands owned by the City of Mount Vernon Park and Recreation Department. The control reach is downstream in Cottonwood Island Public Fishing Access Area, on lands owned by the WDFW.

Project Objective

The objective of this project was to construct approximately 34 acres of restored off-channel sloughs and reconnect isolated habitat to the Skagit River. This off-channel habitat adds to the natural river functions and increases the ability of the area to provide key protection and shelter habitat to all salmon species at various life stages. LWD was added to support bank stability and add to habitat diversity. The target species for this project is Chinook salmon. The City of Mount Vernon sponsors this project and Larry Otos and Curt Miller are the primary contacts.

Project Data

During the Year 0 survey, measurements for the impact reach were taken in a dry channel, approximating the planned channel location and width. Fish surveys were not possible due to dry channels in both control and impact reaches.

In Year 1, reach lengths were re-calculated based on the newly constructed channel length in the impact reach. The location of constructed channel was slightly different than the location of the impact reach that was surveyed in Year 0. Surveys were conducted in winter to ensure that water was present in the impact reach; however, the control reach remained dry.

In 2007 (Year 3), multiple attempts were made to survey the impact reach while there was water present in the channel; however, flows rarely reached levels sufficient to inundate the channel and it usually only occurred for a brief period following large storm events. As a result, the Year 3 survey was conducted when the channel was mostly dry and no fish data could be obtained.

Figures 4-24 and 4-25 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-15 summarizes the data collected during Year 0 and Year 3 monitoring of the Edgewater Park Project.

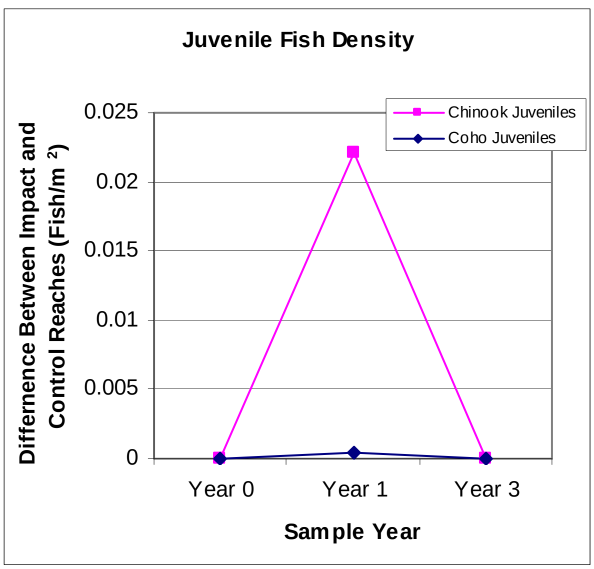


Figure 4-24. Juvenile Fish Density in the Skagit River

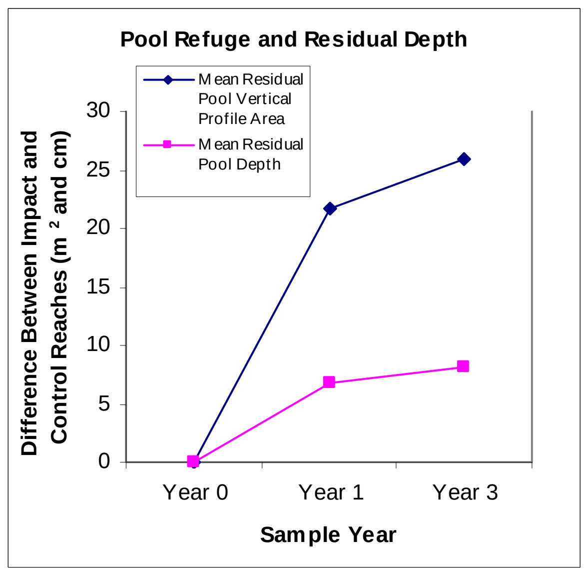


Figure 4-25. Pool Refuge and Residual Depth in the Skagit River

Table 4-15. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	0	0	0	21.72	0	25.92
Mean Residual Pool Depth (cm)	0	0	0	6.83	0	8.15
Log_{10} of Volume of LWD (m^3)	0.96	0.74	0.79	1.58	0.62	1.13
Fish Data						
Chinook Juveniles (fish/m^2)	0	0	0	0.0221	0	0
Coho Juveniles (fish/m^2)	0	0	0	0.0004	0	0
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	208	N/A	179
Data collected on July 29, 2004 (Year 0); November 11 and 15, 2005 (Year 1); and January 30, 2008 (Year 3)						

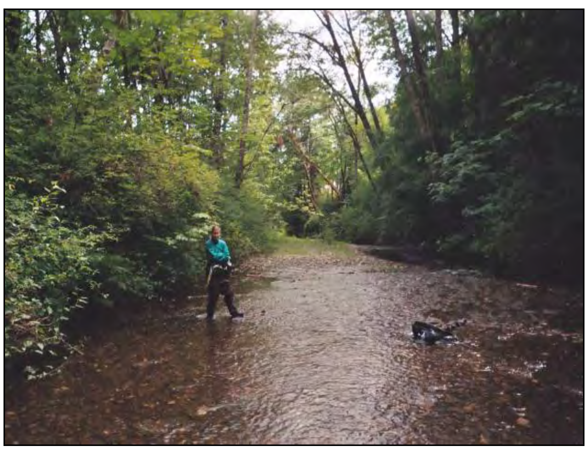
Summary

Data collected at the Edgewater Park Project indicate that the connection of the side channel to the Skagit River is being affected by deposition in the of-channel habitat area, which reduces the opportunity for juvenile salmonids to utilize the habitat. Although small increases were noted in geomorphic variables, the water level required for connection was higher in 2007 than in previous years. LWD placed at the site remained generally stable (86 percent were re-located). However, due to low water levels, no fish were observed at the site. Adjustment of the channel conditions may be necessary to ensure that the channel is accessible to fish. Monitoring was not conducted at Edgewater in 2008 and Year 5 data will be collected in 2009.

04-1209 Chico Creek In-Stream Habitat Restoration

Chico Creek, which flows to Dyes Inlet in Kitsap County, supports one of the largest runs of fall chum salmon (30,000-80,000 fish/year) in the south Puget Sound, as well as coho, steelhead, cutthroat trout and occasional stray Chinook salmon. The stream channel within the impact reach has been channelized and disconnected from its historic floodplain. Large woody debris and riparian vegetation within the project reach are severely limited by adjacent land use. A set of concrete box culverts exists beneath Golf Course Hill Road. The culverts created a fish passage issue, which was addressed by the placement of a series of log weirs. These weirs provided adequate passage, but were spaced too closely together, creating a mechanism for the structure to be undermined or washed out. They have also promoted the development of overly wide and shallow channel morphology. The weirs are located in a reach that historically was quality salmon spawning habitat.

This restoration project will include the removal of the log weirs and will establish a more natural stream gradient, meander pattern and floodplain dimension. The riparian zone will be enhanced with native conifer tree species and shrub vegetation. Large woody debris will be placed within the channel to provide in-stream habitat, maintain the meander and stabilize bed material. This project will restore productive spawning habitat, provide high flow refuge and facilitate upstream migration to the other 16 miles of habitat in the upper watershed.


Control reach at Transect K (2006)


Impact reach at Transect F (2006)

Project Location

This project is located in Kitsap County on Chico Creek, a tributary to Dyes Inlet. The project will take place from RM 0.5 to 0.8 on property owned by Kitsap Golf and Country Club. The Kitsap Golf and Country Club is an active partner in the project. The upstream end of the impact reach is located at the box culverts. The downstream end lies at the second footbridge downstream, at the edge of the golf course. The control reach begins upstream of the culvert and ends just downstream of the bridge.

MC-2 In-Stream Habitat

Project Objective

This project will add LWD to the channel to increase the habitat complexity and improve gravel retention and recruitment for salmon spawning. Other objectives include maintaining the channel meander sequence and providing rearing habitat for juvenile fish and cover for adults. The target species for this project is chum salmon. This project is sponsored by Kitsap County and Kathleen Peters is the primary contact.

Project Data

Table 4-16 summarizes the data collected during Year 0 and Year 0* monitoring of the Chico Creek Project.

Table 4-16. Summary Statistics for Pre-Implementation (Year 0 and Year 0*) Monitoring

	Year 0 (2005)		Year 0* (2006)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Mean Residual Pool Vertical Profile Area (m^2/reach)	24.47	16.75	35.78	22.02
Mean Residual Pool Depth (cm)	9.79	6.70	14.31	8.81
Log_{10} (Volume of LWD) (m^3/100m)	0.55	0	0.50	0.16
Fish Data				
Chinook Juvenile (fish/m^2)	0	0	0	0
Coho Juvenile (fish/m^2)	0.1263	0.0724	0.0943	0.0342
Steelhead Parr (fish/m^2)	0.4136	0.1558	0	0.0007
In-Stream Structures				
AIS Present (#)	N/A	N/A	N/A	N/A
Data collected June 21, 2005 (Year 0) and July 29, 2006 (Year 0*). * Year 0* indicates second year baseline data.				

Summary

Implementation at Chico Creek has been delayed due to a number of factors. In December 2007, flooding of the project area resulted in the need for re-design of the project and additional funds for implementation. The LWD component of this project is currently planned for implementation in 2009 and monitoring will be conducted once the project is complete.

04-1338 Lower Newaukum Restoration

The Lower Newaukum Restoration Project focused on restoring fluvial processes and habitat functions throughout the stream and floodplain in the lower 800 feet of Newaukum Creek. This included the installation of four channel-spanning log jams in the creek and grading within the right and left bank floodplain to enhance connectivity and function of approximately 12 acres of floodplain habitat adjacent to Newaukum Creek and the Green River. King County sponsors this project and believes that it will provide great benefits in terms of restoring fluvial processes and aquatic habitat.

Transect A in the control reach in 2008 (Year 0)

Transect A in the impact reach in 2008 (Year 0)

Project Location

This project is located in King County on Newaukum Creek. The land is owned by King County, but is accessed through a residential neighborhood. Local residents are supportive of the project.

Project Objective

Chinook salmon, which are the target species for this project, spawn in Newaukum Creek in large numbers. This project aims to restore in-stream roughness and hydraulic complexity and enhance the channel's connection with its floodplain in the lower portions of Newaukum Creek, thereby restoring dynamic, habitat-forming processes within the project reach. This will be accomplished by: 1) restoring a historic meander; 2) setting back a berm and naturalizing the restored floodplain area; 3) placing several engineered LWD jams in the channel and floodplain to provide cover, spawning, and resting areas; and 4) planting the riparian buffer with appropriate native plants. The project is sponsored by King County Department of Natural Resources and Parks and Dan Eastman is the primary contact.

Project Data

Figures 4-26 and 4-27 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-17 summarizes the data collected during Year 0 and Year 1 monitoring of the Lower Newaukum Creek Restoration Project.

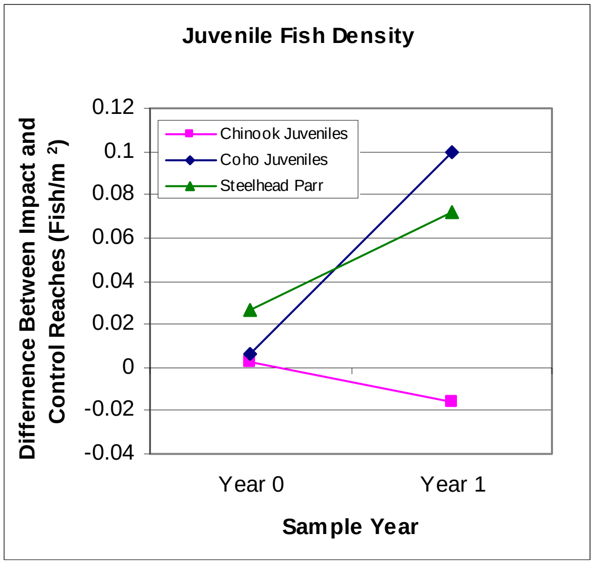


Figure 4-26. Juvenile Fish Density in Newaukum Creek

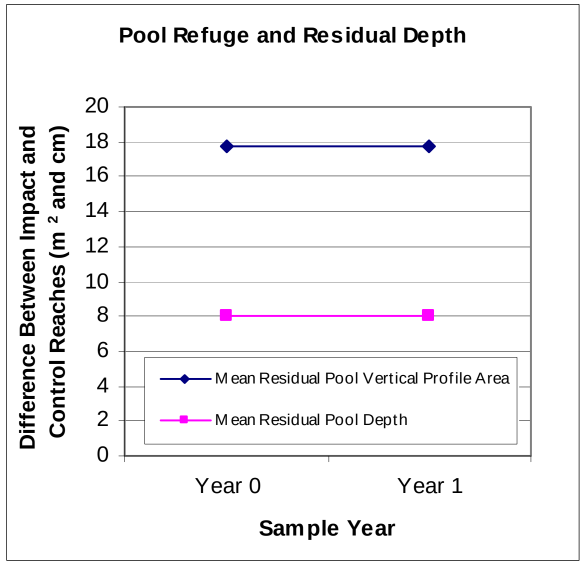


Figure 4-27. Pool Refuge and Residual Depth in Newaukum Creek

Table 4-17. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2008)		Year 1 (2008)	
	Control	Impact	Control	Impact
Mean Residual Pool Vertical Profile Area (m^2/reach)	7.29	25.01	7.12	24.86
Mean Residual Pool Depth (cm)	3.31	11.37	3.24	11.30
Log (Volume of LWD) (m^3/100m)	0.99	0.63	0.74	1.75
Fish Data				
Chinook Juvenile (fish/m^2)	0.0038	0.0064	0.0156	0
Coho Juvenile (fish/m^2)	0.0028	0.0094	0.0109	0.1103
Steelhead Parr (fish/m^2)	0.0038	0.0307	0.0891	0.1610
In-Stream Structures				
AIS Present (#)	N/A	N/A	N/A	43
Data collected on May 14-15, 2008 (Year 0) and August 18-19, 2008 (Year 1)				

Summary

Two years of baseline data were collected at Newaukum Creek in 2005 and 2006. However, due to property owner issues, changes to the project's location were required. As a result, a new Year 0 survey was conducted in spring of 2008, prior to project implementation. The project was implemented during the summer of 2008 and the Year 1 survey was conducted late that summer. Distinct increases in juvenile densities for coho and steelhead were observed between Year 0 and Year 1 when control data are subtracted from impact data for each year. The values for pool refuge and residual depth did not change when the two reaches were compared.

04-1448 Grays River PUD Bar Habitat Enhancement Project

The PUD Bar Project consists of the rehabilitation of approximately 0.2 miles of the Grays River in the vicinity of RM 11.8. The project improved habitat complexity for four listed species and provided spawning opportunities by creating a series of eight (8) riffle/pool sequences where only one pool and two 500 foot long riffles previously existed. The addition of LWD in this project was designed to provide hiding refugia and channel stability. Wood was also incorporated into the proposed stone vane structures. The entire area (5 acres) has been re-vegetated with Western red cedar, red osier dogwood, willow (spp), Douglas-fir, and Western hemlock.

Control reach at Transect A in 2005 (Year 0)

Impact reach at Transect F in 2005 (Year 0)

Project Location

This project is located on the Grays River (WRIA 25) in Wahkiakum County, west of Longview Washington. The project site is located approximately 1,600 feet below the Satterlund Bridge on the Grays River. The control reach begins immediately upstream from the bridge.

Project Objective

The addition of LWD in this project provided hiding refugia and channel stability. Project objectives included the installation of one rock "W" vane, one LWD jam, and 6 J-hook vanes. Wood was also incorporated into the proposed stone vane structures. The entire area (5 acres) has been revegetated with Western red cedar, red osier dogwood, willow (spp), Douglas-fir and Western hemlock.

Project Data

Figures 4-28 and 4-29 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-18 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Grays River PUD Bar Habitat Enhancement Project.

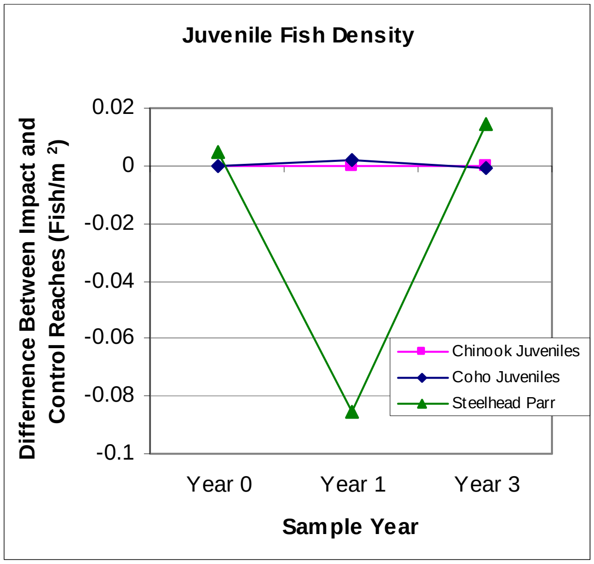


Figure 4-28. Juvenile Fish Density in Grays River

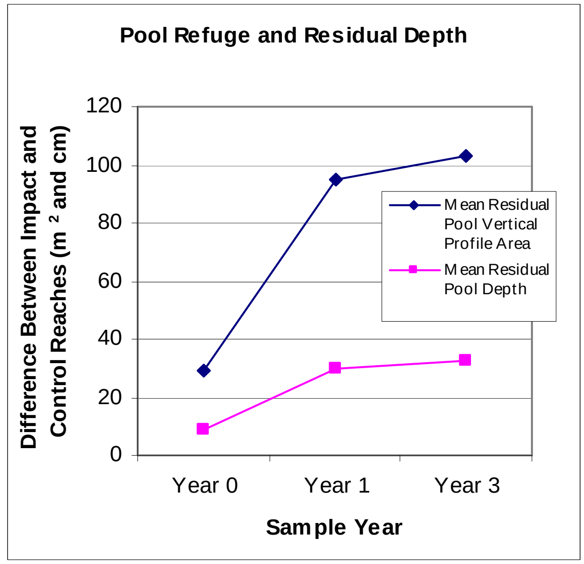


Figure 4-29. Pool Refuge and Residual Depth in Grays River

Table 4-18. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	56.22	85.20	64.89	159.86	128.09	231.45
Mean Residual Pool Depth (cm)	17.57	26.62	20.28	49.96	40.03	72.33
Log10 of Volume of LWD (m^3)	1.42	0.98	1.14	0.80	1.45	1.25
Fish Data						
Chinook Juveniles (fish/m^2)	0	0	0.0002	0	0.0001	0
Coho Juveniles (fish/m^2)	0	0	0.0073	0.0091	0.0010	0.0001
Steelhead Parr (fish/m^2)	0.0130	0.0176	0.0916	0.0061	0.0093	0.0236
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	27	N/A	24
Data collected July 18-21, 2005 (Year 0); September 18-20, 2006 (Year 1); and July 15-17, 2008, (Year 3).						

Summary

Compared to the control reach, the impact reach has shown both increased volume of LWD and pool habitat since project implementation. Twenty-seven primary log structures were placed in the impact reach in Year 1 (2006) and 24 (88 percent) were found to be still in place in Year 3 (2008). Juvenile densities for Chinook and coho decreased slightly as compared to a control response in Year 3 as compared to Year 1. The survival of these fish may be affected by the presence of Northern Pike Minnow that were noted during the snorkel survey. Northern Pike Minnow are a known predator of juvenile salmonids. However, steelhead densities, which had declined compared to a control in Year 1, increased sharply in Year 3. Increasing trends in both pool refuge and residual depth were observed in Years 1 and 3.

04-1575 Upper Washougal River LWD Placement Project

The upper Washougal River LWD Project addressed degraded floodplain conditions and functions identified by the Lead Entity and the WDFW as limiting salmon and steelhead production in the upper Washougal watershed. This project treated specific reaches of the mainstem Washougal River from RM 15 to approximately RM 22 that have become deeply incised in a bedrock channel due to log drives and catastrophic forest fires in the late 1800s and early 1900s. The project directly benefits a primary population of ESA-listed summer steelhead, as well as contributing populations of ESA-listed Chinook and winter steelhead. Other species present in the impact reach include coho salmon, resident cutthroat and rainbow trout, and mountain whitefish.


Impact reach at Transect A in 2005 (Year 0)


Impact reach at Transect A in 2008 (Year 3)

Project Location

The project is located on the Washougal River (WRIA 28) in Skamania County. The impact site is located 0.15 miles upstream from the wooden bridge and the control site can be reached from the Three Corner Rock Trailhead parking area.

Project Objective

Engineered log jams (ELJs) and log/ boulder complexes capable of withstanding peak flows were constructed to decrease channel width and increase in-stream cover, spawning and rearing areas, pool depth, and sub-surface flows to directly benefit ESA-listed summer steelhead, as well as ESA-listed Chinook and winter steelhead. Other species present in the treatment area include coho salmon, resident cutthroat and rainbow trout, and mountain whitefish. The project sponsor is the Lower Columbia River Fish Enhancement Group and Tony Meyer is the primary contact. The landowners are the WDFW, WDNR, Longview Fiber, and Skamania County.

Project Data

Figures 4-30 and 4-31 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-19 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Upper Washougal River LWD Placement Project.

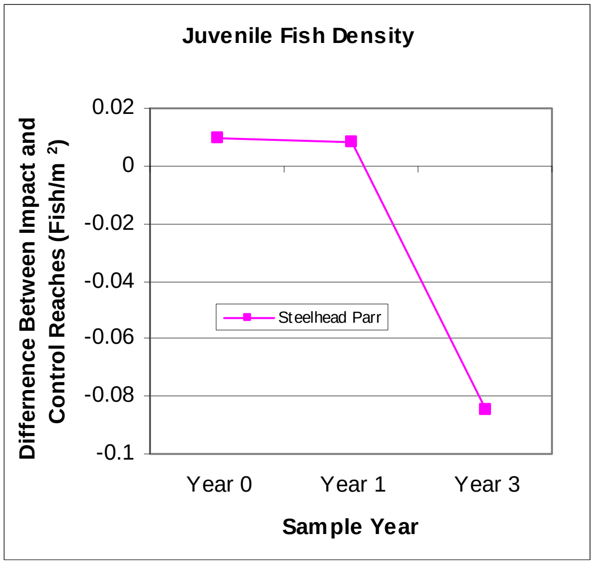


Figure 4-30. Juvenile Fish Density in the Washougal River

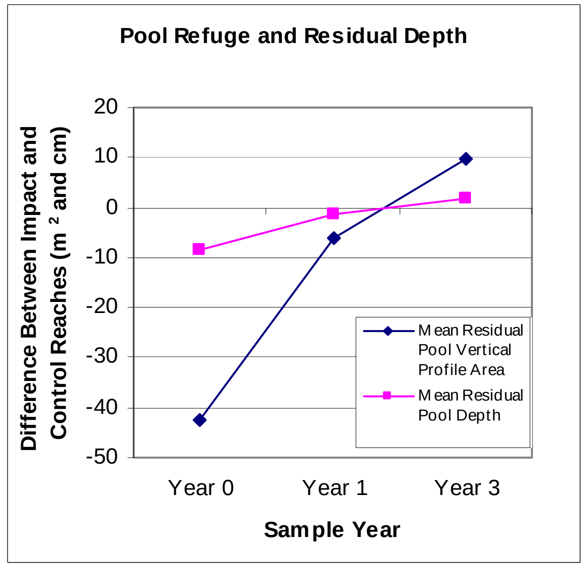


Figure 4-31. Pool Refuge and Residual Depth in the Washougal River

Table 4-19. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 3 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	124.13	81.54	112.50	106.38	87.95	97.64
Mean Residual Pool Depth (cm)	24.83	16.31	22.50	21.28	17.59	19.53
Log10 of Volume of LWD (m^3)	0.80	-0.16	0.07	1.83	0.77	1.85
Fish Data						
Steelhead Parr (fish/m^2)	0.0216	0.0315	0.0204	0.0288	0.0997	0.0148
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	6	N/A	6
Data collected June 27 - 29, 2005 (Year 0); October 3 - 5, 2006 (Year 1); and July 30 - August 1, 2008 (Year 3).						

Summary

Compared to the control reach, the impact reach has shown both increased volume of large woody debris and pool habitat since project implementation. Six primary log structures were placed in the impact reach in Year 1 (2006) and all were found to be still in place in Year 3 (2008). Sharp decreases in steelhead density were observed in Year 3 as compared to Year 1 and Year 0 once control densities were subtracted. Increases were observed in Years 1 and 3 for impact minus control values for pool refuge and residual depth.

04-1589 Dungeness River Railroad Bridge Restoration

As recently as the early 1980s, Clallam County regularly collected and burned LWD from the Dungeness River. This contributed to a loss of structural complexity and sufficiently sized LWD within the river. Since then, the habitat has started to recover, but continued to lack sufficient logjams.

The Dungeness River Railroad Bridge Restoration Project is located upstream of some of the healthiest remaining salmonid habitat in the lower Dungeness River; however, stable log jams are lacking in this reach of the river. The restoration project involved placement of 4 log jam structures to encourage the creation of pool habitat and increase the amount of suitable salmonid habitat. The project is expected to benefit approximately 2,092 meters of stream habitat.

The project reach is a very active reach with frequent channel avulsions, a wide floodplain with multiple side channels, substrate that is on average too large for spawning salmonids, and a range of riparian forest types and ages. The log jams that have been installed as part of this project are intended to create high flow refugia for salmonids and rearing pools within and upstream of each jam. In addition, the network of logjams is designed to stabilize gravel bars for riparian forest establishment and contribute to channel complexity, sinuosity, and pool frequency through time.

Salmonids observed in impact reach in Year 1 (2008)

Transect A in control reach in Year 1 (2008)

Project Location

This project is located in Clallam County, on the Dungeness River, at the end of the road in Railroad Bridge Park. The project area extends both upstream and downstream of the bridge and is located on land owned by the Severson Family. Both the impact and control reaches are approximately 500 meters in length.

MC-2 In-Stream Habitat

Project Objective

The objective of this project was to add four large log jams to increase in-stream cover, spawning habitat, and resting areas for spawners, as well as rearing habitat for juvenile salmonids. The target species for this project is Chinook salmon. Jamestown S'Klallam Tribe sponsors this projects and Byron Rot is the primary contact.

Project Data

Figures 4-32 and 4-33 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-20 summarizes the data collected during Year 0, Year 0*, and Year 1 monitoring of the Dungeness River Project.

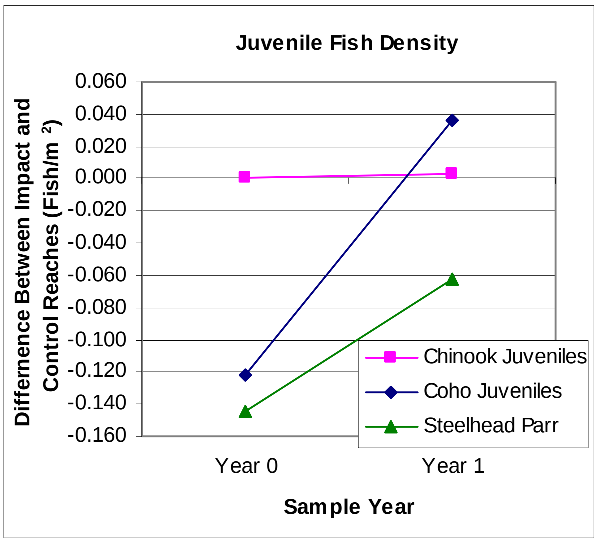


Figure 4-32. Juvenile Fish Density in the Dungeness River

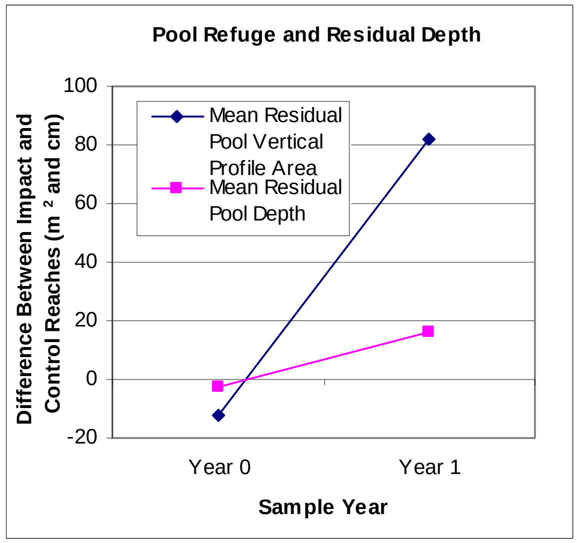


Figure 4-33. Pool Refuge and Residual Depth in the Dungeness River

Table 4-20. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 0*, and Year 1) Monitoring

Variable	Year 0 (2005)		Year 0* (2006)		Year 1 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	65.22	52.95	87.31	70.78	90.02	172.08
Mean Residual Pool Depth (cm)	13.04	10.59	17.46	14.16	18.00	34.07
Log10 of Volume of LWD (m^3)	1.14	0.96	1.45	0.96	1.03	1.81
Fish Data						
Chinook Juveniles (fish/m^2)	0.0012	0.0201	0.0066	0.0067	0.0005	0.0030
Coho Juveniles (fish/m^2)	0.2173	0.2718	0.2921	0.1705	0.0686	0.1043
Steelhead Parr (fish/m^2)	0.5485	0.2730	0.2537	0.1088	0.1369	0.0747
In-Stream Structures						
AIS Present (#)	N/A	N/A	N/A	N/A	N/A	81

Data collected on September 2, 2005 (Year 0); August 17-18, 2006 (Year 0*); and September 22-23, 2008 (Year 1)
Year 0 indicates second year baseline data

MC-2 In-Stream Habitat


Construction just downstream of Transect A in control reach in Year 1 (2008)


LWD placed in downstream end of Transect A in control reach in Year 1 (2008)

Summary

Engineered log jams were installed at the Dungeness River site and post-project monitoring was conducted in 2008. While monitoring the control site, field crews observed work being conducted within the downstream end of Transect A. Monitoring was still conducted within the control reach and photos were taken to document the construction. Increases in mean vertical pool profile area and residual depth were observed within the first year of implementation. Additionally, increases were also observed for steelhead, parr, coho, and Chinook juveniles when compared with Year 0*, the most recent baseline year.

04-1660 Cedar Rapids Floodplain Restoration

The Cedar Rapids Floodplain Project is intended to restore 1,850 feet of riparian and floodplain habitat along a reach of the Cedar River. Historic levees along this reach have constricted, reduced, and degraded in-stream and riparian habitat for Chinook salmon. The project reach contains very few pools, lacks large woody debris, and off-channel habitat is inaccessible or lacking. The riverbed is incised and spawning gravel has been limited by high velocity flows.

The project will restore a more natural channel form and improve aquatic, riparian, and off-channel floodplain habitats in this important Chinook spawning and rearing area. The project will remove levees and bank armoring, reconnect high flows to the adjacent floodplain, restore in-stream channel, gravel bar, and pool habitats, and recreate riparian floodplain and side channel habitats.


Control reach at Transect F (2006)


Impact reach at Transect F (2006)

Project Location

This project is located in King County on the Cedar River. The impact reach is located off Jones Road on County property. The control reach is upstream of the impact reach. The right bank and adjacent floodplain are accessed via Jones Road. The left bank is accessed via the Cedar River Trail off of State Route 169.

Project Objective

The objective of this project is to increase in-stream cover, spawning, and holding sites for Chinook salmon. Mainstem restoration will include placement of anchored, floating logs to reduce near-bank water velocities for natural deposition of river sediments within incised areas and improved spawning gravel recruitment. Removal of bank armoring and added LWD will increase spawning habitat along the main channel margins and will reconnect rearing habitat along the mainstem and side channel areas. Invasive species removal and replanting with native shrubs will also be conducted. King County Water and Land Resources sponsors this project and King County Department of Natural Resources and Parks owns the land adjacent to the project site. Nancy Faegenburg of King County serves as the primary contact.

Project Data

Table 4-21 summarizes the data collected during Year 0 and Year 0* monitoring of the Cedar Rapids Project.

Table 4-21. Summary Statistics for Pre-Implementation (Year 0 and Year 0*) Monitoring

Variable	Year 0 (2005)		Year 0* (2006)	
	Control	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Mean Residual Pool Vertical Profile Area (m^2/reach)	93.74	178.52	106.51	155.32
Mean Residual Pool Depth (cm)	18.75	35.70	21.30	31.06
Log_{10} (Volume of LWD) (m^3/100m)	0.24	0.80	-0.03	0.79
Fish Data				
Chinook Juveniles (fish/m^2)	0.0103	0	0.0006	0.0005
Coho Juveniles (fish/m^2)	0.0108	0	0.0172	0.0091
Steelhead Parr (fish/m^2)	0.0024	0.0012	0.0108	0.0045
In-Stream Structures				
AIS Present (#)	N/A	N/A	N/A	N/A

Data collected June 13-14, 2005 (Year 0) and August 10, 2006 (Year 0*).
* Year 0* indicates second year baseline data.

Summary

Pre-project monitoring was conducted at the Cedar Rapids site in 2005 and 2006. Construction of the restoration project was started in 2008, but was not completed in time for monitoring. Year 1 monitoring of the site is scheduled for 2009.

05-1533 Doty Edwards Cedar Creek Restoration Project

The Doty Edwards Cedar Creek Project involved: 1) adding root wads to provide in-stream LWD, 2) adding gravel holding cross-vanes to restore the pool-to-riffle ratio function and allow eroded banks to re-vegetate, 3) planting trees and shrubs to provide shading and cover, and 4) reconnecting a small side-channel to provide rearing habitat and flood protection to fry and juveniles. The project created new high-quality spawning area and resting pools, cover and protection for adult Chinook, coho, steelhead and parr, and rearing habitat for parr. In addition, stream bank re-vegetation has been conducted to reduce summer stream temperatures within the Cedar Creek impact reach.

Impact reach at Transect F in Year 0 (2006)

Impact reach at Transect F in Year 1 (2008)

Project Location

The project is located on Cedar Creek in the Lewis River (WRIA 27) subbasin in Clark County within Township 5N, Range 3E, Section 18. The impact and control reaches are located on private property owned by the Doty, Edwards, and Jackson families.

Project Objective

Past activities (splash dams, excessive logging, and grazing) have essentially caused the creek to become a single long, shallow, unstable "run" with no riffles, pools, or protective cover for all of the life stages of salmonid fish (coho, Chinook, and steelhead) that once made extensive use of this reach of Cedar Creek, on the North Fork Lewis River system. The objective of this project is to restore the structure and complexity of 425 meters of stream channel to benefit salmonids. Fish First is the project sponsor and Dick Dyrland is the project contact.

Project Data

Figures 4-34 and 4-35 show the response of juvenile fish, mean residual pool vertical profile area, and residual depth through time. Table 4-22 summarizes the data collected during Year 0 and Year 1 monitoring of the Cedar Creek Project.

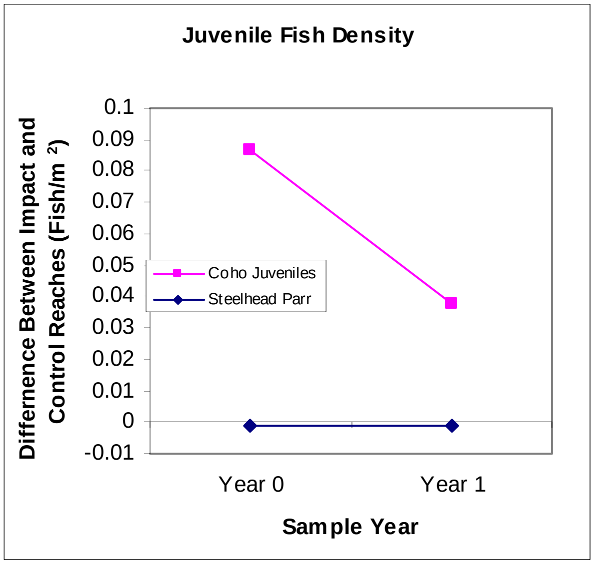


Figure 4-34. Juvenile Fish Density in Cedar Creek

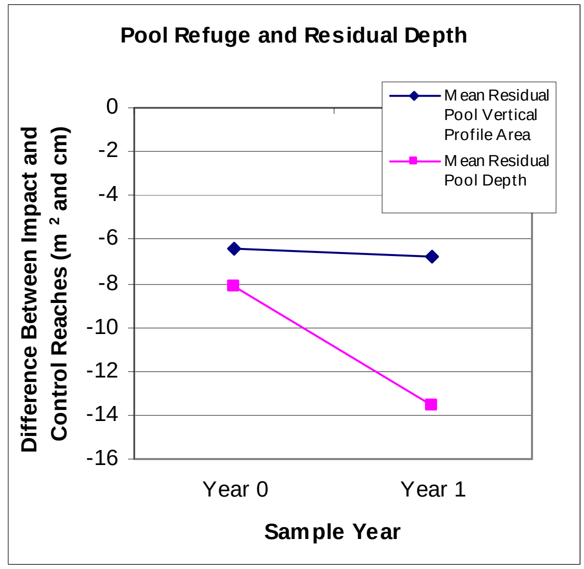


Figure 4-35. Pool Refuge and Residual Depth in Cedar Creek

Table 4-22. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2008)	
	Control	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Mean Residual Pool Vertical Profile Area (m^2/reach)	27.00	20.57	50.70	43.93
Mean Residual Pool Depth (cm)	15.00	6.86	28.17	14.64
Log_{10} of Volume of LWD (m^3)	0.82	0.15	0.91	0.90
Fish Data				
Coho Juveniles (fish/m^2)	0.0490	0.1356	0.0193	0.0573
Steelhead Parr (fish/m^2)	0.0060	0.0051	0.0011	0.0002
In-Stream Structures				
AIS Present (#)	N/A	N/A	N/A	26
Data collected from June 26-29, 2006 (Year 0) and September 6-9, 2008 (Year 1).				

Summary

The placement of artificial in-stream structures was extended by the project sponsor upstream into what had originally been designated as the original control reach. Therefore, the length of the control reach was shortened to include only un-impacted habitat, from Transect A to Transect E. The data for Year 0 and Year 1 were adjusted and analyzed accordingly. Data shown in Figure 4-34 suggest a relative decrease in juvenile density for the impact reach as compared to the control reach for coho juveniles, and no change in density for steelhead parr. Additionally, Figure 4-35 shows a decrease in pool refuge and residual depth in the impact reach as compared to the control reach in the first year after implementation. However, this reduction in the reach average pool depth is due to greater increases in the control reach than in the impact reach, which may be the result of high flows, or greater scour in the control reach, and gravel storage at cross vanes placed in the impact reach. Additional review of the changes at specific transects is warranted to assess the changes at this project site.

07-1803 Skookum Reach Restoration

The Skookum Reach Restoration Project involves the removal and relocation of an abandoned Whatcom County road that runs along 2,500 feet of the South Fork Nooksack River bank. The project will include the restoration of channel migration and natural bank conditions, the placement of two engineered wood structures, and the reforestation of 11.8 acres of riparian buffer. The two ELJs will be placed in the cool water mixing zone of Skookum Creek, which provides thermal refuge in the temperature-limited South Fork Nooksack. The Skookum Reach Restoration project will address habitat factors limiting the recovery of South Fork Nooksack River Chinook salmon, bull trout, steelhead trout, and other salmonid species. These factors include elevated water temperatures, lack of key habitat features, and low habitat diversity. The project will address the WRIA 1 salmon recovery habitat restoration goals for this reach of the South Fork Nooksack River.

Impact reach at Skookum Reach in 2008 (Year 0)

Collecting data in the control reach in 2008 (Year 0)

Project Location

The project is located on the South Fork Nooksack River, near RM 14, in Whatcom County. Skookum Reach is in WRIA 1, Township 37N, Range 5E, and Section 29. Both the impact and control reaches are 500 meters in length. The land within the project area is owned by Whatcom Land Trust, a private landowner, and the Lummi Nation.

Project Objective

The objective of the Skookum Reach Restoration Project is to improve in-stream morphology and habitat for salmonid species. The project will increase in-stream cover, spawning, and resting areas within Skookum Reach. The primary species targeted in this project is Chinook salmon. The Lummi Indian Business Council sponsors this project and Melissa Brown is the primary contact.

MC-2 In-Stream Habitat

Project Data

Table 4-23 summarizes the data collected during Year 0 monitoring of the Skookum Reach Restoration Project.

Table 4-23. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	**Year 0 (2008)**	
	Control	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	152.19	61.43
Mean Residual Pool Depth (cm)	30.44	12.29
Log_{10} of Volume of LWD (m^3)	0.63	0.95
Fish Data		
Chinook Juveniles (fish/m^2)	0.0017	0.0054
Coho Juveniles (fish/m^2)	0.0001	0
Steelhead Parr (fish/m^2)	0.0035	0.0025
In-Stream Structures		
AIS Present (#)	N/A	N/A
Data collected September 15-16, 2008 (Year 0)		

Summary

Pre-project sampling was conducted at Skookum Reach during the summer of 2008. Both the control and impact sites were severely lacking in large woody debris structures and channel complexity. Future monitoring at Skookum Reach will be conducted following implementation of the project.

4.1.3 Riparian Planting Projects

4.1.3.1 Protocol Description

In 2008, five riparian plantings were monitored out of nine active projects. Monitoring for riparian plantings includes measuring riparian vegetation structure and shading before projects are implemented, and adding monitoring of planting survival and percent cover of woody vegetation in riparian planting areas after project implementation. Table 4-24 identifies the variables used in monitoring Riparian Planting Projects.

Figure 4-36 shows the locations of all of the Riparian Planting Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects included in the program.

Quantifying Riparian Plantings

Crawford (2008c) describes the methods for measuring the survival of riparian plantings. For areas 1 to 2 acres or smaller, a complete census of plantings was conducted after implementation. If the planting was larger, 10 random points were selected within the planting area and 18.1 meter (59.4 feet) circular plots were sampled. The center point of each plot was marked and data collected were used to calculate average plant density per acre. Survival was measured in Years 1 and 3 and the project considered effective if 50 percent survival is achieved by Year 3.

The above protocols also describe the methods for measuring percent woody cover of riparian vegetation in the riparian planting area. Percent cover of woody riparian species is measured in 10 permanent plots randomly located in the riparian planting area. Estimates of percent woody cover include cover provided by naturally recruited tree and shrub seedlings, as well as cover provided by planted seedlings. The project is considered effective if an average of 80 percent cover of woody riparian species is achieved by Year 10.

Riparian Vegetation Structure

Crawford (2008b) describes the steps used to measure riparian structure. The dominant vegetation type for the canopy (deciduous, coniferous, broadleaf evergreen, mixed, or none) was determined at each lettered transect, along with the aerial cover classes of small and large trees within the canopy layer. The dominant vegetation in the understory layer was also determined at each transect and the aerial cover class was recorded for woody shrubs, saplings, seedlings, non-woody vegetation, and the amount of bare ground. Similar measurements were recorded for ground cover. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in riparian vegetation structure in the impact reaches by Year 10 and if *t*-test results are statistically significant.

Shading

Crawford (2008b) was used to measure shading for riparian plantings. Measurements of canopy cover were taken at each lettered transect using a densiometer. Densiometer readings were taken at the right and left banks and in four directions in the middle of the channel. Results were averaged from the bank measurements to produce the mean canopy density at each transect. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in mean canopy density in the impact reaches by Year 10 and if *t*-test results are statistically significant.

Actively Eroding Streambanks

Crawford (2008c) was used to estimate the percent of the linear distance of the channel on both sides at each transect that is actively eroding at active channel height. The project will be considered effective if a 20 percent reduction in percent bank length that is actively eroding is observed within 10 years and if *t*-test results are significant.

4.1.3.2 Results/Data Summaries/Decision Criteria

Table 4-24 identifies the summary statistics used to evaluate Riparian Planting Projects. Survival of plantings was measured after project implementation.

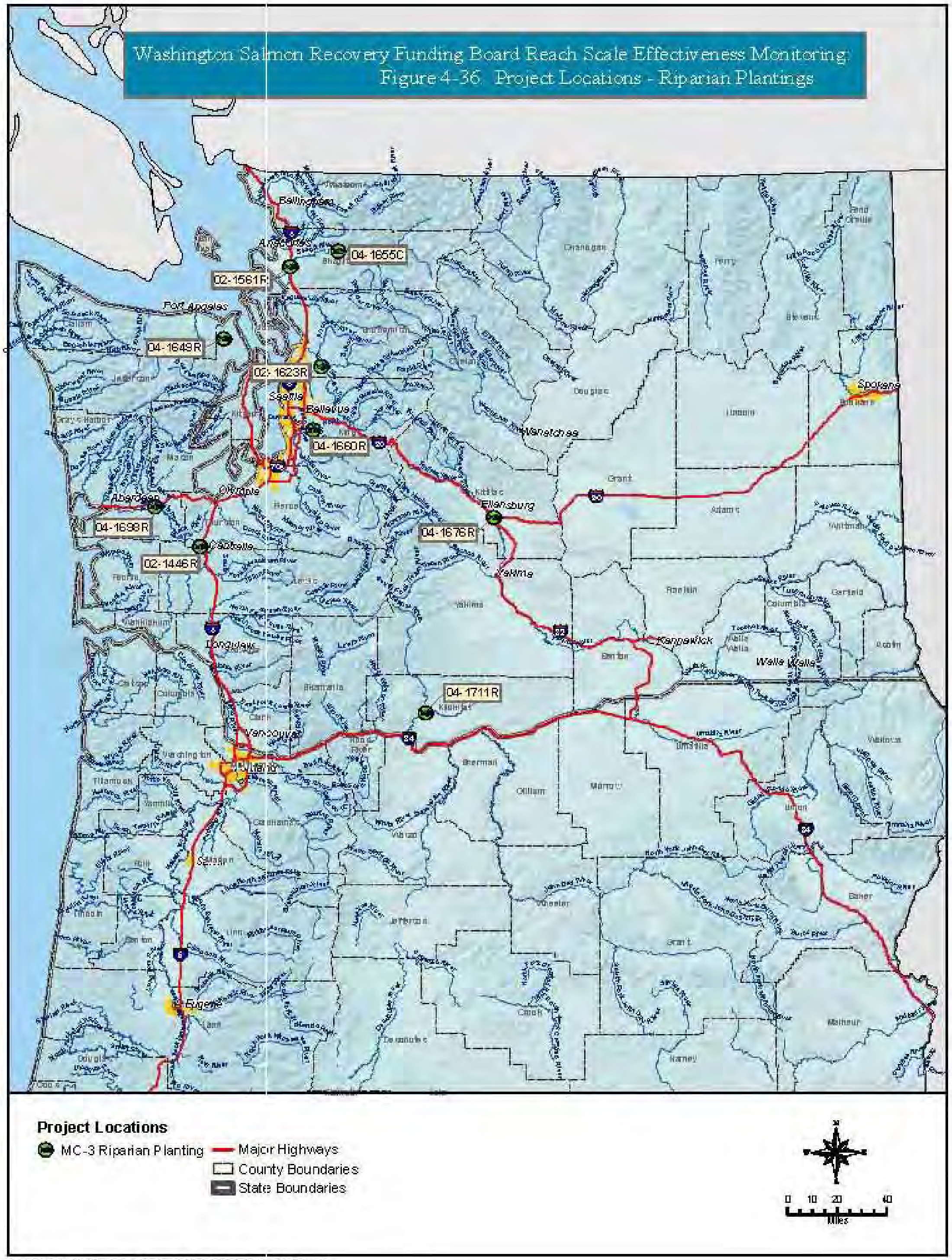
Table 4-24. Decision Criteria for Riparian Plantings

Monitoring Parameters	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Plantings	The number of planted plants remaining in the impact area	#	None. Count of original riparian plantings still alive	≥ 50% of original riparian plantings are living by Year 3
Percent Woody Cover	Mean percent cover of woody species in the riparian planting area	%	None. Mean percent woody cover as measured in riparian planting plots	≥ 80% cover of woody riparian species by Year 10
Riparian Condition	Mean percent canopy density at the bank by densiometer reading	1-17 score	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between impact and control by Year 10
	Three-layer riparian vegetation presence (proportion of reach)	%	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between impact and control by Year 10
	Actively eroding banks	%	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an decrease between impact and control by Year 10
	Riparian area	m^2	None. Measure of riparian area planted	One-time measurement of area planted

Source: Crawford 2008c.

MC-3 Riparian Plantings

Figure 4-36. Project Locations – Riparian Planting



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4.1.3.3 Data Issues

Vegetation structure, shading, and bank erosion measurements can show substantial changes when the actual riparian area has changed very little. This has been found in the riparian structure variable and occasionally in the canopy density measurements. These issues can affect data used in Riparian Planting, Livestock Exclusion, and Channel Connectivity projects.

The riparian vegetation structure is recorded as a cover class (range for percent cover) for the three layers of vegetation, rather than absolute percentage estimates. While this is generally thought to improve consistency between biologists, it can lead to what appears to be large changes in the data for a small actual change in the vegetation. An example should clarify. Five Cover Classes are used in the vegetation structure monitoring (0 = absent, 1 = <10 percent cover, 2 = 10–40 percent, 3 = 40–75 percent, 4 = >75 percent). In year one, if the canopy is estimated at less than 10 percent cover of the sample area, the Cover Class recorded is 1. The following year, despite little or no change, it might be estimated at 15 percent and the Cover Class would be recorded as 2. Thus, given the size of the Cover Classes, the recorded change appears larger than the small change in the estimate. While one observation may not make much difference in the analysis, several of these at one site would indicate more change in a site than actually occurred.

In another situation, the estimate could change between Cover Class 0 (absent) and Cover Class 1 (<10 percent) when there is no underlying change. The measurement area for vegetation structure is 10 square meters on a horizontal plane and as visualized from the stream. The subjective determination of a sample area boundary location can add variation to the estimates for a Cover Class. If a Cover Class appeared at the edge of a sample area, particularly at the far side of a sample area on a steep slope, it could be perceived as included in the sample area one year and counted as out during the following year.

Canopy cover is measured using a densiometer held at the edge of and a foot above the stream. The stream edge location relative to the shading vegetation, particularly on gently sloping banks, can vary enough from year to year to change the canopy cover readings. Thus, there can be variation in the canopy cover data that is due to lower or higher stream flows rather than an actual change in the riparian vegetation.

4.1.3.4 Project-Specific Summaries

Riparian Planting Projects are monitored prior to implementation of the project (Year 0) and for a period of ten years following implementation. Post-project monitoring is scheduled to be conducted at the control site and impact site during Years 1, 3, 5, and 10. Recommendations in this report include lengthening the time between surveys to five years. Summary statistics for Riparian Planting Projects are presented on the following pages. Projects sampled prior to 2008 have multiple years of data. New projects for 2008 only have baseline data. This may vary if project implementation was delayed or incomplete during 2008 or previous years.

02-1446 Centralia Riparian Restoration Project

The Centralia Riparian Restoration Project is located on a one-mile stretch of the Chehalis River that has suffered extensive removal of riparian trees and shrubs as a result of prior agricultural practices. Decades of use by livestock has led to a significant loss of streambank and the lack of re-establishment of a healthy riparian zone. A limited number of cottonwood trees and conifers still existed prior to the project, as well as some small stands of shrubs and willows; however, the dominant plant species on site was reed canary grass.

The Centralia Riparian Restoration Project included the restoration of a riparian zone measuring 60 meters wide by 1.6 kilometers long. The area was previously agricultural field and was restored to forest. Within the project reach, Chinook salmon spawn, juvenile salmonids overwinter, and bull trout, coho, chum salmon, steelhead, and cutthroat trout migrate. An existing off-channel rearing area was enhanced through planting of local willows. In all, eleven acres of riparian habitat were planted. The target species for this project is coho salmon and it is expected to benefit approximately 1,609 meters of stream habitat.

Impact reach in Year 0 (2004). Note tall conifer in center of the photo at top of bank.

Impact reach in Year 3 (2007). Note tall conifer from 2004 photo is no longer present, as it eroded in the 2006/2007 flooding events.

Project Location

The Chehalis Basin Plan for Habitat Restoration identified the Chehalis River mainstem as a high priority subbasin and the reach between the Skookumchuck River and Scatter Creek as a priority for riparian revegetation. The Centralia Riparian Restoration Project lies within these boundaries on the east shore between RM 61 and 62. This project site is located in Lewis County on the east bank of the upper Chehalis River, in WRIA 23. The site is on the grounds of Centralia’s new wastewater treatment plant, on lands owned by the City of Centralia. Both the impact and control reaches that are monitored for this project are approximately 150 meters in length.

MC-3 Riparian Plantings

Project Objective

The plantings installed as part of the Centralia Riparian Restoration Project were intended to reduce bank erosion, and provide shade, cover, and microhabitats for salmonids. Large woody debris recruitment will also likely increase over the long-term as a result of this project. This project was sponsored by the City of Centralia and Kahl Jennings serves as the primary contact.

Project Data

Figure 4-37 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-25 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Centralia Project.

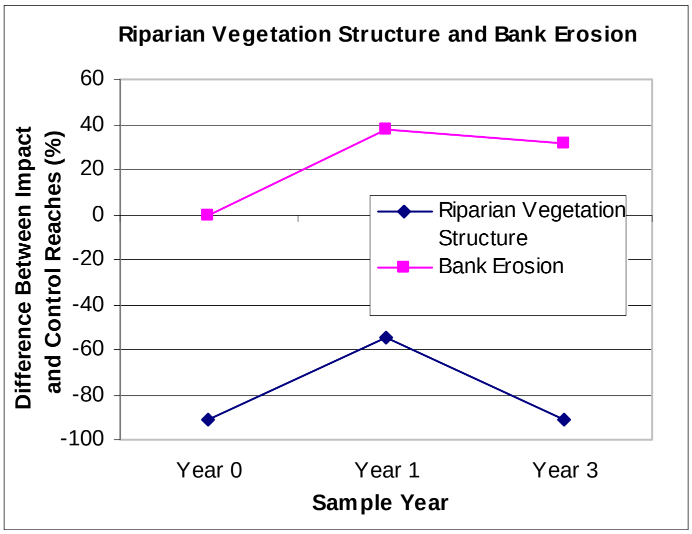


Figure 4-37. Riparian Vegetation Structure (3 layers) and Bank Erosion at Centralia

Table 4-25. Summary Statistics for Pre- and Post-Implementation Monitoring (Year 0, Year 1, and Year 3)

Variable	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Reach Width (m)	17	25	17	25	17	30
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	12.09	4.73	15.73	4.67	11.82	2.91
Riparian Vegetation Structure (% 3 layers)	100	9.1	72.7	18.2	95.5	4.5
Bank Erosion (%)	0	0	12	50	18	50
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	4,763	N/A	4,763
Area Planted (acres)	N/A	N/A	N/A	11	N/A	11
% Plants Living	N/A	N/A	N/A	100	N/A	85
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	1.8	N/A	1.0
Data collected October 5, 2004 (Year 0); May 19, 2005 (Year 1); and August 8, 2007 (Year 3).						

MC-3 Riparian Plantings

Summary

When the restoration plantings were initially installed, they were set back from a 5- to 8-foot-high eroding bank; however, during the three years of monitoring at this site, the bank has eroded toward the plantings. In 2007, the plantings were 20 to 40 feet from the steep bank. The plantings have been watered and the pasture grass has been mowed to aid in tree and shrub survival. The plants that are alive are mostly in good condition due to the maintenance. The survival of plants to Year 3 is considered high, at 85 percent. The 15 percent loss is largely due to loss of plantings in a plot that was accidentally mowed. This 15 percent loss likely explains the slight decrease in average percent cover of woody species in riparian planting plots.

In the impact reach, vegetation structure declined (see Table 4-25) due to loss of trees and shrubs during the erosion events. The plantings will not have an effect on the structure along the water for several years, if ever. The plantings are presently further than 10 meters (30 feet) from the river's edge, which is outside of the area where the vegetation structure measure occurs.

In the control reach, the vegetation did not change substantially. The densiometer and vegetation structure measured in Year 3 are closer to Year 0 measurements than Year 1 because the water level was closer to that of Year 0. The measurements are taken from the river's edge and the accessible side of the control reach has a flat, wide bank. For a river with a flat, wide bank, small changes in water level can make a large difference in distance from the water's edge and the vegetation.

In summary, the efforts on the part of the project sponsor have resulted in high survival of installed plantings. Due to the location of the plantings with respect to the river, changes in measured variables due to the plantings have not been observed. Monitoring was not conducted at Centralia in 2008; however, Year 5 monitoring is scheduled for 2009.

02-1561 Edgewater Park Off-Channel Restoration

The Edgewater Park site is located on the west side of the Skagit River within the river's floodplain. From Sedro Woolley downstream for over 22 miles, the natural processes of the river have been restrained between levees. At the park, the levee has been set back from the river, which is a unique condition. Historically, the south end of the park had been bisected by several off-channel sloughs; however, over time, these sloughs have been partially filled at their north end. The remaining slough areas (34 acres) act as a refuge for wildlife and offer protection and shelter to salmon at various life stages during times of high water. A bar at the south end makes passage out of the sloughs difficult as the river recedes, causing stranding.

The Edgewater Park Off-Channel Restoration project involved the construction of off-channel sloughs and reconnection of isolated habitat to the river. The goal is the re-emergence of historic landscape processes and a functioning off-channel slough system, which is a rare resource in the lower Skagit River. This project is expected to benefit approximately 318 meters of off-channel habitat.

Willow plantings along bank of new channel in Year 1 (2005)

Dry side channel looking upstream in Year 3 (2007). A few of the willow stakes are growing through the sandfill in the lower right foreground.

Project Location

This project is located on the Skagit River (WRIA 3), at Edgewater Park, in the City of Mount Vernon, Skagit County. The impact site is approximately 318 meters in length and is located in the south end of the park on lands owned by the City of Mount Vernon Park and Recreation Department. The control reach is also 318 meters long and is located downstream in Cottonwood Island Public Fishing Access Area, on lands owned by the WDFW.

Project Objective

The objective of this project was to plant along approximately 34 acres of restored off-channel sloughs to shade the reconnected habitat. This off-channel habitat was designed to add to the natural river functions and increase the ability of the area to provide key protection and shelter habitat to all salmon species at various life stages. Plantings were installed to augment the existing vegetation and to replace some of the vegetation that was removed during channel construction. LWD was added to support bank stability and provide additional habitat diversity. The target species for this project was Chinook salmon. The City of Mount Vernon sponsored this project and Larry Otos and Curt Miller are the primary contacts.

Project Data

The survey conducted in Year 0 (2004) was prior to construction; therefore, measurements for the impact reach were taken in the dry channel, approximating the planned channel location and widths. Bankfull widths were used whenever the control or impact reach was dry. During the Year 1 survey, reach lengths and location changed to accommodate the actual dimensions of the constructed channel. Plantings were completed in late December of 2005, following the construction of the new channel.

During 2006 and 2007, there was notable sand deposition and scouring at the project site. As a result, the exact vegetation plots could not be relocated. Riparian planting sites were measured from the transect origin to approximate the original location. The plots surveyed in 2007 were likely within 5 meters of the original plots and represented the conditions on the site.

Figure 4-38 shows changes measured in riparian vegetation structure and bank erosion. Table 4-26 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Edgewater Park Project.

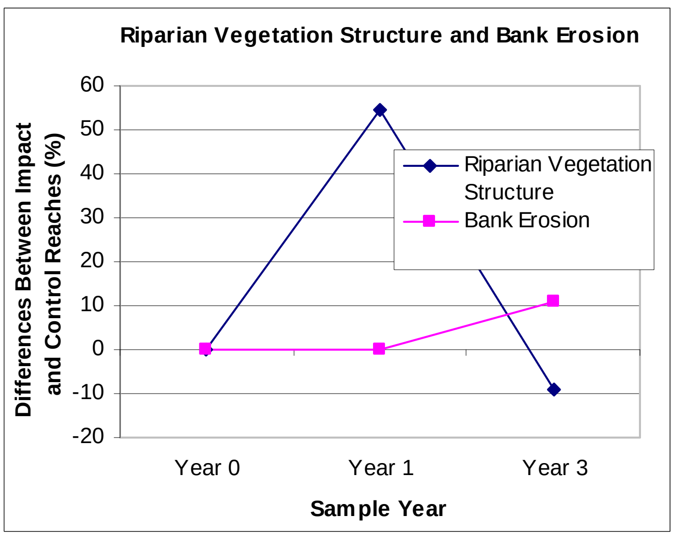


Figure 4-38. Riparian Vegetation Structure and Bank Erosion at Edgewater Park

MC-3 Riparian Plantings

Table 4-26. Summary Statistics for Pre- and Post-Installation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Reach Width (m)	5.28	2.75	5.57	14.89	5.50	1.73
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	16.75	16.86	16.96	10.23	16.46	10.18
Riparian Vegetation Structure (% 3 layers)	100	100	4.5	59.1	77.3	68.2
Bank Erosion (%)	0	0	0	0	0	11
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	53,052	N/A	53,052
Area Planted (acres)	N/A	N/A	N/A	34	N/A	34
% Plants Living	N/A	N/A	N/A	98.6	N/A	57.0
Percent Cover of Woody Vegetation (avg)	Percent cover not collected at this site in Year 0, Year 1, and Year 3					
Data collected on July 29, 2004 (Year 0), January 26, 2005 (Year 1), and August 8, 2007 (Year 3)						

Summary

During the first two winters after planting, in some areas of the project portions of the bank eroded and, in others, the plantings located at lower elevations were buried by sand deposition. Most willows and cottonwood stakes planted near the shoreline were buried by sand, with a few sprouting through the sand.

Japanese knotweed, a noxious weed, established in the north end of the channel in 2007, covering an area approximately 50 feet by 20 feet. Japanese knotweed reproduces vegetatively and through seed and can overwhelm a site. The surviving plantings in the project area were heavily shaded by the knotweed.

South of the knotweed, in the central portion of the reach, scour resulted in the removal of most of the plantings on the bank. South of the scoured area, there was an area of 50 feet by 20 feet with dense willow seedlings that were establishing well. These were counted as survivors because it was impossible to know if they resulted from the plantings or if they were volunteers, as willow reproduce easily through sprouting of branches that fall into favorable areas. Other than willow stakes, many of the plantings outside the scoured area were surviving. Despite the scour removal and burial of many plantings, 57 percent of plantings found in plots are living, including willow shoots. Monitoring was not conducted at Edgewater Park in 2008.

02-1623 Snohomish River Confluence Reach Restoration

The Snohomish River Confluence Reach Restoration Project is a reach-scale restoration effort on 3 miles of the Snohomish River downstream from the confluence of the Skykomish and Snoqualmie rivers. The area that forms the confluence of the Skykomish and Snoqualmie in the Snohomish River is a biologically rich zone. This reach includes extensive refuge areas, large riffles, and several important spawning areas. It provides spawning, rearing, migration, and holding habitat for Chinook salmon and other salmonids. Dikes, bank armoring, and clearing of riparian forests have substantially degraded the quantity and quality of habitat along this critical reach. This area has been identified by the Snohomish Basin Salmon Recovery forum as a “focus area” due to the importance of this area to Chinook salmon and other salmonids.

Three primary restoration sites were identified in this area: Twin Rivers floodplain, Crabb meander, and Bob Heirman Wildlife Park. Restoration planned for these areas included riparian planting, bank restoration, LWD placement, reconnection of off-channel areas, and breach design at two dike sites. This project is expected to benefit approximately 1,609 meters of stream habitat.

Overview of planting area in Year 1 (2004)

Overview of planting area in Year 3 (2008)

Project Location

This impact reach is located in Snohomish County on the north side of the Snohomish River on the west side of the Highway 522 Bridge on lands owned by the Snohomish County Parks. The control reach is downstream and across the Snohomish River at the Bob Heirman Wildlife Refuge County Park. Each reach is approximately 150 meters in length.

Project Objective

The objective of this project is to restore vegetation along an stretch of the Snohomish River deemed as important spawning, rearing, migration, and holding habitat for Chinook Salmon and other salmonids. Restoration plans were based on a comprehensive reach-scale analysis conducted by Snohomish County and include riparian plantings, LWD placement, and reconnection of off-channel areas. This project was sponsored by Snohomish County and Robert Aldrich serves as the primary contact.

Project Data

Figure 4-39 illustrates the change in riparian vegetation structure. Table 4-27 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Snohomish River Confluence Reach Restoration Project.

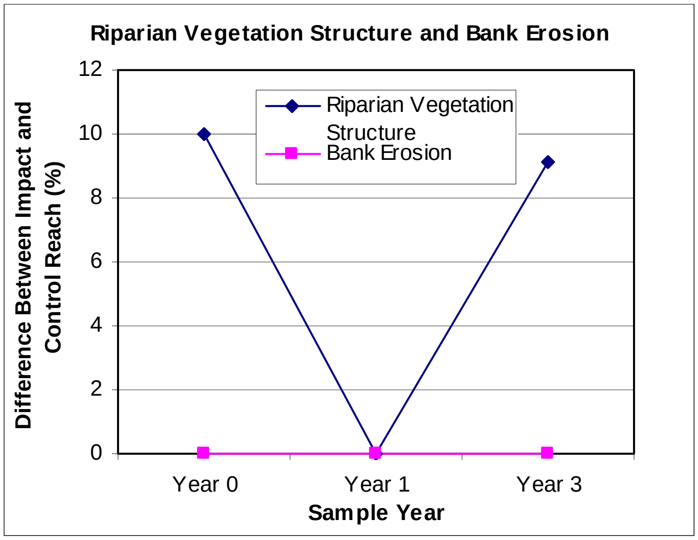


Figure 4-39. Riparian Vegetation Structure at the Snohomish River Confluence

Table 4-27. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2006)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Reach Width (m)	7.0	3.0	1.0	1.5	1.5	1.5
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	0	0	0	9.3	17.0	11.8
Riparian Vegetation Structure (% 3 layers)	0	10.0	0	0	9.1	18.2
Bank Erosion (%)	0	0	0	0	0	0
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	3,510	N/A	3,510
Area Planted (acres)	N/A	N/A	N/A	6	N/A	6
% Plants Living	N/A	N/A	N/A	96.3	N/A	88.9
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	4.6	N/A	23.2
Data collected October 5, 2004 (Year 0), June 15, 2006 (Year 1), and July 9, 2008 (Year 3).						

Summary

A portion of the impact site was planted in 2003/2004 and approximately 300 plants were installed along 500 feet of riverbank in the spring of 2005. During the winter of 2005/2006, large 6 to 10 foot trees were planted along the side channel and between the side channel and

Snohomish River. The trees were installed in widely-spaced rows to facilitate mowing and other maintenance. The trees were planted south of the side channel in old pastures between the channel and the Snohomish River. Initial survival of the plantings (Year 1) was over 96 percent. In 2008, Year 3 survival was 88.9 percent and the majority of the plants appeared vigorous and healthy. In addition, average percent canopy cover for riparian planting plots increased from 4.1 percent in 2006 to 23.2 percent in 2008.

In July 2008, there was no water flowing in the side channel. However, there was sediment and debris deposits up to 4 feet high on many of the plantings, indicating that there had been high water flowing in the channel during the winter/spring of 2007/2008. Despite the high survival and continued growth of the riparian plantings, there was also heavy cover of invasive species such as reed canarygrass (*Phalaris arundinaceae)*, Canada thistle (*Cirsium arvense)*, common St. Johnswort (*Hypericum perforatum*), and creeping buttercup (*Ranunculus repens*) in the channel and in the riparian planting area.

In 2008, the vegetation in the control reach was almost entirely reed canarygrass. The original channel was not visible at the time of monitoring, consistent with what had been documented in 2006. The control reach was established in a wet reed canarygrass meadow and it is likely that the entire meadow floods yearly and the side channels may change course on a fairly regular basis. In August 2008, the meadow was dry with no standing water and no side channels visible.

04-1649 Salmon/Snow Lower Watershed Restoration

The Salmon/Snow Lower Watershed Restoration Project is a partnership between WDFW, Jefferson Conservation District, and North Olympic Salmon Coalition. This watershed is the stronghold of Strait of Juan de Fuca population of Hood Canal summer-run chum salmon which are federally listed as threatened. Stream reaches in the project area are major spawning areas for summer chum. Salmon/Snow Creek also contains critical stocks of coho, steelhead and cutthroat. The project is expected to benefit approximately 2,286 meters of salmon habitat.

The partners for this project intend to provide a long-term vision for restoration of the Lower Snow and Salmon Creeks and their common estuary and implement the most effective projects identified by the Chumsortium, a coalition of private and public entities, including the Jefferson Conservation District, North Olympic Salmon coalition, and WDFW, whose goal is protecting and restoring salmon habitat.

The majority of the work will be done on WDFW property which was purchased for fish/wildlife habitat. Historically this land was utilized for agriculture and currently has minimal forested riparian areas. Wider forested riparian areas will address a limiting factor and benefit fish species in both Salmon and Snow Creeks.

Impact reach at Transect A facing F in Year 0 (2005)

Impact reach at Transect A facing K in Year 3 (2008)

Project Location

This project site is located in Jefferson County in Discovery Bay, Washington. The impact reach is approximately 150 meters in length and is located along Lower Snow Creek, on lands owned by WDFW (the Salmon/Snow Creek Wildlife Area). The control reach is also 150 meters long and is located on privately owned land upstream of the impact reach on Salmon Creek.

MC-3 Riparian Plantings

Project Objective

The objective of this project is to restore shoreline habitat diversity and function. Goals for this project included:

- Determine the final design for several high priority estuarine restoration actions.
- Plan for future restoration actions, including, partial removal of railroad grade.
- Determine the feasibility of reconnecting and restoring lower Salmon and Snow Creeks given historical reference conditions and contemporary constraints.
- Implement actions including removal of fill from salt marsh and tidal channels, shoreline restoration and revegetation, and removal of abandoned buildings in the nearshore riparian and intertidal zone
- Extend riparian planting to 180 feet on each side of the new Salmon Creek channel.
- Extend Snow Creek planted riparian area to 180 feet from the existing channel.

The target species for this project is coho salmon. This project was sponsored by the North Olympic Salmon Coalition and Paula Mackrow serves as the primary contact.

Project Data

Figure 4-40 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-28 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Salmon/Snow Lower Watershed Restoration Project.

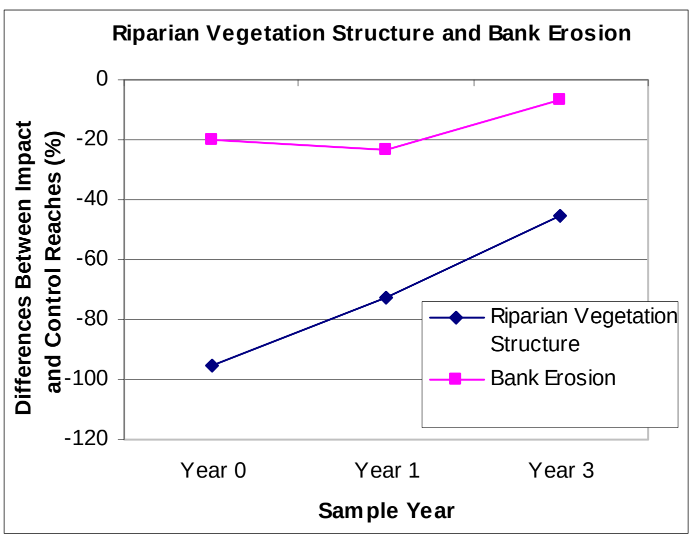


Figure 4-40. Riparian Vegetation Structure and Bank Erosion at Salmon/Snow Creek

MC-3 Riparian Plantings

Table 4-28. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2006)		Year 3 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Reach Width (m)	4	3	4	3	4	3
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	16.77	13.15	16.59	12.68	16.32	14.5
Riparian Vegetation Structure (% 3 layers)	100	4.5	81.8	9.1	90.9	45.5
Bank Erosion (%)	19.75	0	23.25	0	9.25	2.5
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	17,597	N/A	17,597
Area Planted (acres)	N/A	N/A	N/A	29	N/A	29
% Plants Living	N/A	N/A	N/A	96.4	N/A	55.2
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	4.9	N/A	10.6
Data collected July 19, 2005 (Year 0), July 7, 2006 (Year 1), and July 10, 2008 (Year 3).						

Summary

More than 17,000 plants of 26 species were planted with plastic tube protection during winter of 2005/2006. Initial planting survival in 2006 was measured at over 96 percent; however, in 2008 (Year 3), survival was 55.2 percent. The plantings directly along the river appeared healthy and vigorous; however, the plantings farther from the river, especially those in plots 1 through 5 on the east side, showed significant mortality. Many of the original plantings in these plots were no longer visible, with many plastic plant tube protectors containing only reed canarygrass and other introduced grasses. In addition, there were many broken tube protectors found in mowed areas indicating that many plants may have been mowed over. Species such as Oregon ash (*Fraxinus latifolia*), twinberry *(Lonicera involucrate*), red alder (*Alnus rubra*), and Sitka spruce (*Picea sitchensis*) appeared the most vigorous when surveyed in 2008. Despite significant mortality, average percent cover of woody species in riparian planting plots increased from 4.9 percent in 2006 to 10.6 in 2008. This increase is presumably due to the growth of planted species, such as those listed above.

During the Year 3 survey, there was heavy cover of reed canarygrass and other introduced grasses in the planting area, and shading of the stream in many areas was provided primarily by reed canary grass. Other invasive species seen scattered widely throughout the site included birdsfoot trefoil (*Lotus corniculatus*), Canada thistle (*Cirsium arvense*), and teasel (*Dipsacus fullonum*).

04-1655 Hoy Riparian Restoration Project

The Hoy Riparian Restoration Project is located on property owned by Seattle City Light, as part of their Endangered Species Act early action plan for the recovery of listed fish species. The property is located adjacent to one of the most important spawning areas for Chinook salmon, chum salmon, pink salmon, and steelhead trout in the lower and middle Skagit River. This area was selected for restoration because the riparian vegetation corridor in many locations on the Hoy property has been substantially impacted by cattle grazing and land clearing for farming, the effects of which have been worsened by periodic flood events. As a result, there is substantial bank erosion in some areas.

Riparian plantings were installed in the project area in 2005 at the top of and on a 3-meter high eroding slope along the Skagit River. Additional plantings were placed in other areas in fall of 2006. The plantings will provide a wide buffer for the river, approximately 60 meters. A fence was installed at the edge of the plantings to exclude cattle that graze in the adjoining hay field. This project is expected to benefit approximately 3,218 meters of salmonid habitat.

Impact reach in Year 1 (2006). Plantings are not visible in the tall grass.

Impact Reach in Year 3 (2008). Note planted area. Late snowfall pushed over and matted grass around plantings.

Project Location

This project is located on the Skagit River in Skagit County. The project area is a 3.2-kilometer section of the Skagit River east of the town of Hamilton. The 240-acre property is located on the south side of the Skagit River. Both the impact and control reaches measure approximately 210 meters in length.

Project Objective

The objective of the project was to restore and protect natural streamside vegetation, improve stream temperature, reduce erosion, improve filtration, and recruit LWD. Restoration of riparian vegetation will result in protection of the river bank along the Hoy property, which will ultimately sustain the river channel morphology in this area of the middle Skagit. This project is co-sponsored by Seattle City Light and the Skagit Land Trust.

Project Data

Figure 4-41 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-29 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Hoy Project.

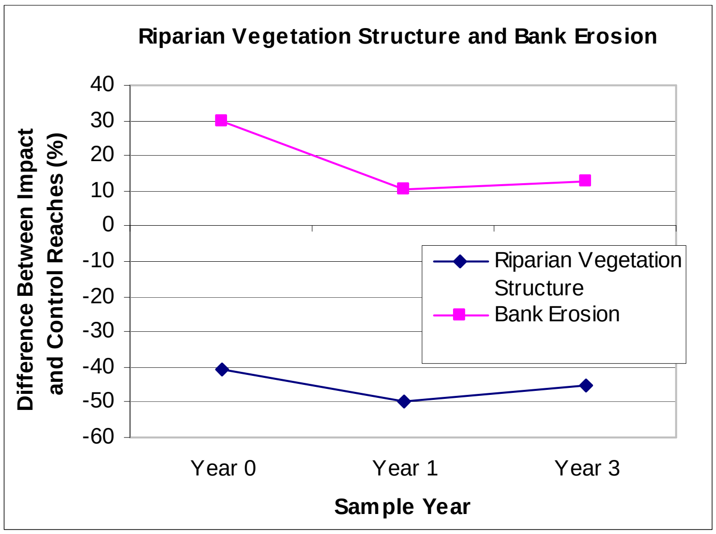


Figure 4-41. Riparian Vegetation Structure and Bank Erosion at Hoy

Table 4-29. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2006)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Reach Width (m)	234	150	234	150	234	150
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	16.73	6.00	16.64	3.09	15.91	5.27
Riparian Vegetation Structure (% 3 layers)	59.1	18.2	50.0	0	50.0	4.5
Bank Erosion (%)	70.0	100.0	89.5	100.0	82.5	95.5
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	10,705	N/A	10,705
Area Planted (acres)	N/A	N/A	N/A	38	N/A	38
% Plants Living	N/A	N/A	N/A	100	N/A	77.0
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	3.2	N/A	1.8
Data collected May 6, 2005 (Year 0), July 19, 2006 (Year 1), and May 5, 2008 (Year 3).						

MC-3 Riparian Plantings

Summary

Overall plantings appeared healthy, though there were numerous dead alders in the planting area. Thick deposits of sediment around plantings indicated that this area had experienced high water levels this year. In many places matted down grass, resulting from the heavy, late snow, was wrapped around plantings.

The survival of plants to Year 3 is considered high, at 77 percent. The 23 percent loss may be due in part to flooding, though it is also likely an artifact of the small number of plantings included in the analysis. That is, the spacing of the plantings is such that few are included in the sample plots, resulting in a small sample size (13 total, of which 3 died) such that a small reduction in the number of individual plants equates to a high percentage.

In the impact reach, vegetation structure and densiometer measures in Year 3 (5.3 densiometer; 4.5 percent vegetation structure) indicate an overall decrease in riparian vegetation from Year 0 estimates (6.0 densiometer; 18.2 percent vegetation structure) but a slight increase from Year 1 measurements (3.1 densiometer; 0.0 percent vegetation structure). The initial reduction in riparian vegetation was due to loss of trees and shrubs during erosion along the steep bank of the Skagit River. The slight increase between Year 1 and Year 3 is due to the establishment of many volunteer willows on the eroding slope. However, erosion along this reach continued between 2006 and 2008 (50.0 percent in 2006 and 95.5 percent in 2008), but this trend should stabilize once plantings mature.

In the control reach, the vegetation did not change substantially. The densiometer measurements have remained consistent through Years 0, 1, and 3 (16.7, 16.6, and 15.9, respectively), as have vegetation structure measures (59.1 percent, 50.0 percent, and 50.0 percent, respectively.

04-1660 Cedar Rapids Floodplain Restoration

The Cedar Rapids Floodplain Project is intended to restore 1,850 feet of riparian and floodplain habitat along a reach of the Cedar River. Historic levees along this reach have constricted, reduced, and degraded in-stream and riparian habitat for Chinook salmon. The project reach contains very few pools, lacks large woody debris, and off-channel habitat is inaccessible or lacking. The riverbed is incised and spawning gravel has been limited by high velocity flows.

The project will restore a more natural channel form and improve aquatic, riparian, and off-channel floodplain habitats in this important Chinook spawning and rearing area. The project will remove levees and bank armoring, reconnect high flows to the adjacent floodplain, restore in-stream channel, gravel bar, and pool habitats, and recreate riparian floodplain and side channel habitats.

Control reach at Transect F (2006)

Impact reach at Transect F (2006)

Project Location

This project is located in King County on the Cedar River. The impact reach is approximately 500 meters in length and is located off Jones Road on county property. The control reach is also 500 meters long and is upstream of the impact reach. The right bank and adjacent floodplain are accessed via Jones Road. The left bank is accessed via the Cedar River Trail off of State Route 169.

Project Objective

The objective of this project is to increase in-stream cover, spawning, and holding sites for Chinook salmon. Mainstem restoration will include placement of anchored, floating logs to reduce near-bank water velocities for natural deposition of river sediments within incised areas and improved spawning gravel recruitment. Removal of bank armoring and added large woody debris will increase spawning habitat along the main channel margins and will reconnect rearing habitat along the mainstem and side channel areas. Invasive species removal and replanting with native shrubs will also be conducted. King County Water and Land Resources sponsors this project and King County Department of Natural Resources and Parks owns the land adjacent to the project site. Nancy Faegenburg of King County serves as the primary contact.

Project Data

Table 4-30 summarizes the data collected during Year 0 and Year 0* monitoring of the Cedar Rapids Project.

Table 4-30. Summary Statistics for Pre-Implementation (Year 0 and Year 0*) Monitoring

Variable	Year 0 (2005)		Year 0* (2006)	
	Control	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Reach Width (m)	25.00	25.00	10.00	10.00
Riparian Characteristics				
Canopy Density (1-17)	13.46	16.5	12.97	13.0
Riparian Vegetation Structure (%)	95.5	86.4	80	77.3
Bank Erosion (%)	0	0	0	0
Riparian Planting				
Number of Plantings (total)	N/A	N/A	N/A	N/A
Area Planted (m^2)	N/A	N/A	N/A	N/A
% Plants Living	N/A	N/A	N/A	N/A

Data collected on June 14, 2005 (Year 0) and August 9, 2006 (Year 0*).
* Year 0* indicates second year baseline data.

Summary

Pre-project monitoring was conducted at the Cedar Rapids site in 2005 and 2006. Construction of the restoration project was started in 2008, but was not completed in time for monitoring. Year 1 monitoring of the site is scheduled for 2009.

04-1676 YTAHP Wilson Creek Riparian Restoration

The Yakima Tributary Access and Habitat Program (YTAHP) Wilson Creek Riparian Restoration Project is intended to establish a more functional riparian zone by establishing native woody species in areas currently dominated by reed canarygrass (*Phalaris arundinacea*). Historically, Wilson Creek provided both spawning and rearing habitat for a variety of anadromous species but fish access has been blocked by diversion dams since the 1880s. The SRFB, Bonneville Power Administration, Yakama Nation, Kittitas County Conservation District, and WDFW have invested heavily in fish screening and passage on the lower 12.8 kilometers of Wilson Creek. To optimize the benefit of reconnected upstream passage a more functional riparian zone is necessary. This project is expected to benefit approximately 724 meters of salmonid habitat.

Impact reach plantings from Transect K to A (2005)

Impact reach plantings from Transect K to A (2008)

Project Location

This project is located in Kittitas County on Wilson Creek. The City of Ellensburg owns land adjacent to its sewage treatment plant that encompasses 3,400 feet of Wilson Creek. Both banks are owned along 1,300 feet of the creek; however, the remaining ownership, including the impact reach, is limited to the left bank only. Both the impact and control reaches are approximately 150 meters in length.

Project Objective

The project area was dominated by reed canarygrass with few areas of sparse Pacific willow, cottonwood, and shrub species. Less than 10 percent of the lower 12.8 kilometers of Wilson Creek is characterized by native woody riparian vegetation. The project objective is to establish shrub and tree species to provide stream shading, bank stabilization, input of organic matter such as leaf litter, and recruitment of woody debris in order to produce more beneficial stream bank and near-shore habitat characteristics. The target species for this project is steelhead. This project is sponsored by the Kittitas County Conservation District and the primary contact is D.J. Shook.

Project Data

Figure 4-42 shows changes measured in riparian vegetation structure and bank erosion. Table 4-31 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the YTAHP Wilson Creek Riparian Restoration Project.

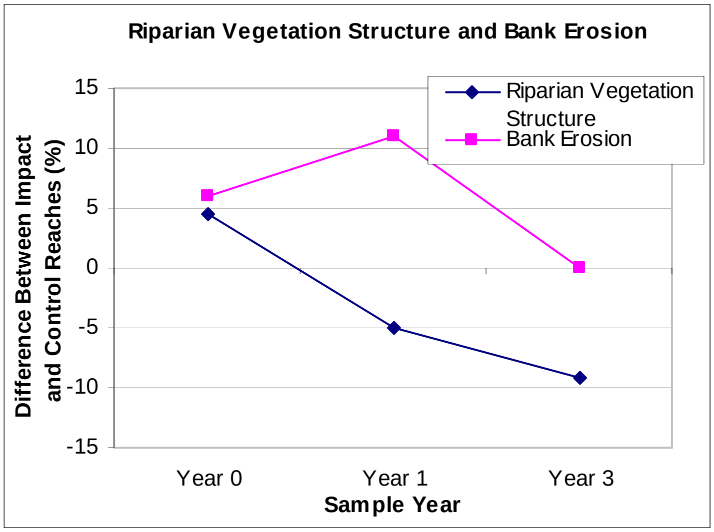


Figure 4-42. Riparian Vegetation Structure and Bank Erosion in Wilson Creek

Table 4-31. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2006)		Year 3 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Reach Width (m)	5.0	5.8	2.0	2.0	2.0	2.0
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	4.32	4.23	16.50	10.23	7.82	6.32
Riparian Vegetation Structure (% 3 layers)	0	4.5	5.0	0	13.6	4.5
Bank Erosion (%)	66	72	1.0	12	0	0
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	1,606	N/A	1,606
Area Planted (acres)	N/A	N/A	N/A	1.1	N/A	1.1
% Plants Living	N/A	N/A	N/A	61.8	N/A	47.1
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	4.1	N/A	22.8
Data collected April 29, 2005 (Year 0), July 12, 2006 (Year 1), and August 20, 2008 (Year 3).						

Summary

Initial plantings in the impact reach were not installed until May of 2006 in order to finish efforts to control reed canarygrass prior to planting. In July 2006 (Year 1), survival of riparian plantings was 61.8 percent; however, in 2008 (Year 3), only 47.1 percent of the riparian plants initially installed were still alive. Additional plants were installed in the impact reach in February and November of 2007. In February of 2007, 28 cottonwood cuttings were planted in the impact reach and in November of 2007, additional cottonwood, quaking aspen, blue elderberry, ponderosa pine, serviceberry, mock orange, red osier dogwood, and coyote willow were planted in the project area. These additional plantings have helped increase the riparian plant cover measured along the impact reach. When monitored in 2008, average plant cover in the impact reach had increased from 4.1 percent cover in 2006 to 22.8 percent cover in 2008.

Several individuals from the original plantings, as well as the newly installed plants appeared to be stressed or dying when surveyed in 2008. It appeared that this stress was potentially due to drift of aerially sprayed herbicide which had been applied to control reed canarygrass on the right bank of Wilson Creek (D.J. Shook, personal communication, August 2008).

Despite weed control efforts there was still a significant cover of reed canarygrass (*Phalaris arundinacea*) in the impact reach. Other invasive species along the river and in the planting area included yellow flag iris (*Iris pseudacorus*), thistle (*Cirsium* spp.), field bindweed (*Convolvulus arvensis*), and Russian thistle (*Salsola kali*).

04-1698 Vance Creek Riparian Planting

Vance Creek supports cutthroat trout, coho, and possibly chum salmon, as well as lamprey, sculpin, mud minnows, and other aquatic life. The creek has been historically manipulated to accommodate agriculture, mining, and residential development. Despite this, coho and cutthroat continue to use the stream in limited numbers. Two primary limiting factors affecting the habitat are high sediment input and lack of riparian cover. In an effort to help restore the function of the creek and riparian zones, local landowners agreed to allow fencing and riparian planting along a 25-foot buffer on both sides of the stream. With the help of volunteer and student labor from the local school district, and support of the Chehalis Basin Education Consortium, the lower portion of the stream was replanted and fences were installed to exclude livestock.

Impact reach – stream shows little change since 2005 (2007)

Impact reach with livestock fencing and riparian plantings (2007)

Project Location

The project is located on Vance Creek, south of the town of Elma, in Chehalis County. Vance Creek originates in forest lands NW of Elma, flows through residential lands, an abandoned gravel mine, which is now a County park, then through farmlands, entering the Chehalis River at RM 20. Approximately one-quarter of the riparian area restored was county-owned and the remainder was privately owned. The control reach is located in a county park, Vance Creek Park.

Project Objective

The objective of the project was to protect and restore natural streamside vegetation, improve stream temperature, reduce erosion, improve filtration, and recruit LWD. This project provided 12,500 feet of fencing and 16,000 square feet of riparian planting to improve fish habitat in Vance Creek, a tributary to the Chehalis River. The creek is 8.6 miles long with 6 miles of documented salmonid spawning and rearing habitat. The target species for this project was coho salmon. Chehalis Basin Fisheries Task Force sponsored this project and Lonnie Crumley is the contact person.

MC-3 Riparian Plantings

Project Data

Figure 4-43 illustrates changes measured in canopy density. Table 4-32 summarizes the data collected during Year 0 and Year 1 monitoring of the Vance Creek Project.

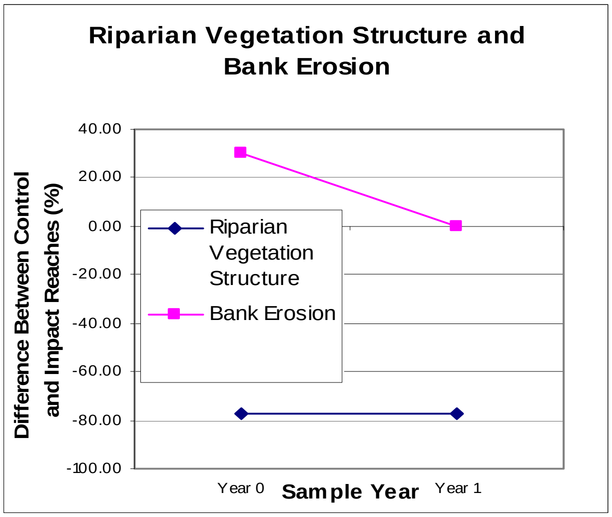


Figure 4-43. Canopy Density at Vance Creek

Table 4-32. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2005)		Year 0* (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Reach Width (m)	4.0	3.0	3.0	2.0	4.0	5.0
Riparian Characteristics						
Canopy Density (1-17)	14.82	14.27	16.65	15.91	15.68	13.68
Riparian Vegetation Structure (%)	81.8	4.5	95.5	18.2	86.4	9.1
Bank Erosion (%)	0	0	40.0	70.0	0	0
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	N/A	N/A	150
Area Planted (m^2)	N/A	N/A	N/A	N/A	N/A	0.27
% Plants Living	N/A	N/A	N/A	N/A	N/A	92
% Cover of Woody Vegetation	N/A	N/A	N/A	N/A	N/A	N/A

Percent cover was not collected at this site in Year 0 or Year 1.
Data collected August 2, 2005 (Year 0); October 4, 2006 (Year 0*); and September 11, 2007 (Year 1)
* Year 0* indicates second year baseline data.

Summary

Livestock exclusion fencing and riparian plantings were installed at the site 2007. The plantings were placed with the assistance of local school students. Data collected at the impact site indicate no change in bank erosion (none present at the site), a slight increase in riparian vegetation structure, and a slight decrease in canopy density between Year 0 and Year 1. As the plantings mature, improvements in these variables are expected. Monitoring was not conducted at Vance Creek in 2008.

04-1711 Lower Klickitat Riparian Restoration

The Lower Klickitat Riparian Restoration Project is intended to restore native riparian and floodplain vegetation between RM 2.6 and 18.3 of the Klickitat River. This reach is a migration and rearing corridor for nearly 100 percent of all migratory fish in the Klickitat watershed and has accounted, on average, for 10 percent of observed basin-wide steelhead spawning. The project area occurs within a reach identified as the third highest of 21 top priority geographic areas in the "Klickitat Lead Entity Region Salmon Recovery Strategy" (Klickitat County 2003). Phase 1 of the project will involve restoration activities on seven sites and will total 6.9 acres of riparian plantings along 1.45 miles of stream bank.

Riparian conditions in this reach are generally poor due to a combination of the 1996 flood deposits and channel encroachment by highway and road fill. Many of the flood deposits are well above the two-year flood surface and at a comparable elevation to surfaces that are well-vegetated and are generally stable. Vegetation has been very slow in colonizing these coarse, well-drained substrates. Similar deposits from flooding in 1974 along Swale Creek, a Klickitat River tributary, are still bare. This project attempts to address the limiting features and functions of poor riparian and floodplain vegetation which were identified in the *Klickitat Lead Entity Region Salmon Recovery Strategy* (Klickitat County 2003).


Survey being conducted in control reach in Year 3 (2008)


Impact reach at Transect F facing Transect A (2008)

Project Location

This project is located in Klickitat County on the Klickitat River. The restoration sites are visible from State Route 142. The impact reach is approximately 200 meters in length and is located on the bank of the Klickitat River at the first pullout one-quarter mile south of Horseshoe Bend Road, on the east side of State Route 142. The control reach is also 200 meters long and is located across the river and downstream from the treatment reach, approximately three-quarters mile south of Horseshoe Bend Road on the Klickitat Trail.

MC-3 Riparian Plantings

Project Objective

The goal of this project is to improve riparian and floodplain vegetation in order to restore natural streamside vegetation, increase bank cover, reduce erosion, increase woody debris recruitment, and increase the potential for trapping fine sediment. The target species for this project is steelhead. This project was sponsored by the Mid-Columbia Regional Fisheries Enhancement Group and the primary contacts are Will Conley (Yakama Nation) and Margaret Neuman (Mid-Columbia Regional Fisheries Enhancement Group).

Project Data

During monitoring in 2008 there was a notable amount of sand and gravel deposition in the impact reach planting areas. Many of the stakes marking the vegetation plots were buried and could not be relocated visually; however, GPS coordinates and, in several cases, a metal detector were used to identify the original location of vegetation plots. New plot centers were established at these locations.

Figure 4-44 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-33 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Lower Klickitat Riparian Restoration project.

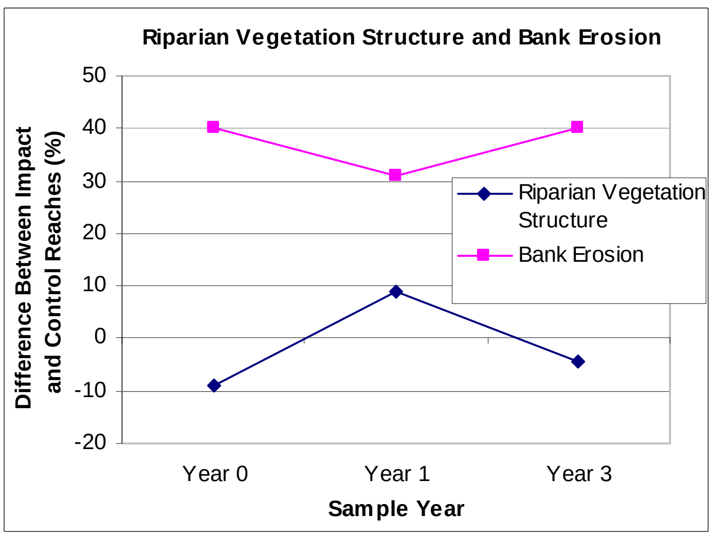


Figure 4-44. Riparian Vegetation Structure and Bank Erosion at the Lower Klickitat

Table 4-33. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 3 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Reach Width (m)	15	15	20	20	20	20
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	6.82	4.91	4.41	4.65	5.55	7.91
Riparian Vegetation Structure (% 3 layers)	18.2	9.1	18.2	27.3	31.8	27.3
Bank Erosion (%)	0	40	0	31	0	40
Riparian Planting						
Number of Plantings (total)	N/A	N/A	N/A	4,733	N/A	4,733
Area Planted (acres)	N/A	N/A	N/A	5.2	N/A	5.2
% Plants Living	N/A	N/A	N/A	92.7	N/A	85.4
Percent Cover of Woody Vegetation (avg)	N/A	N/A	N/A	11.6	N/A	29.2
Data collected May 11, 2005 (Year 0), June 20, 2006 (Year 1), and July 1-2, 2008 (Year 3)						

Summary

When initially installed, riparian plantings were placed in 18-inch deep trenches dug into the cobble banks using heavy equipment. The trenches were dug to allow plantings to establish in areas with adequate moisture in the root zone during low stream flow. Initial survival of the plantings was measured at over 90 percent. Despite the noticeable silt and sand deposition in the planting areas, overall, plant survival was still high (85.4 percent) when monitored in 2008.

Substantial growth of planted willows and cottonwoods has occurred between the Year 1 and Year 3 monitoring period. Average height increased from 57 cm in 2006 to 150 cm in 2008. Additionally, average percent cover of woody species in riparian planting plots increased from 11.6 percent in 2006 (Year 1) to 29.2 percent in 2008 (Year 3). Volunteer willows and cottonwoods were also scattered throughout the planting area. Many planted cottonwoods were bushy and multistemmed due to evident beaver browse. Despite the continued survival and growth of planted cottonwood and willow species, there were many invasive species including cheatgrass (*Bromus tectorum*), bulbous bluegrass (*Poa bulbosa*), yellow sweet-clover *(Melilotus officinalis),* yellow salsify (*Tragopogon dubius*), and noxious weeds such as St. John's Wort (*Hypericum perforatum*) and Dalmatian toadflax (*Linaria dalmatica*) scattered widely throughout the impact reach. However, these invasive weeds did not appear to be impacting survival and growth of the riparian plantings.

4.1.4 Livestock Exclusion Projects

4.1.4.1 Protocol Description

Livestock Exclusions

The Oregon Watershed Enhancement Board (OWEB) and the Washington SRFB both have the responsibility for funding watershed and salmon habitat restoration projects in their respective states. Both states have developed comprehensive, long-term monitoring strategies to identify monitoring needs for restoration actions. Effectiveness monitoring of projects has occurred at the local level, but has not been consistently coordinated within each state or across the state boundary. Additionally, the management of salmon requires coordinated data collection across the region such that restoration efforts can address the needs of species whose ranges cross state and jurisdictional boundaries.

In order to address common monitoring needs, the OWEB SRFB Coordinated Monitoring Program for Livestock Exclusions was developed as a pilot program to combine monitoring efforts across state jurisdictions and produce comparable and compatible data from a regional perspective. Livestock Exclusion Projects were selected because there was a need in Washington to increase the number of Livestock Exclusion Projects monitored so that data analysis could be improved by increasing sample size, and there was a need in Oregon to monitor a subsample of the large number of Livestock Exclusion Projects implemented.

In 2008, 2 Livestock Exclusion Projects were monitored, out of 12 active projects in the Coordinated Monitoring Program. Variables measured include livestock presence, riparian vegetation structure, shading, and bank erosion.

Figure 4-45 shows the locations of all of the Livestock Exclusion Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects included in the program.

Livestock Presence

Crawford (2008d) was used to assess the implementation of the exclusion by checking for livestock presence. Photographs were taken to document any effects from, or evidence of, livestock and to try to determine the point of entry for any livestock. As a monitoring category, Livestock Exclusions Projects will be considered functional if 80 percent of the projects continue to exclude livestock after 10 years. Any entrance of livestock into the riparian area would constitute lack of project success. Data analysis methods are discussed further in Chapter 5.0.

MC-4 Livestock Exclusion

Riparian Vegetation

Riparian vegetation structure was monitored using the same approach as described in Section 4.1.3.1.

Shading

Shading was monitored using the same approach as described in Section 4.1.3.1.

Actively Eroding Streambanks

Crawford (2008d) was used to estimate the percent of the linear distance of the channel on both sides at each transect that is actively eroding at active channel height. The project will be considered effective if a 20 percent reduction in percent bank length that is actively eroding is observed within 10 years and if *t*-test results are significant.

4.1.4.2 Results/Data Summaries/Decision Criteria

Table 4-34 identifies the summary statistics for livestock exclusions. The determination on functional exclusions was made after implementation.

4.1.4.3 Data Issues

Similar data issues that were discussed in Section 4.1.3.3 also occurred for Livestock Exclusion Projects.

Table 4-34. Decision Criteria for Livestock Exclusions

Monitoring Parameters	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Livestock Exclusion Fencing	The percent of the total number of Livestock Exclusion Projects meeting the design criteria for excluding livestock from the stream	%	None. Count of functional exclusions	≥ 80% of exclusions are functional by Year 10 “Functional” means there are no holes in the fencing and no recent signs of livestock inside the exclusion.
	Area of Exclusion	Acres	None	None
Riparian Condition	Mean percent canopy density at the bank Densiometer Reading	1-17 score	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between impact and control by Year 10
	Three-layer riparian vegetation presence (proportion of reach)	%	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between impact and control by Year 10
	Actively eroding banks	%	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect a decrease between impact and control by Year 10

Source: Crawford 2008d

4.1.4.4 Project-Specific Summaries

Projects that involve fencing riparian areas to exclude use by livestock are monitored prior to implementation of the project (Year 0) and for a period of 10 years following implementation. Post-project monitoring is conducted at the control site and impact site during Years 1, 3, 5, and 10. Summary statistics for each Livestock Exclusion Project are presented below. Projects sampled prior to 2008 may have pre-implementation (Year 0) and post-implementation data. This may vary if project implementation was delayed or incomplete during 2008 or previous years.

MC-4 Livestock Exclusion

02-1498 Abernathy Creek Riparian Restoration (Livestock Exclusion) – SRFB

The Abernathy Creek Riparian Restoration Project aimed to restore 84 acres of riparian area along Abernathy Creek, a tributary to the Columbia River, which provides critical spawning and rearing habitat for ESA-listed Chinook, chum, and steelhead, as well as for coho and sea-run cutthroat trout. The project involved the removal of weedy plant species, the exclusion of livestock through the installation of approximately 5,000 feet of fencing, and planting of native trees and shrubs, including conifers, within the riparian area. The project is expected to benefit approximately 4,023 meters of stream habitat.

As part of this project, conservation easements were purchased from private landowners who agreed to leave the riparian areas undisturbed in perpetuity. The cooperative efforts of those landowners allowed sensitive areas to remain intact, while maintaining use of the areas for recreational activities, such as hiking and fishing. These easements encompassed approximately 44 acres of land and 11,000 linear feet of Abernathy Creek shoreline. The remaining 40 acres of land within the project area is WDFW property located at the mouth of Abernathy Creek.

Impact reach prior to livestock fencing in 2004 (Year 0)

Impact reach after livestock fencing in 2007 (Year 3)

Project Location

The project area is located along Abernathy Creek (WRIA 25), a tributary to the Columbia River, in Cowlitz County, Washington. The project area begins at the highly disturbed mouth of the creek (on WDFW property) and continues through conservation easements purchased by Cowlitz County, situated below the USFWS Abernathy Technical Center. The impact reach is 240 meters in length and is located within one of the conservation easement areas on private property. The control reach is also 240 meters long and is located 1.3 miles upstream from the impact reach on USFWS property, adjacent to the Abernathy Fish Technology Center.

MC-4 Livestock Exclusion

Project Objective

Cowlitz County sponsored the Abernathy Creek Project, which was designed to restore approximately 84 acres of riparian habitat along Abernathy Creek, including 2.5 miles of shoreline. Prior to the project, the creek had excessive sediments, lacked large woody debris, and had water temperatures that exceeded state standards. This project was designed to mitigate these conditions by restoring riparian vegetation, fencing out livestock, and restricting vehicle access at the mouth of the creek.

Project partners include Cowlitz County, Cowlitz Conservation District, Academy Surveying, WDFW, Cowlitz Indian Tribe, USFWS, and the Washington Jail Industries Board. The contact person for this project is Darin Houpt.

Project Data

Figure 4-46 shows the changes measured in riparian vegetation structure and bank erosion. Table 4-35 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Abernathy Creek Riparian Restoration (Livestock Exclusion) Project.

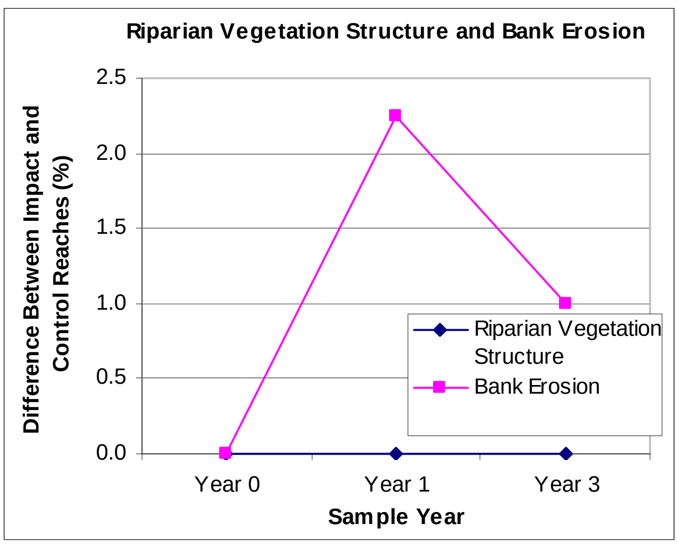


Figure 4-46. Riparian Vegetation Structure and Bank Erosion at Abernathy Creek

Table 4-35. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	16.68	15.55	16.55	15.41	16.46	14.18
Riparian Vegetation Structure (% 3 layers)	100	100	100	100	100	100
Bank Erosion (%)	2.0	2.0	0.25	2.5	2.8	3.8
Riparian Planting						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	84.0	N/A	84.0
Data collected June 11-12, 2004 (Year 0); June 7-8, 2005 (Year 1); and June 4-5, 2007 (Year 3)						

Summary

Data collected at the Abernathy project site indicate that the high quality habitat present at the site is being maintained. Small decreases in canopy density and increases in bank erosion are within the range of natural variability at this site. Continued maintenance of the fencing should maintain the level of measured variables throughout the monitoring period. Monitoring was not conducted at Abernathy in 2008, but Year 5 monitoring is scheduled for 2009.

04-1655 Hoy Riparian Restoration (Livestock Exclusion)

The Hoy Riparian Restoration Project is located within a 2-mile section of the middle Skagit River east of the town of Hamilton, Washington. This section of river is one of the most important spawning areas for Chinook salmon, chum salmon, pink salmon, and steelhead in the lower and middle Skagit River. Spawning surveys conducted in recent years indicated that this section of the river possesses the highest concentration of fall Chinook salmon spawners in the middle Skagit River. Fall Chinook salmon are one of six distinct populations of Chinook in the Skagit watershed, and this population is undergoing the greatest decline. The riparian vegetation corridor along many areas of the project site has been substantially impacted by cattle grazing and land clearing for farming. The poor riparian conditions resulting from these activities have led to erosion along the river bank. In 2005, a livestock exclusion fence was installed at the edge of the plantings to exclude cattle that graze in the adjoining hay field. This project was designed to restore the riparian area along this property and protect the river banks, sustaining the morphology of the river channel over approximately 3,218 meters.

Impact reach before livestock exclusion fencing in 2005 (Year 0). Fence shown here was original fencing and was removed by bank erosion between 2005 and 2006.

Impact reach after fencing in 2008 (Year 3)

Project Location

This project was located on Seattle City Light property along the Skagit River in Skagit County. The project area is a 2-mile section of the middle Skagit River east of the town of Hamilton. The 240-acre property is located on the south side of the Skagit River. Both the control and impact reaches measure 210 meters in length.

Project Objective

The objective of the project was to restore and protect natural streamside vegetation, improve stream temperature, reduce erosion, improve filtration, and recruit LWD. Restoration of riparian vegetation will result in protection of the river bank along the Hoy property, which will ultimately sustain the river channel morphology in this area of the middle Skagit. This project is co-sponsored by Seattle City Light and the Skagit Land Trust.

Project Data

Figure 4-47 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-36 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Hoy Project.

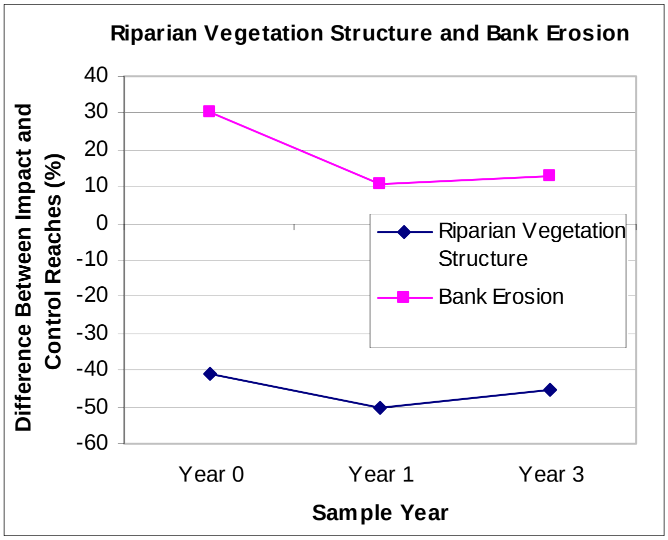


Figure 4-47. Riparian Vegetation Structure and bank erosion at Hoy

Table 4-36. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 3) Monitoring

Variable	Year 0 (2005)		Year 1 (2006)		Year 3 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics						
Canopy Cover (from densiometer 1-17)	16.73	6.0	16.64	3.09	15.9	5.3
Riparian Vegetation Structure (% 3 layers)	59.1	18.2	50.0	0	50.0	4.5
Bank Erosion (%)	70.0	100	89.5	100	82.5	95.5
Riparian Planting						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	38.0	N/A	38.0
Data collected May 6, 2005 (Year 0); July 19, 2006 (Year 1); and May 5, 2008 (Year 3)						

MC-4 Livestock Exclusion

Gate within exclusion fence.

Cattle droppings observed along the exclusion fence within the riparian planting area in 2008 (Year 3)

Summary

Fencing was installed in 2005 at the edge of the plantings to exclude cattle that graze in the adjoining hay field. Plantings in the impact area were also installed in 2005 at the top of the eight to ten-foot high eroding slope along the Skagit River. The plantings will provide a wide buffer for the river, approximately 200 feet, protected by the fencing. Vegetation data collected in 2008 indicated that there has been slight improvement in riparian vegetation structure and canopy density since Year 1 (2006), due to the establishment of volunteer willows. However there has been no improvement in riparian habitat or bank erosion from Year 0 (2005).

In 2008, the exclusion fence was intact though a gate for livestock was also present, suggesting that cattle may be moved through the area. Cattle sign was documented within the exclusion in the form of tracks and droppings. Year 5 monitoring at the Hoy site is scheduled for 2010.

04-1698 Vance Creek Riparian Planting and Fencing – SRFB

Vance Creek supports cutthroat trout, coho, and possibly chum salmon, as well as lamprey, sculpin, mud minnows, and other aquatic life. The creek has been historically manipulated to accommodate agriculture, mining, and residential development. Despite this, coho and cutthroat continue to use the stream in limited numbers. Two primary limiting factors affecting the habitat are high sediment input and lack of riparian cover. In an effort to help restore the function of the creek and riparian zones, local landowners agreed to allow fencing and riparian planting along a 25-foot buffer on both sides of the stream. With the help of volunteer and student labor from the local school district, and support of the Chehalis Basin Education Consortium, the lower portion of the stream was replanted and fences were installed to exclude livestock. The Vance Creek Project is expected to benefit approximately 7,644 meters of stream habitat.

Impact reach – stream shows little change since 2005 (2007)

Impact reach with livestock fencing and riparian plantings (2007)

Project Location

The project is located on Vance Creek, south of the town of Elma, in Chehalis County. Vance Creek originates in forest lands NW of Elma, flows through residential lands, an abandoned gravel mine, which is now a County park, then through farmlands, entering the Chehalis River at RM 20. Approximately one-quarter of the riparian area restored was county-owned and the remainder was privately owned. The control reach is located in a county park, Vance Creek Park. Both the impact and control reaches measure 150 meters in length.

Project Objective

The objective of the project was to protect and restore natural streamside vegetation, improve stream temperature, reduce erosion, improve filtration, and recruit LWD. This project provided 12,500 feet of fencing and 16,000 square feet of riparian planting to improve fish habitat in Vance Creek, a tributary to the Chehalis River. The creek is 8.6 miles long with 6 miles of documented salmonid spawning and rearing habitat. The target species for this project was coho salmon. Chehalis Basin Fisheries Task Force sponsored this project and Lonnie Crumley is the contact person.

MC-4 Livestock Exclusion

Project Data

Figure 4-48 shows changes measured in riparian vegetation structure and bank erosion. Table 4-37 summarizes the data collected during Year 0 and Year 1 monitoring of the Vance Creek Project. The project was not completed in 2006, so Year 1 data were collected in 2007.

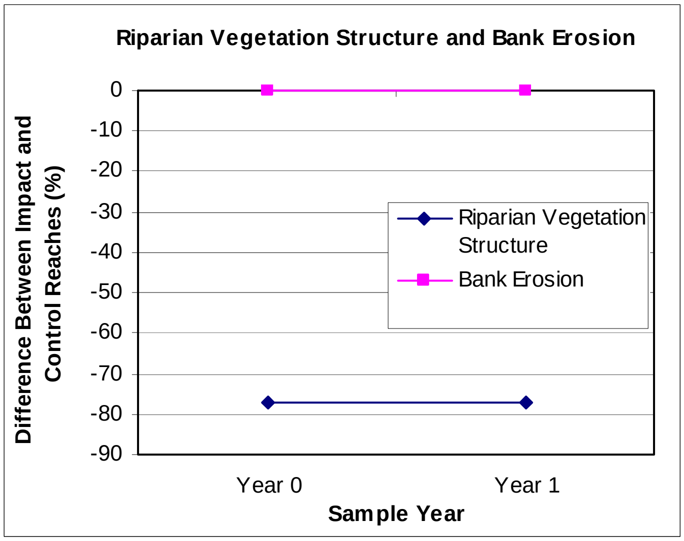


Figure 4-48. Riparian Vegetation Structure and Bank Erosion at Vance Creek

Table 4-37. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

	Year 0 (2005)		Year 1 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	14.82	14.27	15.68	13.68
Riparian Vegetation Structure (%)	81.8	4.5	86.4	9.1
Bank Erosion (%)	0	0	0	0
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	5.0
Data collected August 2, 2005 (Year 0) and September 11, 2007 (Year 1)				

Summary

Livestock exclusion fencing was installed in 2007, north of the creek, where horses are pastured. The fencing project was done at the same time that the riparian plantings were placed by local school classes. The fencing is electric and prevents livestock from accessing the creek. Data collected at the site indicate no change in bank erosion (none present at the site), a slight decrease in vegetation structure relative to the control reach, and a slight decrease in canopy density. These results are due to the removal of vegetation to install the new plantings. As the plantings mature, improvements in these variables are expected. Monitoring was not conducted at Vance Creek in 2008. Year 3 monitoring of Vance Creek is scheduled for 2009.

05-1447 Indian Creek Yates Restoration Project (Livestock Exclusion) – SRFB

The Indian Creek Yates Restoration Project addresses protection of high priority habitats in WRIA 62. It is one of the few streams in WRIA 62 where bull trout observations have occurred in recent years. The project implements the first priority action in the eighth ranked high priority subbasin in the Pend Oreille Lead Entity area. In 1995, a fish habitat survey was conducted and found that, of the 2.3 miles of stream assessed, 28 percent of the spawning habitat in Indian Creek was found within the project area.

Fish habitat in the project reach has been impacted by an impassable culvert and livestock grazing. Historically, at the upstream end of the barrier, splash boards were placed to create a small pond. Silt deposited and filled the channel for approximately 60 meters upstream of the culvert. The riparian area was used for grazing three horses. The horses trampled the stream banks and riparian area, limiting the recruitment of riparian shrubs. The Indian Creek Yates Restoration Project was designed to address these issues and improve fish habitat and connectivity within approximately 965 meters of the creek.

Exclusion fencing installed in Year 1 (2007)

Impact reach in Year 1 (2007)

Project Location

The project area is located on Indian Creek, a tributary to the Pend Oreille River, in Pend Oreille County, within the Pend Oreille River subbasin (WRIA 62). The impact reach is 160 meters in length and is located on the Walker property within Township 32N, Range 45E, and Section 20. The control reach also measures 160 meters in length.

Project Objective

This project was intended to benefit bull trout. The objectives of the project were to replace the undersized culvert with a small bridge; dredge the upstream channel section and stabilize the silt deposits by seeding; and construct a riparian fence to promote bank stabilization and re-vegetation. Implementation of this project has helped to restore connectivity throughout Indian

Creek, as no other barriers are known to exist. This project was sponsored by the Kalispel Indian Tribe and Todd Anderson is the primary contact person.

Project Data

Figure 4-49 shows the changes measured in riparian vegetation structure and bank erosion at the Indian Creek Yates Project. Table 4-38 summarizes the data collected during Year 0 and Year 1 monitoring.

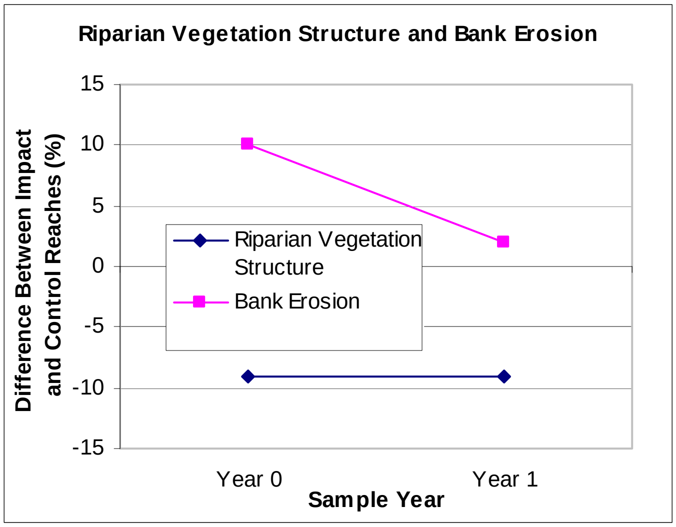


Figure 4-49. Riparian Vegetation Structure and Bank Erosion at Indian Creek Yates

Table 4-38. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact
Riparian Characteristics				
Canopy Density (1-17)	12.0	16.1	15.5	16.8
Riparian Vegetation Structure (%)	100	90.9	100	90.9
Bank Erosion (%)	0	10.0	0.3	2.3
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	4.5
Data collected May 30-31, 2006 (Year 0) and August 20-21, 2007 (Year 1)				

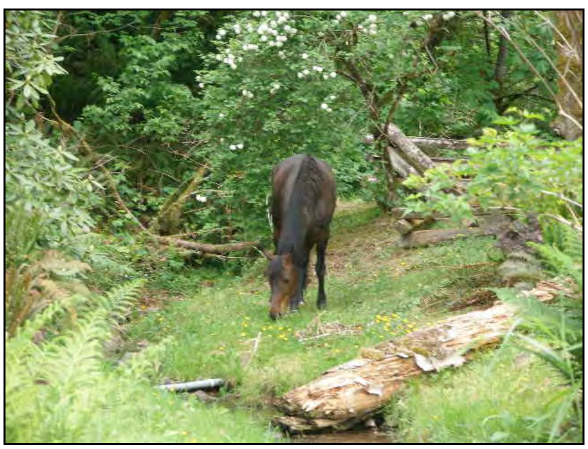
Summary

Data collected at the Indian Creek Yates Restoration site indicate improvement or maintenance in all three measured variables. Bank erosion decreased substantially between Year 0 and Year 1 and the high rating for vegetation structure was maintained. A slight increase in canopy density was noted, but this increase was smaller than that seen in the control reach, so it can not be considered a direct project effect. Canopy density at the project site is currently high, but may still increase as vegetation continues to develop. Evidence of recent riparian degradation along Indian Creek was observed in the impact reach at livestock crossings during the Year 0 survey; however, by Year 1, the ground cover at these same locations had already shown obvious signs of recovery. Monitoring was not conducted at the Indian Creek Yates site in 2008, but Year 3 monitoring is scheduled for 2009.

05-1547 Rauth Coweeman Tributary Restoration – SRFB

The Coweeman subbasin is identified as one of the most significant areas for salmon recovery among the Washington Cascade strata subbasins, based on fish population significance and realistic prospects for restoration. The Rauth Coweeman Tributary Restoration Project is intended to provide short-term and long-term benefits to all life stages of Chinook, coho, steelhead, chum, and searun cutthroat. As stated in the Coweeman Subbasin Plan, all Coweeman River salmon and steelhead need to be restored to a high level of viability to meet regional recovery objectives. This project encompasses the lower 2,000 feet of an unnamed tributary to the Coweeman River. This is a multi-faceted project that includes tasks to: provide fish passage by replacing a known barrier, providing access to 2.5 miles of habitat; restore the appropriate cross section to lower 400 feet of channel; install woody debris to restore pool habitat; establish and improve woody vegetation in 2.25 acres of riparian area; and construct a livestock exclusion fence to protect riparian plantings. The project is expected to benefit approximate 1,207 meters of stream habitat.

The landowner and Toutle High School students provided the labor to remove the existing fence, conduct site preparation activities necessary to establish woody riparian vegetation, plant the riparian vegetation, and are willing to help to maintain the riparian plantings for the first two years, and reconstruct the livestock exclusion fence as needed. Cowlitz Conservation District provided plants and fencing materials.



"Joe" grazing in the impact area prior to fencing (Year 0)

Impact area after livestock fencing (Year 1)

Project Location

The project area is located in Cowlitz County within the Cowlitz River subbasin (WRIA 26). The impact reach is 146 meters in length and is located on the Rauth property within Township 8 N, Range 1 W, and Section 26. The control reach is also 146 meters in length and is located 100 yards upstream from the impact reach on the Rauth/Nesbit property. The project site is on an unnamed tributary to the Coweeman River at RM 13.3. The Coweeman River is a tributary to the Cowlitz River at about RM 0.5.

MC-4 Livestock Exclusion

Project Objective

The goal of the project was to restore native riparian vegetation along a salmon bearing stream. The objectives of the project were to restore natural streamside vegetation, improve stream temperature, reduce erosion, increase natural filtration, and recruit large woody debris. Approximately 450 feet of streambank was fenced on the Rauth property to protect riparian plantings from livestock. In addition to the livestock fencing, this project was designed to improve fish passage through barrier removal; restore channel cross-section; improve pool and riffle habitat through installation of large woody debris; and restore 2.25 acres of riparian habitat. This project addresses the needs identified in the Lower Columbia Salmon Recovery Plan. The Cowlitz Wahkiakum Conservation District sponsored this project and Darin Houpt is the contact person.

Project Data

Figure 4-50 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-39 summarizes the data collected during Year 0 and Year 1 monitoring of the Rauth Coweeman Project.

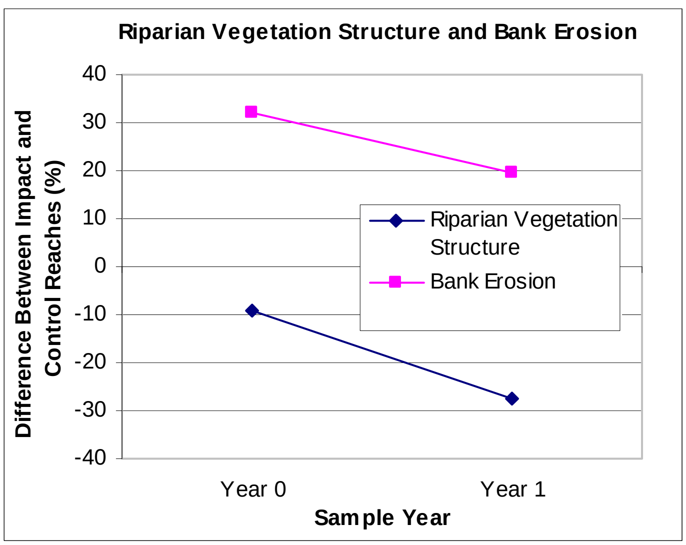


Figure 4-50. Riparian Vegetation Structure and Bank Erosion at Rauth Coweeman

MC-4 Livestock Exclusion

Table 4-39. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

	Year 0 (2006)		Year 1 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	16.96	14.55	16.64	13.86
Riparian Vegetation Structure (%)	100	90.9	100	72.7
Bank Erosion (%)	0.5	32.5	1.8	21.3
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	2.3
Data collected May 19, 2006 (Year 0) and October 12, 2007 (Year 1).				

Summary

Data collected at the Rauth Coweeman project site indicate short-term improvements in some measured parameters. Bank erosion levels were reduced between Year 0 and Year 1 when compared to a control reach. Small decreases were noted in canopy density for both the control and impact reaches. Riparian vegetation structure was maintained in the control reach, but decreased in the impact reach, potentially due to removal of invasive vegetation to allow native species to grow. Over time, as native vegetation matures, these variables are expected to show improvement. Monitoring was not conducted at Rauth Coweeman in 2008, but Year 3 monitoring is scheduled for 2009.

205-060 Bottle Creek Livestock Exclusion Project – OWEB

The Bottle Creek Project site is associated with past timber harvest and land management practices that allowed easy access to the stream by cattle for approximately 80 years. The Bottle Creek Project was sponsored by the Union Soil and Water Conservation District in response to the need for improvements in riparian condition along the banks of the creek. Additionally, this project was intended to increase bank stability, thus reducing sedimentation, and providing additional riparian shading. The Bottle Creek Project is expected to benefit approximately 610 meters of stream habitat.

Impact reach in 2006 (Year 0)

Impact reach in 2007 (Year 1)

Project Location

The project area is located on Bottle Creek, within the Upper Grande Ronde Watershed, in Union County. The impact and control reaches are 150 meters in length and are located near the town of Union, Oregon, in Township 5S, Range 42E, Section 31.

Project Objective

This project was intended to benefit steelhead and resident redband rainbow trout (and potentially bull trout and spring Chinook) by replacing an existing, temporary electric fence with a permanent, four strand, barbed wire “let down” fence to exclude livestock from approximately 2,000 feet of Bottle Creek. “Let down” fencing is laid down in the winter to prevent significant damage to the fence from snow. The objective of this project was to exclude cows from the riparian area such that deciduous riparian vegetation can be protected and enhanced, providing additional shading to the stream. In addition, this project was designed to improve stream bank stability, resulting in decreased sedimentation into the stream. The project area is located on USFS Land and Aric Johnson is the contact person for the Bottle Creek project.

Project Data

Figure 4-51 shows changes measured in riparian vegetation structure and bank erosion at the Bottle Creek Livestock Exclusion Project. Table 4-40 summarizes the data collected during Year 0 and Year 1 monitoring.

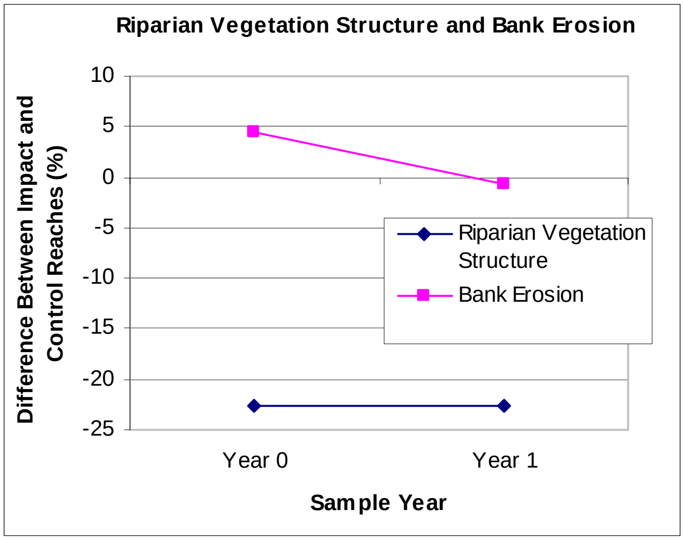


Figure 4-51. Riparian Vegetation Structure and Bank Erosion at Bottle Creek

Table 4-40. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable[1/]	Year 0 (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact
Riparian Characteristics				
Canopy Density (1-17)	14.68	11.23	15.09	10.86
Riparian Vegetation Structure (%)	100	77.30	100	77.30
Bank Erosion (%)	6.5	11.0	2.0	1.3
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	12.5
Data collected June 19-20, 2006 (Year 0) and June 14, 2007 (Year 1).				

Summary

Data collected at the Bottle Creek project site indicate short-term improvement for some variables measured but not for others. Between Year 0 and Year 1, a small decrease in bank erosion was noted in the impact reach when compared to a control reach. However, no change was noted in riparian structure, and canopy density decreased slightly when compared to a control reach. Over time, as vegetation growth increases, improvements are expected in canopy density and vegetation structure. If improvement is not observed in the 10-year time frame, re-assessment of the “let down” practice and fence function is recommended.

The new fencing was inspected along the impact reach and found to be fully intact. The project area is inhabited by livestock and elk, both of which potentially can impact the stream habitat at the project site. In 2006 (Year 0), recent evidence of stream habitat degradation by elk and/or livestock was observed in the impact reach. However, no recent evidence of elk or livestock activity was observed in the impact reach during the Year 1 (2007) survey. Monitoring was not conducted at Bottle Creek in 2008; however, Year 3 monitoring is scheduled for 2009.

205-060 North Fork Clark Creek Tributary Exclusion Project – OWEB

The North Fork Clark Creek Tributary Project site is in an area that has been used for timber harvest in the past. Additionally, land use management has allowed livestock access to the stream for 25-30 years, resulting in deteriorated conditions along the riparian corridor. The Union Soil and Water Conservation District sponsored the project to address the need for improvements in riparian condition along the banks of the creek. Additionally, the project was intended to increase bank stability, thus reducing sedimentation, and providing additional riparian shading. The North Fork Clark Creek Tributary Project is expected to benefit approximately 732 meters of stream habitat.

Impact reach at Transect K in 2006 (Year 0)

Impact reach at Transect K in 2007 (Year 1)

Project Location

The project area is located on North Fork Clark Creek Tributary, within the Upper Grande Ronde Watershed, in Union County. The impact and control reaches are each approximately 150 meters in length and are located near the town of Elgin, Oregon, in Township 1S, Range 41E, Section 18.

Project Objective

This project was intended to benefit steelhead and resident redband rainbow trout (and potentially bull trout and spring Chinook) by replacing the previously existing, temporary electric fence with a permanent, four strand, barbed wire “let down” fence to exclude livestock from approximately 2,400 feet of North Fork Clark Creek. The objective of this project was to exclude livestock from the riparian area such that deciduous riparian vegetation may be protected and enhanced, providing additional shading to the stream. In addition, this project was designed to improve stream bank stability, resulting in decreased sedimentation into the creek. The project area is located on USFS Land and Aric Johnson is the contact person for the Clark Creek Tributary Project.

MC-4 Livestock Exclusion

Project Data

Figure 4-52 shows the changes measured in bank erosions at the North Fork Clark Creek Livestock Exclusion Project. Table 4-41 summarizes the data collected during Year 0 and Year 1 monitoring.

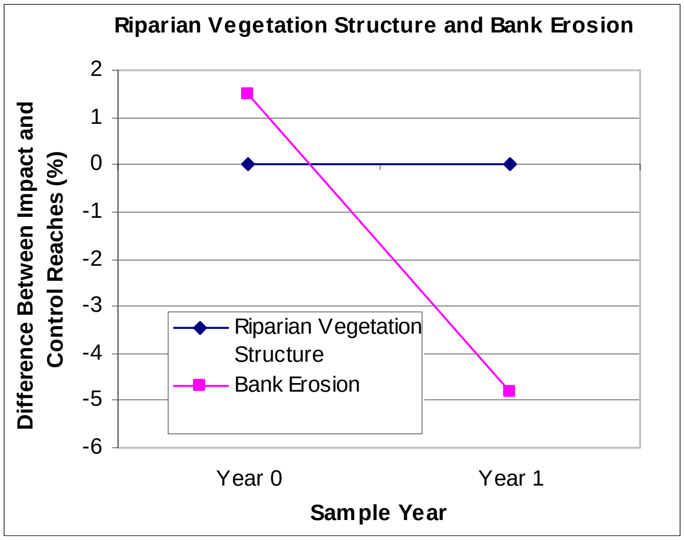


Figure 4-52. Riparian Vegetation Structure and Bank Erosion at North Fork Clark Creek Outlet

Table 4-41. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006) Control	Year 0 (2006) Impact	Year 1 (2007) Control	Year 1 (2007) Impact
Riparian Characteristics				
Canopy Density (1-17)	14.14	14.82	13.14	15.41
Riparian Vegetation Structure (%)	100	100	100	100
Bank Erosion (%)	37.0	38.5	4.8	0
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	6.5
Data collected June 20, 2006 (Year 0) and June 15, 2007 (Year 1).				

Summary

Data collected at the North Fork Clark Creek project indicate improvement in three parameters measured. As compared to the control reach, a slight increase was noted for canopy density and a decrease was noted for bank erosion. Both the impact reach and the control reach were at the maximum level for vegetation structure and this was maintained.

This project includes a “let down” fence that is laid down in the winter to prevent significant damage to the fence from snow. The “let down” practice does not appear to be negatively affecting the exclusion performance at this site. In 2006 (Year 0), recent evidence of stream habitat degradation by elk and/or livestock was observed in the impact reach; however, no recent evidence of elk or livestock activity was observed in the impact reach during the Year 1 (2007) survey. Monitoring was not conducted at North Fork Clark Creek in 2008; however, Year 3 monitoring is scheduled for 2009.

206-072 Gray Creek Livestock Exclusion Project – OWEB

The Gray Creek Project is located on an active dairy and the land has been used for agricultural purposes for at least the past 25 years. Approximately 120 cattle have used the land adjacent to the creek for grazing and have had access to the creek previously, which has resulted in degradation of the aquatic habitat. The Gray Creek Project was intended to improve the riparian and stream conditions through livestock exclusion practices, by fencing along both sides of the creek.

Impact reach at Transect A in 2006 (Year 0)

Impact reach at Transect A in 2007 (Year 1)

Project Location

The Gray Creek Project area is located in the Coquille Watershed, southwest of Coquille, Oregon, approximately 0.5 miles from the Watershed Council Office along State Highway 42. The habitat within the proposed project area is a low-gradient meandering stream that runs through a dairy at the site. The control reach is located at the Coquille Valley Elks Golf Course, upstream along Gray Creek, across Highway 42.

Project Objective

The objective of the project was to install livestock exclusion fencing, with the goal of preventing livestock access to the creek and allowing riparian vegetation cover and bank stability to increase along Grays Creek. The project involved fencing along both sides of the creek for approximately 1,981 meters, excluding a total area of approximately 2.8 acres. The fence has two setbacks, one at 5 feet and one at 12 feet, to allow for maintenance of the waterway. The Coquille Watershed Association sponsored this project and the land owners within the project area included the Coquille Valley Elks Golf Course along the control reach and Mike and Lisa Miranda, private landowners, on the impact reach. Jennifer Hampel and Heather Lilienthal, of the Coquille Watershed Association, are the contacts for this project.

MC-4 Livestock Exclusion

Project Data

Figure 4-53 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-42 summarizes the data collected during Year 0 and Year 1 monitoring of the Gray Creek Livestock Exclusion Project.

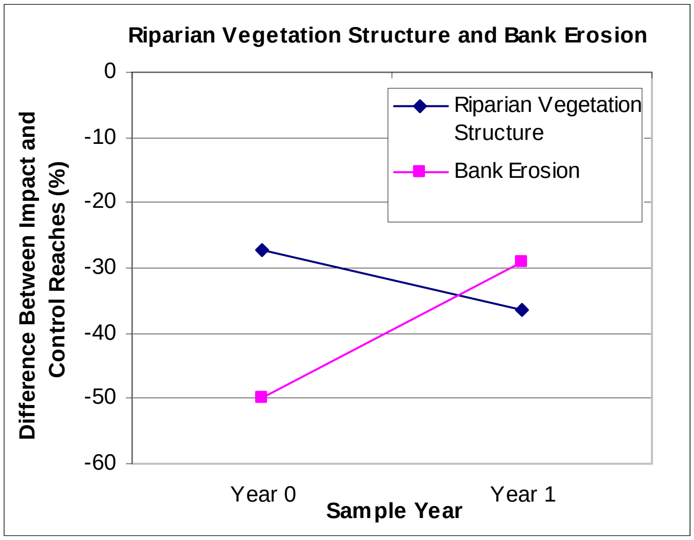


Figure 4-53. Riparian Vegetation Structure and Bank Erosion at Gray Creek

Table 4-42 Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

	Year 0 (2006)		Year 1 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	11.64	16.36	13.46	15.77
Riparian Vegetation Structure (%)	27.3	0	36.4	0
Bank Erosion (%)	63.2	13.4	64.0	34.8
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	No
Area of Exclusion (acres)	N/A	N/A	N/A	2.8
Data collected June 8, 2006 (Year 0) and June 26, 2007 (Year 1).				

Summary

After the first year, improvements in measured variables have not been observed at the Gray Creek project site. Photo documentation indicates potential access by livestock through the fencing. During Year 1 monitoring (2007), fencing was observed onsite and all posts and lines were intact in the impact reach. All livestock were observed to be excluded from Gray Creek in the impact reach at the time of the survey. Although at the time of the survey no livestock were observed within the exclusion area, it appeared that livestock had grazed the land immediately within the exclusion area at one time prior to the survey. It was speculated that the livestock were eating the vegetation immediately inside the exclusion by reaching their heads through the fence. This was evident in the difference between the height of the vegetation closer to the creek versus the vegetation near the fencing. Once fencing is augmented and access to the stream is prevented, improvements in measured variables are expected over the long-term. Monitoring was not conducted at Gray Creek in 2008; however, Year 3 monitoring is scheduled for 2009.

206-095 Jordan Creek Livestock Exclusion Project – OWEB

The Jordan Creek Project is located in an area that has been used in agricultural production for approximately the past 50 years, resulting in impacted habitat conditions within the creek and adjacent riparian areas. This project is sponsored by the Long Tom Watershed Council with the intent to primarily benefit cutthroat trout, and other cold water species (i.e., state-listed western brook lamprey), which may also be present in Jordan Creek and the Coyote Creek sub-watershed. The project included the installation of woven wire fencing to exclude use of the creek by livestock, the establishment of off-channel watering facilities for livestock use, sloping of the bank in areas where it was too steep for planting, and planting of trees and shrubs in areas adjacent to the creek. Riparian zone restoration included the removal and long-term control of blackberry, followed by re-vegetation with native trees.

Impact reach in 2006 (Year 0)

Impact reach in 2007 (Year 1)

Project Location

Jordan Creek is in the southwest region of the Long Tom Watershed in the Upper Willamette River Basin. The site is in Lane County within the Long Tom Watershed and Coyote Creek sub-watershed.

Project Objective

The objectives of the Jordan Creek Project included a reduction in bank erosion; the eradication and control of blackberry and other invasive, non-native vegetation; increasing native tree and shrub cover to 80 percent within the riparian area; providing shade over 80 percent of the channel and reducing summer stream temperatures in Jordan Creek by an average of 2°C; and increasing large wood, pool frequency, and channel sinuosity within the creek. The land owner within the project area is Deborah Mattson, and Cindy Thieman serves as the contact person for this project.

MC-4 Livestock Exclusion

Project Data

Figure 4-54 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-43 summarizes the data collected during Year 0 and Year 1 monitoring of the Jordan Creek Livestock Exclusion Project.

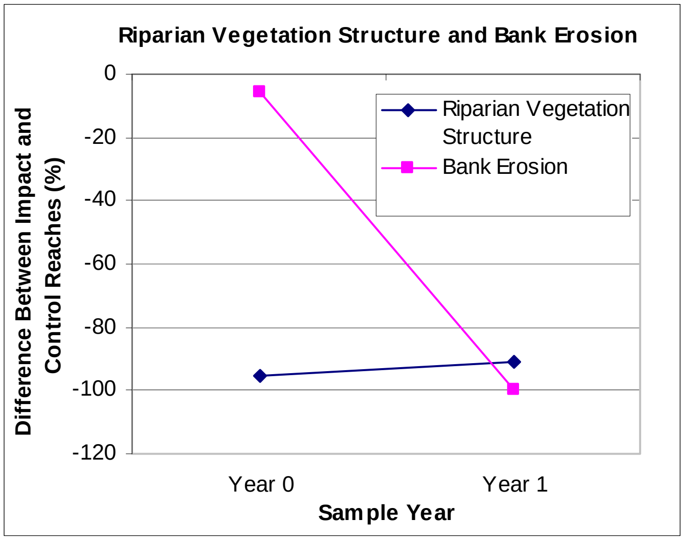


Figure 4-54. Riparian Vegetation Structure and Bank Erosion at Jordan Creek

Table 4-43. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

	Year 0 (2006)		Year 1 (2007)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	16.82	2.05	16.64	1.77
Riparian Vegetation Structure (%)	100	4.5	100	9.1
Bank Erosion (%)	100.0	94.5	100.0	0
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	7.8
Data collected August 14, 2006 (Year 0) and September 13, 2007 (Year 1).				

Summary

Data from the Jordan Creek Livestock Exclusion project indicate short-term success in some measured variables and point to long-term success in others. Bank erosion decreased substantially after project implementation as documented in measurements and site photographs. Small increases have been measured in riparian vegetation structure, and as these plants mature, canopy density measurements are expected to increase.

The Year 1 survey for this project was completed shortly after the fencing was installed. Fresh manure was found within the exclusion area during this survey, but likely resulted from livestock activity just prior to the installation of the fence. The new fence was inspected and found to be fully intact at the time of the survey. Ground cover at the impact site had already shown signs of recovery by the time the Year 1 survey was conducted. Monitoring was not conducted at Jordan Creek in 2008.

206-283 Johnson Creek Livestock Exclusion Project – OWEB

The Johnson Creek Project is located on private land that has been managed for agriculture since the late 1920s. The land around the creek was one of the first areas developed for farming in the region. Actively eroding banks along Johnson Creek, and other creeks, are contributing to a 10-fold increase in the amount of sediment delivered to Tenmile Lakes. This increase in sedimentation is resulting in effects on salmon habitat and water quality. The Tenmile Lakes Basin Partnership sponsored the Johnson Creek Project in an effort to address this issue and improve conditions within Johnson Creek and ultimately, within Tenmile Lakes.

Impact reach at Transect F in 2006 (Year 0)

Impact reach at Transect F in 2007 (Year 1)

Project Location

The project area is located along Johnson Creek, in the Tenmile Lakes Watershed, in Section 36 of Township 23S and Range 12W. The project site is south of the town of Lakeside, Oregon, and east of Highway 101.

Project Objective

The riparian zone functions and bank stability in Johnson Creek have been reduced due to past land use practices in the area. The objective of this project was to improve the riparian condition and reduce sediment input by installing fencing along the creek and excluding livestock from using the area. This project is expected to result in benefits to the watershed over the long-term through increased ground water storage, a reduction in non-point source run-off, increases in stream complexity, and an increase in shading of the channel. Bob and Fontella Hankins, private landowners, are the landowners within the project area and Mike Mader serves as the primary contact for this project.

Project Data

Figure 4-55 shows changes measured in riparian vegetation structure and bank erosion. Table 4-44 summarizes the data collected during Year 0 and Year 1 monitoring of the Johnson Creek Livestock Exclusion Project.

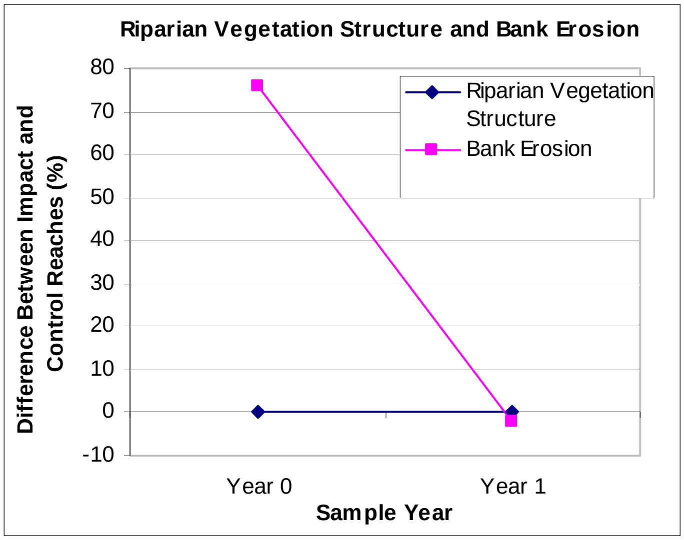


Figure 4-55. Riparian Vegetation Structure and Bank Erosion at Johnson Creek

Table 4-44. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact
Riparian Characteristics				
Canopy Density (1-17)	16.05	6.77	15.32	13.96
Riparian Vegetation Structure (%)	0	0	4.5	4.5
Bank Erosion (%)	4.3	80.2	76.5	74.5
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	No
Area of Exclusion (acres)	N/A	N/A	N/A	4.0
Data collected June 7, 2006 (Year 0) and June 28, 2007 (Year 1).				

In addition to collecting data, photographs are taken at the site during each monitoring event to document changes in the condition of the stream or river over time. The following photos were taken at Johnson Creek during Year 0 and Year 1. The Year 1 photo shows increases in vegetation growth at the site following fence installation.

MC-4 Livestock Exclusion

Impact reach at Transect A in 2006 (Year 0)

Impact reach at Transect A in 2007 (Year 1)

Summary

Data collected at the Johnson Creek site indicate improvement in canopy density and bank erosion relative to the control reach after one year. Vegetation structure also improved in the impact reach, but the same change was noted in the control reach, indicating that this change was environmentally influenced. As vegetation matures through time, further improvement in measured parameters is expected.

The Johnson Creek exclusion was constructed prior to the site visit in 2007, and the fencing appeared to be very strong and effective at keeping livestock out of the impact reach. All livestock were observed to be excluded from the creek in the impact reach at the time of the survey. Although at the time of the survey no livestock were observed within the exclusion area, gates were incorporated into the fence structure (see photos below). These gates were secure and required manual opening to allow cattle to cross the creek or access the exclusion area. There was no indication that livestock grazed within the exclusion, but there was some physical evidence that livestock had, at some point, crossed the creek and compressed the vegetation inside the exclusion. Monitoring was not conducted at Johnson Creek in 2008.

Impact reach - gate in livestock exclusion (2007)

Impact reach - limited physical evidence of livestock crossing (2007)

206-283 Noble Creek/Maria Gulch Livestock Exclusion Project – OWEB

The Noble Creek/Maria Gulch Project was sponsored by the Tenmile Lakes Basin Partnership in response to depleted riparian zone functions along the creek, as well as reduced bank stability and shading. These habitat elements have been impacted by agricultural land use practices employed since the late 1920s. This project provided fencing and riparian planting to reduce the input of sediment from bank erosion in Maria Gulch, a tributary to Noble Creek, and is expected to benefit approximately 1,524 meters of stream habitat.


Noble Creek in 2006 (Year 0)


Noble Creek in 2007 (Year 1)

Project Location

The project area is located in the Tenmile Lakes Watershed east of Lakeside, Oregon, off of Noble Creek Road. The control reach is a currently fenced site that will remain fenced over the period of monitoring. Both the impact and control reaches are approximately 150 meters in length.

Project Objective

This project provided fencing and riparian planting to reduce the input of sediment from bank erosion in Maria Gulch, a tributary to Noble Creek. The fencing and planting project was intended to prevent livestock access to the stream, reduce sediment input and non-point source runoff, and to improve riparian vegetation quality and shading. The land owners within the project area are Joe and Maria Goularte, private landowners and Mike Mader serves as the contact person for this project.

Project Data

Figure 4-56 shows the changes measured in riparian vegetation structure and bank erosion. Table 4-45 summarizes the data collected during Year 0 and Year 1 monitoring of the Noble Creek/Maria Gulch Livestock Exclusion Project.

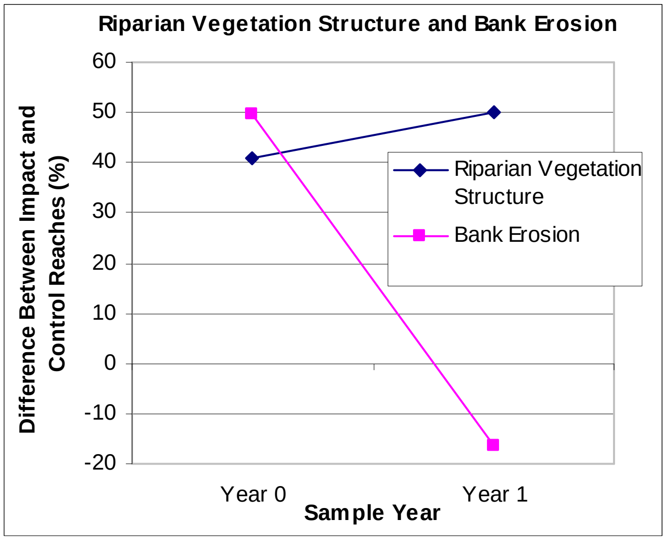


Figure 4-56. Riparian Vegetation Structure and Bank Erosion at Noble Creek/Maria Gulch

Table 4-45. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)	
	Control	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	11.86	10.36	14.50	15.50
Riparian Vegetation Structure (%)	4.5	45.5	0	50.0
Bank Erosion (%)	0	49.6	27.8	11.3
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	3.5
Data collected June 6, 2006 (Year 0) and June 27, 2007 (Year 1).				

Summary

The Noble Creek/Maria Gulch project has demonstrated improvement in all three measured variables. Increases are noted in the first year after implementation for canopy density and vegetation structure and a marked decrease is noted for bank erosion. With continued vegetation growth, improvements in these variables are expected to increase. Monitoring was not conducted at Noble Creek/Maria Gulch in 2008, but Year 3 monitoring is scheduled for 2009.

206-357 Middle Fork Malheur River Bank Stabilization Project

The Middle Fork Malheur River Project area has been in agricultural production since at least the early 1900s. Downcutting and erosion along the river are the result of livestock in the area accessing the creek as a water source. As part of this project, Rosgen J-hook vane structures, bank sloping and re-vegetation, and buffer fencing were used to re-direct streamflows away from the eroding bank, create pool habitat, and re-establish riparian vegetation. Approximately 100 head of cattle were excluded from over 1 mile of the Middle Fork Malheur River when the project is completed. This project was expected to benefit approximately 1,609 meters of stream habitat.

Impact reach prior to livestock fencing in Year 0 (2006)

Livestock fencing in impact reach in Year 1 (2008)

Project Location

The project area is located in Harney County within the Middle Fork Malheur River subbasin. The impact reach is approximately 375 meters in length and is located on the Marshall property at the overlook to the Malheur River. The control site is also 375 meters long and is approximately 0.4 miles upstream. The project is located on private lands owned by Gary Marshall and Marc O'Toole.

Project Objective

The objective of this project is to improve fish habitat, including habitat for bull trout listed on the Endangered Species List, and reduce excessive bank erosion on the Middle Fork of the Malheur River in the Drewsey Valley by rehabilitating several badly downcut and eroding sections of streambank. Harney Soil Water Conservation District sponsors this project and Marty Suter serves as the primary contact.

MC-4 Livestock Exclusion

Project Data

Figure 4-57 illustrates changes measured in riparian vegetation structure and bank erosion. Table 4-46 summarizes the data collected during Year 0 and Year 1 monitoring of the Middle Fork Malheur River Bank Stabilization Project.

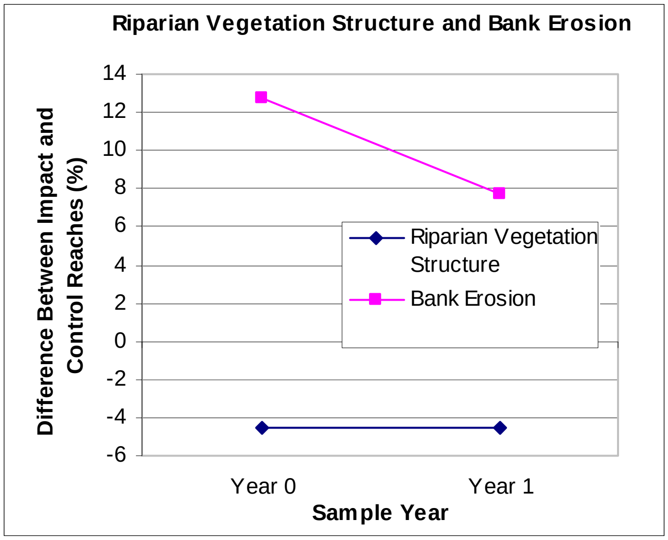


Figure 4-57. Riparian Vegetation Structure and Bank Erosion at Malheur

Table 4-46. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2008)	
	Control	**Impact**	**Control**	**Impact**
Riparian Characteristics				
Canopy Density (1-17)	1.59	3.73	7.14	3.09
Riparian Vegetation Structure (%)	4.5	0	4.5	0
Bank Erosion (%)	58.50	71.25	33.75	41.5
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	62
Data collected August 16, 2006 (Year 0) and August 21, 2008 (Year 1).				

Summary

Monitoring was conducted at the Malheur site prior to implementation in 2006 and during the first year following implementation. Canopy density in the control reach was slightly higher in the control reach in Year 1, but changed very little in the impact reach. Riparian vegetation structure did not change between Year 0 and Year 1. In both the control and impact reaches, bank erosion was substantially lower in Year 1 than in Year 0.

4.1.5 Constrained Channel Projects

One Constrained Channel Project was sampled during the 2008 field season out of nine active projects. While some Constrained Channel Projects occur on wadeable streams, others are on larger rivers where a wadeable stream protocol (Crawford 2004e (revised 2008)) is not appropriate. In 2008, the MC-5 Constrained Channel Protocol was revised to include methods that can be used from a boat. Data collected using the two approaches contain the same parameters, but may not be completely comparable.

Figure 4-58 shows the locations of all of the Fish Passage Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects included in the program.

4.1.5.1 Protocol Description

Stream Morphology

Differences from the stream morphology procedures described in Section 4.1.2.1 are identified below. A boat with a depth finder was used to collect depth information at each transect for Projects 02-1625, 05-1348 and 06-2250. Twenty evenly spaced depths were recorded along the sample reach (versus 100 as described in Crawford 2004e), and the summary statistics were calculated from these depths. Widths were taken using a laser rangefinder at the same 21 transects described in Section 4.1.2.1. For all other projects in this category, stream morphology was measured using procedures described in Section 4.1.2.1. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in mean residual vertical pool profile area and mean residual depth in the impact reaches by Year 10 and if *t*-test results are statistically significant.

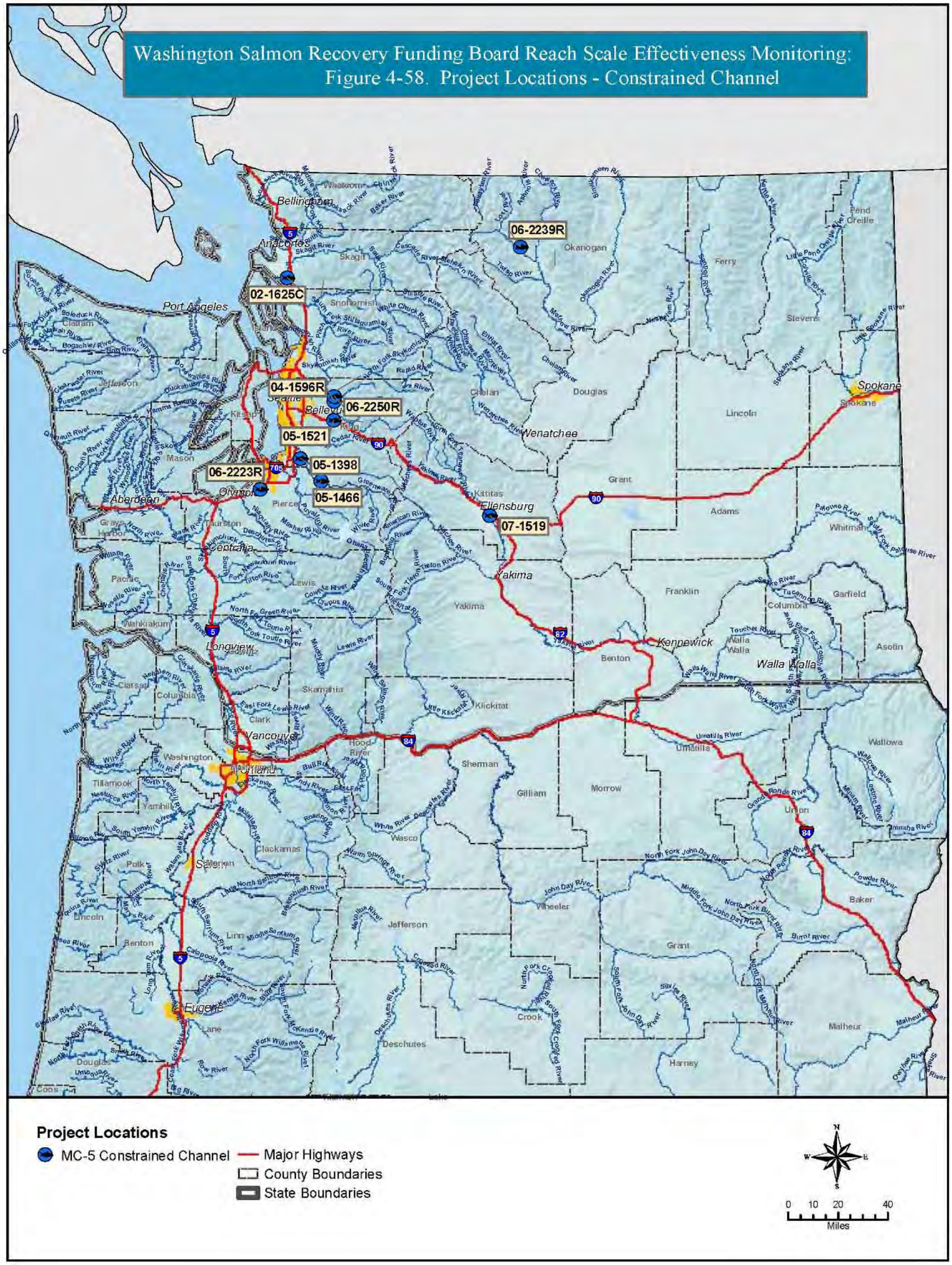
Slope Measurements

Slope data were collected along the water's edge using similar methods as those described in Section 4.1.2.1. When the downstream team member could not be seen at the next transect, interim slope measurements were taken.

Bankfull Channel Capacity

Bankfull channel capacity was calculated using the height of the bank or constraining feature at bankfull height at each transect. The channel capacity was calculated by adding the five depths measured at each cross section to the height of the constraining feature and multiplying by the width of each portion of the cross section, and then taking the average across all cross sections. Projects will be considered effective if there is a decrease of more than 20 percent over the baseline mean value in bankfull channel capacity in the impact reaches by Year 10 and if *t*-test results are statistically significant. This decrease in channel capacity would indicate a better connectivity between the channel and the floodplain.

MC-5 Constrained Channels



Flood-Prone Width

Flood-prone width was measured in the field or using remote sensing via Geographic Information System (GIS) mapping. The width was measured at two times the bankfull height as determined in the field, or if that was not possible, the flood prone width in the valley was measured using landmarks and GIS or aerial photos. The connection with the flood plain will be monitored using this and other measurements made for this category. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in flood prone width in the impact reaches by Year 10 and if *t*-test results are statistically significant.

4.1.5.2 Results/Data Summaries/Decision Criteria

Table 4-47 identifies the summary statistics for constrained channels. As the constraints were removed, the bankfull cross-sectional area and flood prone width were re-measured.

Table 4-47. Decision Criteria for Testing Constrained Channels

Monitoring Parameters	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Channel Conditions	Mean bankfull cross-sectional area taken from mean bankfull width and height	Ave. m^2	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect a change of less than 20 percent between Year 0 and Year 10
	Mean residual pool vertical profile area	m^2	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Mean residual depth	cm	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between Base Year 0 and Year 10
	Flood prone width	m	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between Base Year 0 and Year 10

Source: Crawford 2008e

4.1.5.3 Project-Specific Summaries

Projects that involve the removal of a levee, or channel constraint, are monitored prior to implementation of the project (Year 0) and for a period of ten years following implementation. Post-project monitoring is conducted at the control site and impact site during Years 1, 3, 5, and 10. Summary statistics for Constrained Channel Projects are provided on the following pages. Projects sampled prior to 2008 have both pre-project data and post-project implementation data. The new projects for 2008 have only one year of pre-project (Year 0) data. The number of years of data may vary if project implementation was delayed or incomplete during 2008 or previous years.

02-1625 South Fork Skagit Levee Setback and Acquisition

The South Fork Skagit Levee Setback and Acquisition Project included the acquisition of an area riverward of the existing levee that contains off-channel habitat and high flow channels with excellent riparian vegetation. This area also supports an active bald eagle nest. The project site was restored through the removal and relocation of portions of the existing levee. Approximately 2,500 feet of existing levee were removed and graded to existing "bank top level" at the upper end. The lower end was graded further to facilitate off-channel connectivity. In addition, 1,800 feet of new levee was relocated adjacent to the county road at a maximum of 700 feet from the river bank at the mid-point.

Impact reach at Transect F in 2007 (Year 3)

Control reach at Transect A in 2007 (Year 3)

Project Location

This project is located on the Lower Skagit River, west of the Town of Conway, in Skagit County, Washington. The site is 2 miles downstream of the "forks" of the Skagit River which is commonly understood to be the upper extent of the tidal influence under average river flows. Skagit County Dike District 3 currently owns two of the three land parcels associated with the project, and the third parcel is held in private ownership by Betty Glascock.

Project Objective

The Skagit County Dike District #3 sponsored this project in an effort to restore riparian and side channel areas to benefit multiple salmonid species. This project resulted in the acquisition and restoration of 37 acres of mainstem, off-channel/wetland, and riparian habitat and the setback of approximately 2,500 feet of existing levee, all of which provided multiple benefits to five salmon and two trout species. Additionally, the project included deed restrictions to ensure salmon habitat conservation in the future. The contact person for this project is Dave Olson.

Project Data

The physical conditions of this site required the use of a motorboat and depth-finder to approximate depths within the control and impact reaches. Additionally, substrate data could not be gathered, nor could the presence of submerged logs be recorded. Due to the location of this site within the zone of tidal influence, width and depth measurements varied depending on the tidal stage at which monitoring conducted, regardless of restoration activities. Measurements could be normalized by tidal stage to account for these changes in water depth.

Figures 4-59 and 4-60 show the changes measured in the channel and floodprone widths and the channel capacity and pool refuge. As the levees are reduced, the flood prone width has increased dramatically, indicating development of a wider flood plain. Conversely, the bankfull channel capacity has decreased with the reduction in the levee height along the channel, another indicator of additional connection with the floodplain. Table 4-48 summarizes the data collected during Year 0 and Year 3 monitoring of the South Fork Skagit Levee Setback Project.

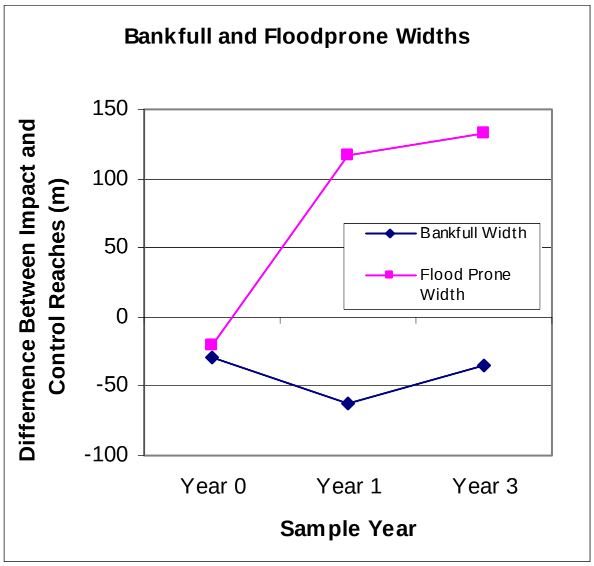


Figure 4-59. Bankfull and Floodprone Widths – Skagit River

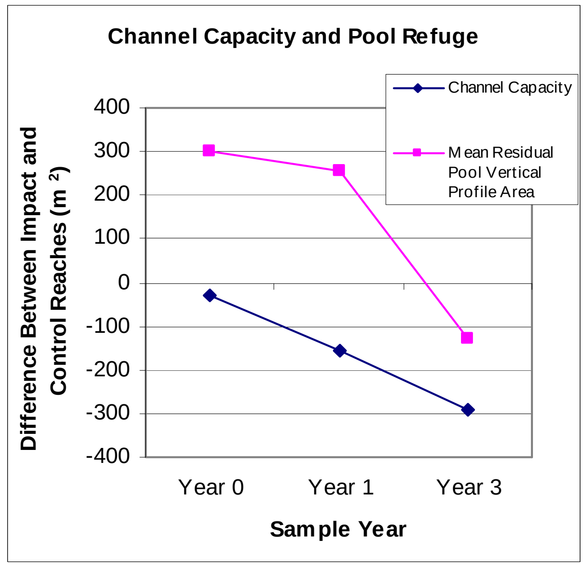


Figure 4-60. Channel Capacity and Pool Refuge – Skagit River

Table 4-48. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 3 (2007)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Bankfull Width (m)	172	143	184	122	187	152
Flood Prone Width (m)	184	164	184	301	184	317
Mean Residual Pool Vertical Profile Area (m^2/reach)	294.04	595.43	387.52	644.92	418.54	287.60
Mean Residual Depth (cm)	56.00	113.42	73.81	128.98	83.71	57.52
Channel Constraints						
Constraining Structure Height at Bankfull (m)	2.0	2.2	2.0	2.2	3.0	1.9
Mean Bankfull Cross Sectional Area (m^2)	461.0	433.6	502.8	347.2	727.9	434.9
Channel Constraint Removed (y/n)	N/A	N/A	N/A	Y	N/A	Y
Data collected July 7, 2004 (Year 0) and June 26-27, 2007 (Year 3).						

MC-5 Constrained Channels

Summary

During monitoring of the South Fork Skagit site in Year 3, levee setback was still functional and evidence of high flows and significant deposition were present along the left bank. The tidal stage ranged from a high of 8.9 feet to a low of -0.1 feet. Significant deposition was observed within the active channel in areas where floodwaters were able to spread out and slow down, depositing fine sediment. This resulted in a reduction in the bankfull channel capacity. An increase was observed in the flood prone width (width measured at 2 times bankfull height). In 2007, floodprone width for both reaches was measured remotely using GIS. Monitoring was not conducted at the South Fork Skagit site in 2008 and Year 5 monitoring is planned for 2009.

04-1596 Lower Tolt River Floodplain Reconnection

The Lower Tolt Floodplain Reconnection Project is intended to restore active floodplain area in the lower half mile of the Tolt River by setting back levees and allowing the river to meander through the restored floodplain area. Snoqualmie Fall Chinook spawn in the Tolt River in large numbers, comprising a large percentage of the annual escapement. In 1997, over 25 percent of the Snoqualmie run was estimated to have spawned in the Tolt River. Implementation of the Tolt project is expected to restore side channel habitat and pool and riffle character to the main channel. The general project components are removal of 2,500 feet of levee along the right bank of the Tolt River, construction of a set back levee roughly 800 feet behind the existing levee, potential placement of large woody debris to encourage the formation of desired habitat features, floodplain planting, and the construction of interpretive and recreational elements to offset impacts to existing recreation uses in the park.


Sampling in control reach


Middle of impact reach

Project Location

This project is located on the Tolt River, just upstream of the confluence of the Tolt and Snoqualmie Rivers, in Carnation. The project site is located downstream of the Highway 203 Bridge over the Tolt River. The control reach is located upstream of this bridge.

Project Objective

The objective of this project is to restore proper function to floodplain meander, sediment transport, energy dissipation, and water storage. Project implementation is expected to restore side channel habitat, as well as pool and riffle character, to the main channel by removal of 762 meters of levee along the right bank of the Tolt River, and construction of a setback levee roughly 245 meters behind the existing levee. In conjunction with the levee setback, potential placement of LWD to encourage the formation of desired habitat features, floodplain planting, and the construction of interpretive and recreational elements to offset impacts to existing recreational uses in the park will be completed. The target species for this project is Chinook salmon. The project sponsor is the King County Department of Natural Resources and Parks and the contact person is Dan Eastman.

MC-5 Constrained Channels

Project Data

Table 4-49 summarizes the data collected during Year 0 and Year 0* monitoring of the Lower Tolt River Project.

Table 4-49. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 0*) Monitoring

	Year 0 (2005)		Year 0* (2006)	
Variable	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics				
Bankfull Width (m)	28.56	37.41	28.56	40.62
Floodprone Width (m)	N/A	N/A	N/A	N/A
Mean Residual Pool Vertical Profile Area (m^2/reach)	145.20	41.83	146.06	29.72
Mean Residual Pool Depth (cm)	29.04	8.34	29.21	5.94
Channel Constraints				
Height of Constraining Feature at Bankfull Width (m)	0.65	0.8	0.65	1.4
Mean Bankfull Cross Sectional Area (m^2)	18.6	29.9	18.6	56.9
Channel Constraint Removed (y/n)	N/A	N/A	N/A	N/A

Floodprone width data was not collected at this site in year 0 or Year 0*
Data collected August 16-17, 2005 (Year 0) and July 13, 2006 (Year 0*).
* Year 0* indicates second year baseline data.

Summary

Baseline monitoring was conducted at the Tolt River site in 2005 and 2006. The project is currently scheduled for construction in 2009. Monitoring will be conducted following completion of the project.

05-1398 Fenster Levee Setback

The Fenster Levee Setback Project involves the removal of approximately 700 linear feet, including rock armoring, of the old Fenster Levee to form a low, vegetated bench and gently sloping river bank to provide shade and overhanging cover, better accommodate floodwater and attenuate floodwater velocities. Rehabilitation of this old side channel will provide an additional passageway for juvenile salmonids to access flood refugia and overwintering habitat in the Slough. Numerous aquatic and terrestrial wildlife species also reside in and near the Slough at various times of the year. Floodplain connectivity will be further rehabilitated by excavation of grass pastures landward of the set back levee to elevations corresponding to the river's existing floodflow regime, which was modified by construction of Howard Hanson Dam in 1964.

Levee along impact reach (2006)

Impact reach with small boat sampling (2006)

Project Location

This project is located on the Green River, at approximately RM 32, in the City of Auburn, within King County. This project is just downstream from the Auburn Narrows Restoration Site, another King County project. The project site is located on King County land in an area proposed for public recreation. The control site is just downstream on the same property.

Project Objective

This project is designed to remove approximately 213 meters of the old Fenster Levee and create a low, vegetated bench that slopes into the river, providing overhanging vegetation, shade, and cover to the channel and also attenuate flood flows. Large woody debris will be installed along the toe of the bank slope and on the vegetated bench to provide cover and hydraulic complexity. The riparian zone landward of the set back levee prism will also be densely planted with native riparian trees and shrubs to improve wildlife habitat and provide allochthonous inputs to the river. A relict channel that was partially filled decades ago when the property was in agricultural use will be excavated to provide off-channel habitat and reestablish floodplain connectivity. The channel will also be connected to several acres of high quality, densely forested off-channel habitat in Pautzke Slough, just upstream from the project site. The project sponsor is the City of Auburn, Parks and Recreation Department in conjunction with King County Department of Parks and Recreation. Ruth Scheaffer, of King County Department of Parks and Recreation, is the project contact.

Project Data

Table 4-50 summarizes the data collected during Year 0 monitoring of the Fenster Levee Setback Project.

Table 4-50. Summary Statistics for Pre-Installation (Year 0) Monitoring

	Year 0 (2006)	
Variable	**Control**	**Impact**
Stream Physical Characteristics		
Bankfull Width (m)	30.55	37.24
Floodprone Width (m)	N/A	N/A
Mean Residual Pool Vertical Profile Area (m^2/reach)	173.56	184.13
Mean Residual Pool Depth (cm)	96.42	102.30
Channel Constraints		
Height of Constraining Feature at Bankfull Width (m)	0.3	0.3
Mean Bankfull Cross Sectional Area (m^2)	9.2	11.2
Channel Constraint Removed (y/n)	N/A	N/A
Floodprone width data was not collected at this site in year 0 or Year 0* Data collected July 10-11, 2006.		

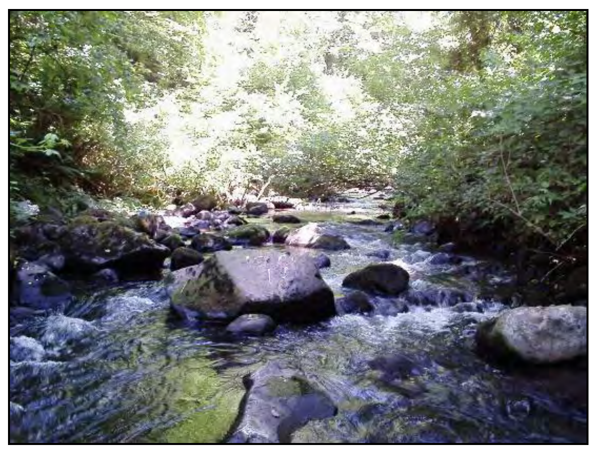
Summary

The Fenster Levee Setback project site is not wadable and small boats (canoes) are needed to access and sample the site from the water. Year 0 monitoring was conducted in 2006; however, the project has not yet been implemented. Project construction is scheduled for completion in 2009 and monitoring will follow.

05-1466 Lower Boise Creek Constrained Channel

Boise Creek is one of the most productive tributary salmon streams in the White River Basin for Chinook, coho, and steelhead. The Lower Boise Creek Constrained Channel Project is intended to restore channel, floodplain, and riparian conditions at the mouth of Boise Creek, a right-bank tributary to the White River near RM 23.3. The creek was placed into its present-day alignment during the construction of adjacent road and railroad corridors. The road and railroad have been removed, and the property within the project area is now in public ownership. The project will relocate the lowest 500 feet of channel into newly constructed channel approximately 1,200 feet in length. The new channel will have a meandering pattern with no levees or revetments anywhere along its length, and it will restore the historic channel gradient and habitat. It will be designed to contain channel forming flows, but to allow out of channel flows and floodplain inundation during flood events. The current berm configuration that confines Boise Creek will be removed to restore a floodplain connection with the White River. The project fits well with the WRIA strategy since it is identified as a near-term priority in the *Salmon Habitat Protection and Restoration Strategy, WRIA-10 Puyallup Watershed and WRIA-12 Chambers/Clover Creek Watershed* (Pierce County 2004). Since this project occurs on easily accessible public land, next to a proposed regional trail, it provides a unique opportunity to promote public education relative to watershed health and salmon recovery.

Levee along bank in impact reach in Year 0 (2006)



Middle of control reach in Year 0 (2006)

Project Location

This project is located on Boise Creek, just upstream from its confluence with the White River. The treatment reach is downstream of where Mud Mountain Road crosses the creek, just off Highway 410, southwest of Enumclaw. The control reach is just upstream from the crossing.

Project Objective

This project is designed to reconnect Boise Creek with its floodplain by moving 150 meters of currently constrained channel into an unconstrained constructed channel about 365 meters long. The new channel will have constructed meander bends, no levees or revetments, and would restore the historical channel gradient and habitat. Boise Creek has been identified as one of the most productive tributary streams to the White River for Chinook salmon, coho salmon, and steelhead. King County Department of Natural Resources and Parks sponsors this project and it is located on King County Land. Josh Latterell serves as the primary contact for the project.

Project Data

Table 4-51 summarizes the data collected during Year 0 monitoring of the Boise Creek Project.

Table 4-51. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2006)	
	Control	Impact
Stream Physical Characteristics		
Bankfull Width (m)	9.31	10.38
Floodprone Width (m)	N/A	N/A
Mean Residual Pool Vertical Profile Area (m^2/reach)	14.17	9.56
Mean Residual Pool Depth (cm)	9.32	6.37
Channel Constraints		
Height of Constraining Feature at Bankfull Width (m)	0.70	0.60
Mean Bankfull Cross Sectional Area (m^2)	6.5	6.2
Channel Constraint Removed (y/n)	N/A	N/A
Floodprone width data was not collected at this site in year 0 or Year 0* Data collected July 6-7, 2006 (Year 0)		

Summary

Pre-project monitoring was conducted at Lower Boise Creek in 2006. The project is currently scheduled for phased construction in 2009. Year 1 monitoring at this site may be conducted in 2009 if it is completed in time. Otherwise, monitoring will be conducted in 2010.

MC-5 Constrained Channels

05-1521 Raging River Preston Reach Restoration

In 1964, a levee was constructed along the Raging River, near the community of Preston, which resulted in a disconnect between the river channel and approximately seven acres of floodplain. Prior to the construction of the levee, frequent channel migration occurred; however, between the 1960s and the current project construction, the channel has maintained a narrow, straight alignment. The channel confinement led to substantial impacts on aquatic habitat conditions. Side channels were eliminated, causing a reduction in spawning, rearing, and refuge habitat for salmonids and other fish species. The Raging River Preston Reach Restoration Project was designed to protect and restore freshwater channel meander migration patterns in the Raging River. This project was intended to improve the floodplain conditions that have been impacted by the presence of the levee over the past 40 years, including meander functions, sediment transport functions, dissipation, and water storage. The restoration of river processes over time will improve the reestablishment of crucial spawning and rearing habitat within the reach.

Project Location

This project was sponsored by the King County Department of Natural Resources and Parks, which currently owns the land on which the levee was constructed. As part of this project, the County obtained the adjacent 10-acre parcel to augment the benefits of the project. The project was located on the Raging River, a tributary to the Snoqualmie River, at approximately RM 4. Work on the impact site was conducted about one mile north of the town of Preston, Washington, and the control reach is located about two miles downstream of the impact reach. The control reach is constrained on both sides by existing levees.

Impact reach in 2006 (Year 0)

Impact reach in 2007 (Year 1)

Project Objective

King County sponsored the Raging River Preston Reach Restoration Project, which was designed to restore meander functions, sediment transport functions, dissipation, and water storage. This project was intended to restore natural river processes and re-establish prime spawning and rearing habitat in the reach. The contact person for this project is Dan Eastman.

MC-5 Constrained Channels

Project Data

Figures 4-61 and 4-62 show the changes measured in the channel and floodprone widths and the channel capacity and pool refuge. Table 4-52 summarizes the data collected during Year 0 and Year 1 monitoring of the Raging River Preston Reach Restoration Project.

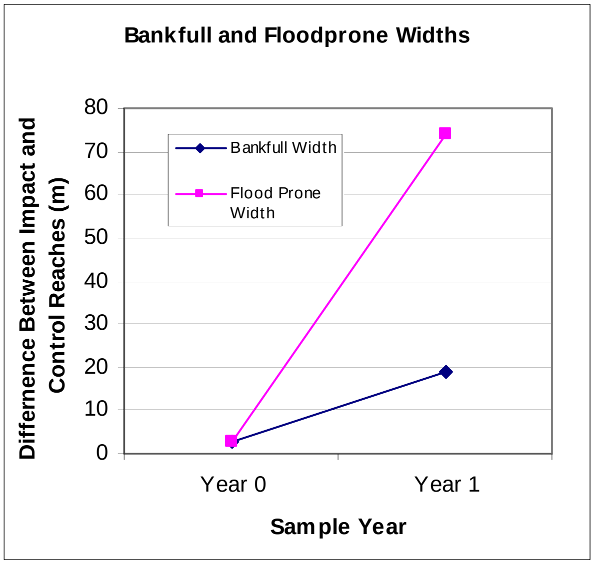


Figure 4-61. Bankfull and Floodprone Widths at Raging River

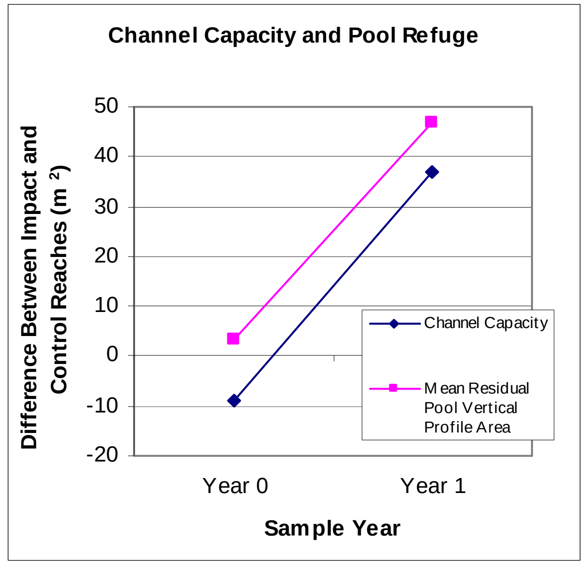


Figure 4-62. Channel Capacity and Pool Refuge at Raging River

Table 4-52. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact
Stream Physical Characteristics				
Bankfull Width (m)	24	27	20	39
Flood Prone Width (m)	24	27	22	96
Mean Residual Pool Vertical Profile Area (m^2/reach)	33.99	37.13	27.43	74.26
Mean Residual Depth (cm)	0.68	0.74	5.49	14.85
Channel Constraints				
Height of Constraining Feature at Bankfull Width (m)	1.7	1.3	1.7	1.9
Mean Bankfull Cross Sectional Area (m^2)	47.1	38.3	37.6	74.7
Channel Constraint Removed (y/n)	N/A	N/A	N/A	Y
Data collected on June 1-2, 2006 (Year 0) and July 19 - 20, 2007 (Year 1).				

Summary

During Year 1 monitoring, restored connectivity between the Raging River and its floodplain was observed where the levee had been removed along the Preston Reach. Along the left bank of the Raging River, an active side channel was present and evidence of floodplain inundation during high flows was suggested by newly downed trees, racks of woody debris, and altered stream banks. This restored connectivity resulted in an increase in the bankfull channel capacity, as well as bankfull width and floodprone width. Geomorphic variables such as the mean residual pool vertical profile area and the mean residual depth all increased significantly as a result of the project action. Monitoring was not conducted at the Raging River site in 2008 and Year 3 monitoring is planned for 2009.

06-2223 Greenwater River Project

The Greenwater River Project will incorporate engineered log jams (ELJs) within the Greenwater River. At least 3 and up to 15 ELJs will be designed at strategic river locations to increase and redistribute the flood plain connectivity, with the intent of recreating the complex habitat features that are lacking in this portion of the Greenwater River. These structures are not designed to move, instead they will collect and sort future LWD and decrease mean grain size sediment. The project is expected to benefit approximately 4,828 meters of stream habitat.

In addition to placement of the ELJs, a 0.5-mile portion of the USFS 70 Road will be decommissioned and removed as part of this project. The section of road that is proposed for removal has been washed out at several locations, resulting in thousands of cubic yards of material being carried into the river. This portion of the road is no longer in use and a bypass road has been constructed to re-route traffic. Removal of the unnecessary road prism will be beneficial to floodplain function and will open up access to historical floodplain areas.


Greenwater River control site (2007)


Greenwater River impact site (2007)

Project Location

The project will occur on lands owned by the USFS. The project area is located near the junction of USFS 70 Road and the USFS 70 Bypass Road, approximately 4 miles east of the town of Greenwater. This area falls along the border of Pierce and King Counties, in the Mt. Baker-Snoqualmie National Forest and Norse Peak Wilderness, Township 19N, Range 10E, and Sections 19, 20, 21, and 22. The Greenwater River is a tributary to the White River at RM 45, within WRIA 10. Work will be conducted on the Greenwater River between RM 4 and RM 7. Both the impact and control reaches are approximately 430 meters in length.

Project Objective

The objective of the Greenwater River Project is to improve instream morphology and habitat by increasing instream cover, spawning, and resting areas for salmonids. In addition to the long-term natural processes that will improve as a result of this project, the ELJs will immediately provide complex habitat for salmonids in the watershed, which will likely result in an increase in juvenile abundance in the White River. This project will jumpstart the recovery of critical salmon habitat that was altered in the 1970s when much of the watershed was destroyed by removing virtually all LWD and gravel from the channel. These ELJs will ultimately re-create some historical habitat conditions needed to increase the capacity of the Greenwater River to support desired fish populations.

Restoration objectives for the Greenwater River ELJ project will be to convert the low sinuosity plane boulder/cobble incised channel to a complex pool-riffle channel. The specific project goals are to: 1) increase the stream and floodplain connectivity, 2) increase off-channel habitat, 3) create structures that will trap mobile debris and sediment, 4) increase number of backwater pools, 5) increase primary pool area, 6) increase the capture and sorting of spawning gravel area, 7) decrease median grain size, 8) reduce erosion and sedimentation sources within the reach, and provide rearing habitat and overhead cover for salmonids.

Achieving these objectives will likely restore anabranching stream channel morphology to the Greenwater River instead of a single, incised channel. The effective increase of habitat area and complexity will translate into more capacity to support larger populations of salmonids and resident fish.

The SPSSEG sponsors this project; Lance Winecka and Kristin Williamson are the primary contacts.

Project Data

Table 4-53 summarizes the data collected during Year 0 monitoring of the Greenwater River Project.

Table 4-53. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007)	
	Control	**Impact**
Stream Physical Characteristics		
Bankfull Width (m)	19	19
Flood Prone Width (m)	70	64
Mean Residual Pool Vertical Profile Area (m^2/reach)	44.99	79.85
Mean Residual Depth (cm)	10.46	18.57
Channel Constraint		
Height of Constraining Feature at Bankfull Width (m)	1.8	3.5
Mean Bankfull Cross-Sectional Area (m^2)	36.3	69.3
Channel Constraint Removed (y/n)	N/A	N/A
Data was collected on August 13-14, 2007 (Year 0)		

Summary

During Year 0 monitoring at the Greenwater River Project site, it was noted that the levee along the left bank confined the majority of the impact reach. The levee was continuous and impeded the Greenwater River from active migration along the left bank. Although the majority of the impact reach was confined along the left bank, active side channels were present, and LWD had been recruited and formed log jams in some segments of the reach. In the impact reach, a steep valley wall exists along much of the right bank of the river.

The project was not implemented in 2008; therefore, monitoring was not conducted at the Greenwater River site. Year 1 monitoring is scheduled for 2010.

06-2239 Fender Mill Floodplain Restoration – Phase I

The Fender Mill Floodplain Restoration Project is designed to address the following limiting factors affecting recovery of anadromous fish identified in the Methow Subbasin Plan: 1) alteration and reduction of riparian habitat; 2) habitat connectivity; and 3) instream and floodplain habitat degradation. The project has been developed to create low gradient side channels to improve connection of the river to the flood plain and to provide low velocity channels that are shaded to protect redds and juveniles, thus, providing optimum rearing habitat for salmon. The project will allow high river flows to enter two to three separate side channels, which will provide flow to low areas that are currently charged by groundwater and retain ponded water throughout a significant portion of the year. Removal of existing berms and structures is required to allow equipment access to the site.

Impact reach in 2007 (Year 0)

Control reach in 2007 (Year 0)

Project Location

The Fender Mill Floodplain Restoration Project is located on the Methow River, just downstream of the Weeman Bridge, between the towns of Winthrop and Mazama, in Okanogan County. The project site is in Township 35N, Range 20E, and Section 15, within the Methow River Basin (WRIA 48). The project is located on lands owned by the USFS, Methow Salmon Recovery Foundation, and Isaacson, a private landowner.

Project Objective

The objective of the Fender Mill Restoration Project is to re-introduce and utilize natural stream processes to ultimately restore habitat for salmon and other native species in the Methow River. The project is intended to provide off-channel rearing habitat and high flow refugia for ESA listed species through a "Minimum Tool" approach. This approach essentially seeks to remove human caused / placed barriers and elements (dikes, roads, etc) that have resulted in isolation of historically active channels, and then allow the channel to reoccupy the opened area. The Methow Salmon Recovery Foundation sponsors this project and Chris Johnson serves as the primary contact.

MC-5 Constrained Channels

Project Data

Table 4-54 summarizes the data collected during Year 0 monitoring of the Fender Mill Project.

Table 4-54. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007)	
	Control	**Impact**
Stream Physical Characteristics		
Bankfull Width (m)	52	103
Flood Prone Width (m)	1,608	1,807
Mean Residual Pool Vertical Profile Area (m^2/reach)	76.46	84.28
Mean Residual Depth (cm)	22.49	24.79
Channel Constraint		
Height of Constraining Feature at Bankfull Width (m)	0.9	0.8
Mean Bankfull Cross-Sectional Area (m^2)	52.5	88.0
Channel Constraint Removed (y/n)	N/A	N/A
Data collected August 22, 2007 through September 27, 2007 (Year 0).		

Summary

Baseline data collected at the Fender Mill Floodplain Restoration Site indicate comparable conditions between the control and impact reaches. Both reaches are constrained currently, but floodplain reconnection is expected in the impact reach once the levee is removed. A series of high flow events may be required to fully establish floodplain reconnection to the point where it can be measured. The Fender Mill Project was not implemented in 2008; therefore, monitoring was not conducted. Year 1 monitoring of this site is scheduled for 2009.

06-2250 Chinook Bend Levee Removal Project

The Chinook Bend Levee Removal Project is intended to restore floodplain habitat by removing a levee that prevents the river from accessing its floodplain at the Chinook Bend Natural Area. Removal of the levee will allow the river to access its floodplain at much lower flows than present conditions allow and will encourage the formation of a floodplain channel, thus increasing habitat complexity along this reach of the river. The Chinook Bend Levee Removal Project is expected to restore rearing habitat in close proximity to productive spawning habitat and along the outmigration corridor for nearly the entire population of the Snoqualmie run of Snohomish Fall Chinook.


Control reach in 2007 (Year 0)


Impact reach in 2007 (Year 0)

Project Location

The project will be constructed in the Chinook Bend Natural Area. The land within the Chinook Bend Natural Area was donated to King County Parks Department to provide habitat for Chinook salmon. The county-owned property consists of 59 acres that are entirely within the 100-year floodplain of the Snoqualmie River, located just northwest of the town of Carnation, Washington. The impact reach for the project is located approximately 1 mile north of Carnation, extending downstream from the bridge on Carnation Farm Road. The control reach is located downstream of the footbridge at Tolt-MacDonald Park, in the town of Carnation, and is constrained on both sides by existing levees.

Project Objective

King County proposed the Chinook Bend Levee Removal Project in response to the need for restoration along this important reach of the Snoqualmie River. The goal of the project is to restore meander migration patterns in the project reach and improve flood plain construction, sediment transport functions, dissipation, and water storage. The Chinook Bend Levee Removal Project will address the WRIA 7 Chinook Salmon Conservation Plan’s call for the removal of levees and other obstructions that hinder the formation of off-channel rearing habitat. Additionally, it will serve as a significant step toward achieving the Snohomish River Basin Salmon Conservation Plan goal of restoring 80 acres of off-channel habitat in the highest priority areas of the Snoqualmie watershed. King County Department of Natural Resources and Parks sponsors this project and the contact person is Dan Eastman.

Project Data

Table 4-55 summarizes the data collected during Year 0 monitoring of the Chinook Bend Levee Removal Project.

Table 4-55. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007) Control	Year 0 (2007) Impact
Stream Physical Characteristics		
Bankfull Width (m)	86	80
Flood Prone Width (m)	91	86
Mean Residual Pool Vertical Profile Area (m^2/reach)	148.65	214.99
Mean Residual Depth (cm)	29.73	43.00
Channel Constraint		
Height of Constraining Feature at Bankfull Width (m)	3.7	3.0
Mean Bankfull Cross-Sectional Area (m^2)	347.3	263.6
Channel Constraint Removed (y/n)	N/A	N/A
Data was collected on August 2-3, 2007 (Year 0)		

Summary

Baseline data collected in 2007 at this project show strong similarities between the control reach and the impact reach. The size of this river requires that sampling be conducted using a small boat and a depth finder, as many sections of the channel are not wadable. This requirement may affect the accuracy of the data. The project was not implemented in 2008; therefore, monitoring was not conducted. Year 1 monitoring of this site is scheduled for 2009.

07-1519 Reecer Creek Floodplain Restoration

The Reecer Creek Project will reintroduce Reecer Creek to its floodplain; increase stream channel length, complexity and habitat area; establish native riparian and upland vegetation; install rock and log structures to support natural channel forming processes; and enhance habitat and improve water quality. Improvement to Reecer Creek's floodplain ecosystem function will occur on 69 acres near its confluence with the Yakima River. Work will include relocating 0.7 miles of diked and channelized creek onto its re-contoured floodplain, stabilizing the channel and floodplain by planting, and increasing the quantity and quality of habitat by increasing channel length to about 1 mile and adding off-channel habitat.


Impact reach at Transect F in Year 0 (2008)


Control reach at Transect A in Year 0 (2008)

Project Location

The project is located in the Yakima subbasin (WRIA 39) in Kittitas County. The control site is located on WDFW property on the left (west) side of Reecer Creek Road. The South Central Washington Resource Conservation and Development District is the project sponsor and Carol Ready is the primary contact.

Project Objective

This project will include creation of habitat for resident and salmonid fish, including Chinook, coho, and steelhead, for rearing, holding and feeding habitats, and potential spawning. The design is intended to dissipate flood flow energy, increase infiltration and water holding capacity, support ground-surface water interactions; and promote water quality (temperature, turbidity) and natural sediment management (deposition, suspension).

Project Data

Table 4-56 summarizes the data collected during Year 0 monitoring of the Reecer Creek Project.

MC-5 Constrained Channels

Table 4-56. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2008)	
	Control	**Impact**
Stream Physical Characteristics		
Bankfull Width (m)	6	10
Flood Prone Width (m)	2,500	48
Mean Residual Pool Vertical Profile Area (m^2/reach)	24.94	28.26
Mean Residual Pool Depth (cm)	14.66	16.62
Channel Constraint		
Constraining Structure Height at Bankfull (m)	0.4	0.85
Mean Bankfull Cross-Sectional Area (m^2)	3.3	12.2
Channel Constraint Removed (y/n)	N/A	N/A
Data collected April 16 and April 24, 2008 (Year 0).		

Summary

A new channel will be excavated within the historic Reecer Creek floodplain as part of this project. The dike which currently constrains Reecer Creek, will be breached first at the lower end and later at the upper end (near Dollar Way) of the new channel to allow Reecer Creek access to the historic floodplain. Ultimately, Reecer Creek will be completely re-routed through this newly constructed channel.

4.1.6 Channel Connectivity Projects

Six Channel Connectivity Projects were monitored in the 2008 field season out of a total of 10 active projects. Monitoring for these projects includes channel connection status, stream morphology, residual depth, shading, vegetation structure, and juvenile salmonid abundance. Table 4-57 identifies the variables used to monitor Channel Connectivity Projects.

Figure 4-63 shows the locations of all of the Channel Connectivity Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A includes the sampling schedule for all active projects in the program.

4.1.6.1 Protocol Description

Channel Connectivity

Crawford (2008f) was used to assess channel connectivity. After implementation, the cross-sectional area of the channel connection was calculated using the bankfull width and bankfull depth of the opening. Projects will be considered effective if 80 percent remain connected after 5 years. Data analysis is discussed further in Chapter 5.0.

Stream Morphology

Stream morphology monitoring was conducted as described in Section 4.1.2.1. For any reaches without water, no depths were taken and widths recorded were bankfull widths. Some summary statistics for this project were zero, as all the depths were zero. Projects will be considered effective if there is a 20 percent increase over the baseline mean value in mean residual vertical pool profile area and mean residual depth in the impact reaches by Year 5 and if *t*-test results are statistically significant.

Slope Measurements

Slope measurements were taken as described in Section 4.1.2.1, except for at reaches without water. At these reaches, a general gradient along the edge of the old channel was measured.

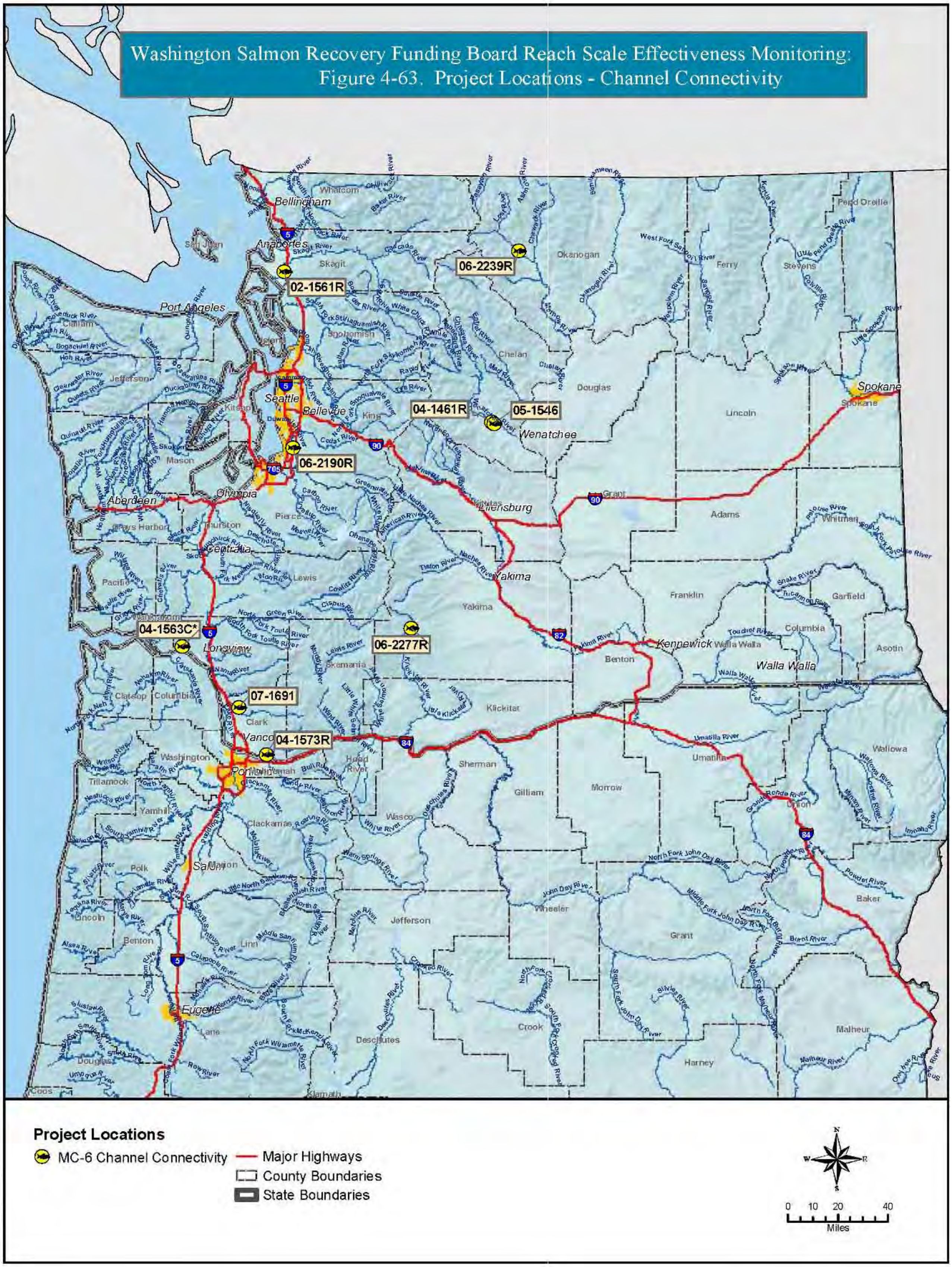
Riparian Vegetation Structure

Riparian vegetation structure was monitored as in Section 4.1.2.1.

Shading

Shading was monitored as in Section 4.1.2.1.

MC-6 Channel Connectivity



Juvenile Salmon

Juvenile salmon abundance was monitored as in Section 4.1.1.1. Seasons for sampling were adjusted to collect data on the target species of juveniles when they were most likely to be present in the off-channel habitat. For example, Site 02-1561, Edgewater Park Off-Channel Restoration, was monitored in winter because the designated use was for overwintering habitat. Each site may have a different sampling time based on the species and conditions at the site and the intended season of use of the off-channel habitat by juvenile fish. Channel Connectivity projects will be considered effective if there is a 20 percent increase over the baseline mean value in juvenile salmonid densities in the impact reaches by Year 5 and if *t*-test results are statistically significant.

4.1.6.2 Results/Data Summaries/Decision Criteria

Table 4-57 identifies summary statistics for Channel Connectivity Projects. Channel connection status will be monitored after implementation.

Table 4-57. Decision Criteria and Statistical Test Type for Channel Connectivity Projects

Monitoring Parameters	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Channel Modification	Measure of whether the channel has remained connected to the stream per design	Yes/No	None. Count of functional channel reconnections	≥ 80% of projects are intact by Year 5. Intact if there is present any visible flow through the channel during moderate flows
Stream Morphology	Mean residual pool vertical profile area	m^2/reach	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
	Mean residual pool area	m^2/100 m	Linear regression or paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
Riparian Habitat	Mean percent shading at the bank (using a densiometer)	%	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
	Proportion of the reach containing all three layers of riparian vegetation, canopy cover, understory, and ground cover	%	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
Juvenile Fish Abundance	Chinook salmon juvenile abundance	#/m^2	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
	Coho salmon juvenile abundance	#/m^2	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5
	Steelhead parr abundance	#/m^2	BACI paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 5

Source: Crawford 2008f

4.1.6.3 Data Issues

Similar data issues found in Section 4.1.3.3 are also found in this monitoring category.

4.1.6.4 Project-Specific Summaries

Projects that involve channel connectivity are monitored prior to implementation of the project (Year 0) and for a period of five years following implementation. Post-project monitoring is conducted at the control site and impact site during Years 1, 2, and 5. Summary statistics for Channel Connectivity Projects are presented on the following pages. Some projects were sampled prior to 2008 and have both pre-project data and post-project data. New projects for 2008 have one year of pre-project (Year 0) data. The number of years of data may vary if project implementation was delayed or incomplete during 2008 or previous years.

02-1561 Edgewater Park Off-Channel Restoration

The Edgewater Park site is located on the west side of the Skagit River within the river's floodplain. From Sedro Woolley, downstream for over 22 miles, the natural processes of the river have been restrained between levees. At the park, the levee has been set back from the river. Historically, the south end of the park had been bisected by several off-channel sloughs. Over time, these sloughs have been partially filled at their north end. The remaining slough areas (34 acres) act as a refuge for wildlife and offer protection and shelter to salmon at various life stages during times of high water. A deposition bar at the south end makes passage out of the sloughs difficult as the river recedes, causing stranding. The Edgewater Park Off-Channel Restoration Project involved the construction of a 318-meter off-channel slough and reconnection of isolated habitat to the river, thus reestablishing a functioning off-channel slough system, which is a rare resource in the lower Skagit River.

Impact reach at Transect F in Year 2 (2006)

Impact reach at Transect K in Year 2 (2006)

Project Location

This project is located in Skagit County at Edgewater Park, on the Skagit River, within the City of Mount Vernon. The control reach is located downstream at the Cottonwood Island Public Fishing Access Site. Both the impact and control reaches are 318 meters in length.

Project Objective

The objective of this project was to construct approximately 13.5 hectares of restored off-channel sloughs and reconnect isolated habitat to the Skagit River. This is intended to add to the natural river functions and increase the ability of the area to provide key protection and shelter habitat to all salmon species at various life stages. The target species for this project is Chinook salmon. Initial data indicate changes in geomorphic variables and winter use of the area by Chinook salmon. The Edgewater Park project is sponsored by the City of Mount Vernon; Larry Otos and Curt Miller serve as the primary contacts. The project is located on lands owned by the City of Mount Vernon's Park and Recreation Department and the Washington State Department of Fish and Wildlife.

Project Data

Figures 4-64 and 4-65 illustrate changes measured in Pool Refuge, Pool Depth, and juvenile fish. Table 4-58 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Edgewater Park Off-Channel Restoration Project.

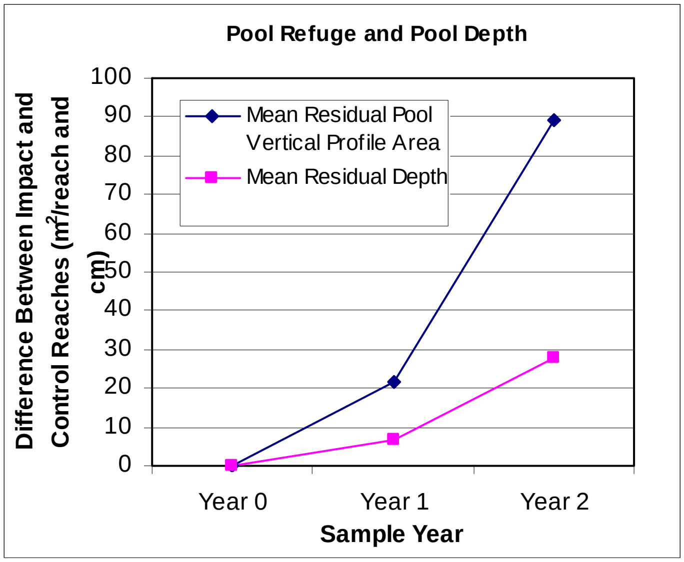


Figure 4-64. Pool Refuge and Pool Depth at Edgewater Park

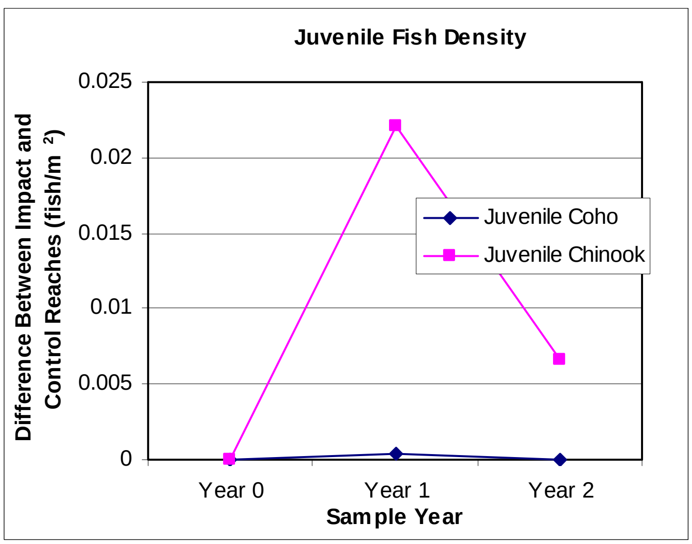


Figure 4-65. Juvenile Fish Density at Edgewater Park

MC-6 Channel Connectivity

Table 4-58. Summary Statistics for Pre- and Post-Acquisition (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2004)		Year 1 (2005)		Year 2 (2006)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	0	0	0	21.72	0	89.40
Mean Residual Pool Depth (cm)	0	0	0	6.83	0	27.94
Riparian Characteristics						
Canopy Density (1-17)	16.75	16.86	16.96	10.23	16.5	9.86
Riparian Vegetation Structure (%)	100	100	4.5	59.1	90.9	45.5
Fish Data						
Coho Juveniles (fish/m^2)	N/A	N/A	N/A	0.0004	N/A	0
Chinook Juveniles (fish/m^2)	N/A	N/A	N/A	0.0221	N/A	0.0066
Channel Connectivity						
Channel Connected? (y/n)	N/A	N/A	N/A	Yes	N/A	Yes

Data collected on July 29, 2004 (Year 0); November 15, 2005 and February 14, 2006 (fish survey) (Year 1); and December 12 and December 19, 2006 (Year 2)
*Reach length was extended in Year 1 due to construction in the impact reach and the control reach was extended to match the length of the impact reach.

Summary

Prior to project implementation, Year 0 measurements were taken in a dry channel in the impact reach, requiring the approximation of the planned dimensions. Fish surveys were not possible in Year 0 due to dry channel conditions in both control and impact reaches. In Year 1, fish surveys were not conducted in the control reach at the time of the survey due to lack of water. The constructed channel was resurveyed and new reach lengths were determined. In Year 2, the control reach remained dry, so fish measurements were not taken. Surveys were conducted in the impact reach. Coho and Chinook juveniles in the control reach remained at zero in Year 2. Both coho and Chinook juvenile densities were lower in Year 2 than in Year 1. Year 5 monitoring is scheduled to be conducted in 2009.

04-1461 Dryden Fish Enhancement Project

The Dryden Fish Enhancement Project is a cooperative habitat enhancement project designed to help endangered spring Chinook, endangered summer steelhead trout, and other salmonids within the lower Wenatchee River. The site consists of 8.8 acres of flood plain and riparian shoreline. Development along the mainstem Wenatchee River has caused significant loss of off-channel habitat and floodplain function, and much of the off-channel habitat has been taken out of salmonid production through past land use practices, as well as stream habitat alterations and fragmentation. The Wenatchee River is critically important to the recovery of salmon and the overall restoration of the watershed. The Dryden Fish Enhancement Project included the construction of an inlet structure and a series of inland channels. Approximately 195 meters of high quality rearing and over-wintering habitat was created for endangered spring Chinook salmon, endangered summer steelhead and other salmonids within the lower Wenatchee River. The target species for this project is Chinook salmon.


Impact reach in Year 0 (2005)


Dryden Pond impact reach (2008)

Project Location

The Dryden Fish Enhancement Project is located on the lower Wenatchee River, WRIA 45, in the Town of Dryden, Chelan County. The site is located on property owned by Washington Department of Fish and Wildlife at RM 15 of the Wenatchee River, which is a tributary to the Columbia River, in Township 24N, Range 18E, and Section 26. The control reach is 500 meters in length and the impact reach is 175 meters in length.

Project Objective

The objective of the project was to create prime, high quality, year-round rearing habitat, predator escape cover, and high flow refuge areas for endangered spring Chinook salmon, endangered summer steelhead, and other important Wenatchee River salmonids. This project was intended to restore ecosystem function and connectivity within the riparian floodplain. The project may play a critical role in the overall salmonid recovery strategy in this stretch of river and function as a catalyst for other joint cooperative salmonid restoration projects. Chelan

County Public Utility District is the project sponsor and Jennifer Burns serves as the primary contact.

Project Data

Figures 4-66 and 4-67 show the changes measured in pool refuge, pool depth, and juvenile fish density at the Dryden Fish Enhancement Project. Table 4-59 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring.

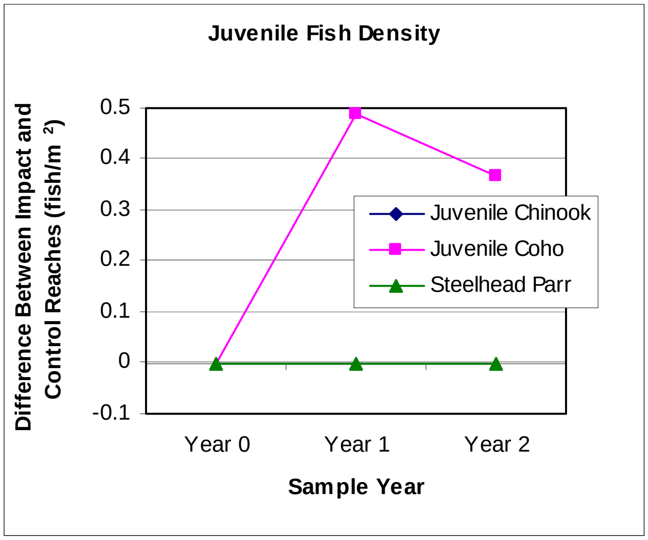


Figure 4-66. Juvenile Fish Density at Dryden Fish Enhancement Project

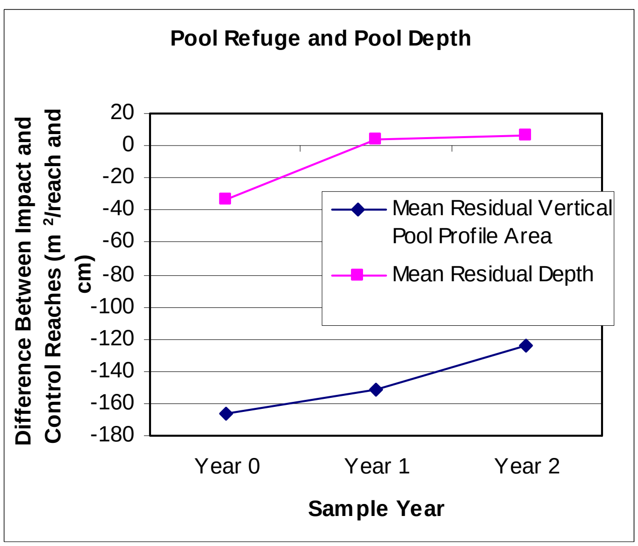


Figure 4-67. Pool Refuge and Pool Depth at Dryden Fish Enhancement Project

MC-6 Channel Connectivity

Table 4-59. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2005)		Year 1 (2007)		Year 2 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	165.91	0	242.51	90.66	207.09	83.58
Mean Residual Pool Depth (cm)	33.18	0	48.50	51.81	41.42	47.76
Riparian Characteristics						
Canopy Density (1-17)	1.82	7.09	6.0	1.5	8.4	2.5
Riparian Vegetation Structure (%)	50.0	68.2	40.9	36.4	59.1	36.4
Fish Data						
Chinook Juveniles (fish/m^2)	0	0	0.0002	0	0.0016	0
Coho Juveniles (fish/m^2)	0	0	0.0002	0.4878	0	0.3675
Steelhead Parr (fish/m^2)	0.0032	0	0.0011	0	0.0024	0
Channel Connectivity						
Channel Connected ? (y/n)	N/A	No	N/A	Yes	N/A	Yes
Data collected August 10-12, 2005 (Year 0); September 24-26, 2007 (Year 1); and September 12-14, 2008 (Year 2)						

Summary

Data collected at the Dryden Fish Enhancement Project illustrate substantial improvements at the site due to the constructed off-channel habitat. Newly created pools (as measured by mean residual pool vertical profile area and mean residual depth) provide habitat for higher densities of coho juveniles than were observed in the control reach in Year 0, Year 1, or Year 2.

Fewer juvenile coho were observed and counted in the impact reach during the Year 2 survey compared to Year 1. However, viewing conditions were limited in Year 2 by substantial surface algae growth and, therefore, the actual number of juvenile coho present in the impact reach in 2008 is likely higher than counted.

04-1563 Germany Creek Conservation/Restoration

The creek supports steelhead, coho, cutthroat, Chinook and an important population of chum salmon. It is identified as a priority watershed for salmonid recovery by the Lower Columbia Fish Recovery Board, and the project site is located in the highest priority reach for most of the populations using Germany Creek. All species in the watershed use the site for migration, spawning and rearing needs. The intertidal portion of the site can be utilized by other Columbia River populations for refugia, rearing and migration. The project addresses a number of watershed limiting factors: floodplain connectivity, riparian condition, side channel availability, sediment loading, and habitat diversity. The project is located in close proximity to other conservation projects including Abernathy Creek and Crims Island. Columbia Land Trust and project partners proposed to permanently protect 155 acres of critical riparian and floodplain habitat, and restore habitat functions for spawning, rearing and migrating salmonids along the lower mile of Germany Creek in Cowlitz County. This project restored/enhanced 2.5 acres of off-channel rearing habitat for a variety of salmonid populations along approximately 183 meters of stream. Management of the riparian habitat enhanced its value for salmon as well as watershed function.

Impact reach at Transect K in Year 0 (2008)

Control reach at Transect F in Year 0 (2008)

Project Location

The Germany Creek project is located in WRIA 25 in Cowlitz County. The impact and control sites are located approximately 300 yards upstream on Germany Creek from the gate. Each site is approximately 155 meters in length.

Project Objective

The objectives of this project are to restore/enhance 2.5 acres of off-channel rearing habitat for a variety of salmonid populations and manage the riparian habitat to enhance its value for salmon as well as watershed function. Species present in the project area include steelhead, cutthroat trout, coho salmon, Chinook salmon, and chum salmon. Ian Sinks is the contact person for this project and Columbia Land Trust is the landowner.

MC-6 Channel Connectivity

Project Data

Table 4-60 summarizes the data collected during Year 0 monitoring of the Germany Creek Project site.

Table 4-60. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2008)	
	Control	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	34.11	138.96
Mean Residual Pool Area (m^2/100m)	22.01	89.65
Riparian Characteristics		
Canopy Density (1-17)	15.36	16.36
Riparian Vegetation Structure (%)	90.9	95.5
Fish Data		
Chinook Juveniles (fish/m^2)	0	0
Coho Juveniles (fish/m^2)	0.0402	0
Steelhead Parr (fish/m^2)	0	0
Channel Connectivity		
Channel Connected ? (y/n)	N/A	No
Data collected March 15 through April 22, 2008 (Year 0)		

Summary

This project will reconnect three currently isolated ponds back to Germany Creek to provide off-channel rearing habitat for juvenile salmonids. These ponds normally have no surface connection to Germany Creek, except during limited high water events. The largest pond is deep and turbid making viewing conditions difficult. Although salmonids were not observed in the ponds during the snorkel survey, one juvenile salmonid was later observed in the largest pond during the habitat survey, suggesting that a small number of salmonids (at least one) apparently were delivered to this location during the most recent high water event but escaped detection during the snorkel survey.

04-1573 Lower Washougal Channel Connectivity & Restoration Project

The Lower Washougal Project addresses degraded floodplain conditions and functions and will directly benefit ESA listed chum salmon and Chinook salmon. Other species present in the treatment area include coho salmon, sea-run cutthroat trout and ESA listed summer and winter steelhead. The project included the construction of two riffles downstream of the old in-stream gravel quarries, allowing natural watershed processes to eventually fill the holes in the floodplain created by past mining activities; the restoration of rearing complexity in the main stem and abandoned quarries by adding LWD and boulder clusters; and the rehabilitation of three abandoned gravel quarries as ten acres of off-channel rearing habitat. The project benefits approximately 1,609 meters of river habitat.

Impact site at Transect K in Year 0 (2005)

Impact site at Transect K in Year 2 (2008)

Project Location

The Lower Washougal Project is located on the Washougal River (WRIA 28) in Clark County. The project site is located just upstream from the bridge crossing. The control reach is approximately 500 meters long and the impact reach is 160 meters long.

Project Objective

The first phase of the Lower Washougal project has three primary objectives, including restoring natural floodplain conditions, complexity in the mainstem, and off-channel rearing habitat. The project sponsor is the Lower Columbia Fish Enhancement Group (LCFEG) and the landowners are Concrete Products Incorporated, City of Camas, Georgia-Pacific Corporation, and Burlington Northern Santa Fe Railroad. The contact person for this project is Tony Meyer of the LCFEG.

MC-6 Channel Connectivity

Project Data

Figures 4-68 and 4-69 show the show the changes measured in pool refuge, pool depth, and juvenile fish density. Table 4-61 summarizes the data collected during Year 0, Year 1, and Year 2 monitoring of the Lower Washougal Project.

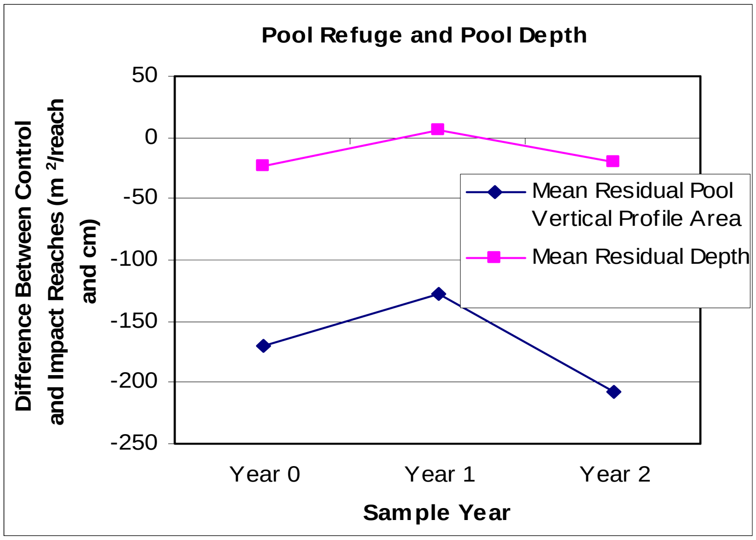


Figure 4-68. Pool Refuge at Lower Washougal

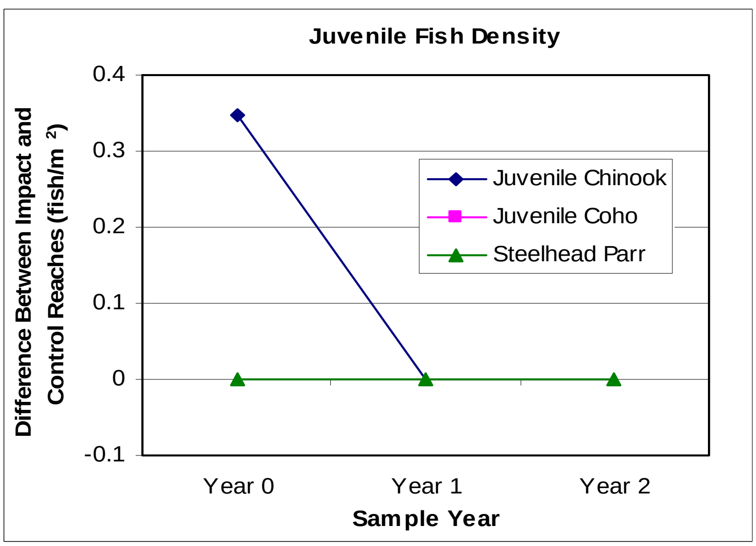


Figure 4-69. Juvenile Fish Density at Lower Washougal

MC-6 Channel Connectivity

Table 4-61. Summary Statistics for Pre- and Post-Implementation (Year 0, Year 1, and Year 2) Monitoring

Variable	Year 0 (2005)		Year 1 (2007)		Year 2 (2008)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	192.21	22.90	203.81	75.97	259.94	51.78
Mean Residual Pool Depth (cm)	38.44	14.31	40.76	47.48	51.99	32.36
Riparian Characteristics						
Canopy Density (1-17)	7.8	2.3	5.6	8.09	9.6	13.6
Riparian Vegetation Structure (%)	45.5	31.8	40.9	45.5	54.5	54.5
Fish Data						
Chinook Juveniles (fish/m^2)	0.1398	0.4868	0.0003	0.0002	0	0
Coho Juveniles (fish/m^2)	0	0	0	0	0	0
Steelhead Parr (fish/m^2)	0	0	0.0001	0	0	0
Channel Connectivity						
Channel Connected? (y/n)	N/A	No	N/A	Yes	N/A	Yes
Data collected March 11, 2005 through June 26, 2005 (Year 0); June 5-6, 2007 (Year 1); and March 24 through June 17, 2008 (Year 2).						

Summary

This unique connectivity project effectively moved the thalweg of the mainstem Washougal River from its most recent course back to its historical course which had been reduced to a side channel. Although the evaluation criteria for connectivity projects do include an assessment of juvenile salmonid abundance as related to improved rearing habitat, this project may, in fact, more effectively enhance adult spawning habitat in the impact area. Survey efforts were hampered in 2008 by exceptionally high Columbia River flows which backwatered the impact site. Despite high flow conditions, visibility was good and allowed for a complete snorkel survey. 2008 was noted as a cold water year in which accumulation of thermal units occurred later, possibly resulting in delayed juvenile emergence.

MC-6 Channel Connectivity

05-1546 Gagnon CMZ Off-Channel Project

Within the lower Wenatchee River the construction of dams and roads, logging, channelization, and human use has resulted in the disconnection of off-channel habitat and floodplain, and the reduction of native woody riparian vegetation. The resulting lack of off-channel refuge, and forested riparian vegetation are the primary salmonid habitat limiting factors. The Gagnon Project reduces these limiting factors by creating approximately 0.56 acres of off-channel high-flow (>3,000 cfs) refuge and rearing habitat along 129 meters of river, while connecting 0.5 acres of currently isolated pond habitat; directly benefiting juvenile Chinook, steelhead, and coho. The project also includes 1.39 acres of riparian restoration. The proposed actions are based upon the current understanding of habitat limiting factors, biological and physical site analysis, and design detailed in the Gagnon Project Design Report, an SRFB-funded project (#04-1538 N).

Impact reach in Year 0 (2006)

Impact reach in Year 2 (2008)

Project Location

The Gagnon project is located in WRIA 45 in Chelan County on the lower Wenatchee River. The control site, which is approximately 150 meters in length, is located on a side channel of the mainstem Wenatchee River, upstream from the impact site. The control site is located immediately downstream from the dam. The impact site measures approximately 200 meters in length.

Project Objective

The Chelan County Natural Resource Department (CCNRD) will construct the Gagnon Off-Channel Habitat Project providing off-channel refuge and rearing habitat for spring Chinook, endangered summer steelhead trout, and other salmonids within the lower Wenatchee River. The CCNRD is the project sponsor and Alan Schmidt is the project contact. Wayne Rymand is the current landowner.

MC-6 Channel Connectivity

Project Data

Figures 4-70 and 4-71 show the changes measured in pool refuge, pool depth, and juvenile fish density. Table 4-62 summarizes the data collected during Year 0 and Year 2 monitoring of the Gagnon CMZ Off-Channel Project.

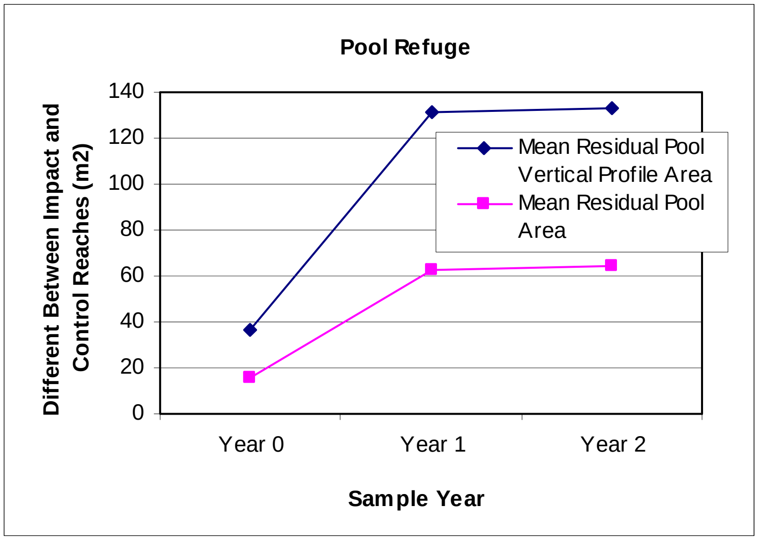


Figure 4-70. Pool Refuge at Gagnon CMZ Off-Channel Project

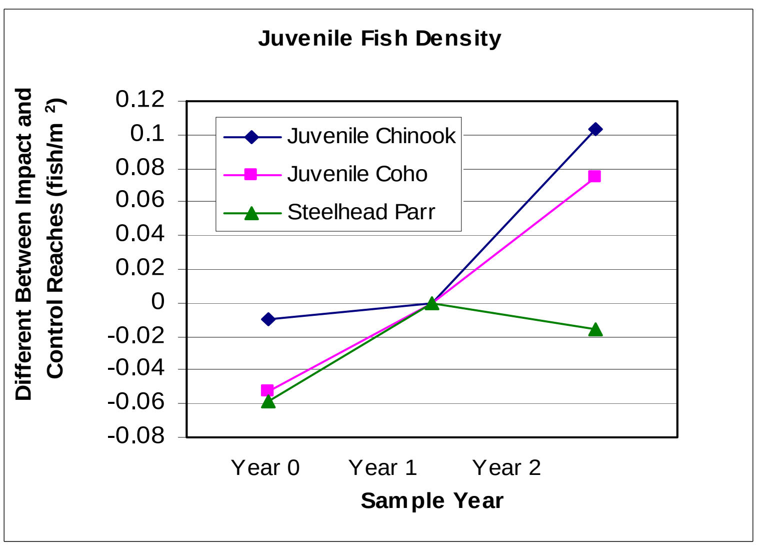


Figure 4-71. Juvenile Fish Density at Gagnon CMZ Off-Channel Project

MC-6 Channel Connectivity

Table 4-62. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 2) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)		Year 2 (2008)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Mean Residual Pool Vertical Profile Area (m^2/reach)	16.95	53.10	18.36	149.68	14.39	147.66
Mean Residual Pool Depth (cm)	11.30	26.55	12.24	74.84	9.60	73.83
Riparian Characteristics						
Canopy Density (1-17)	10.18	13.77	13.14	8.55	10.82	9.86
Riparian Vegetation Structure (%)	54.5	90.9	77.3	54.5	77.3	86.4
Fish Data						
Chinook Juveniles (fish/m^2)	0.0092	0	0	0	0.0018	0.1054
Coho Juveniles (fish/m^2)	0.0525	0	0	0	0	0.0746
Steelhead Parr (fish/m^2)	0.0585	0	0.0007	0	0.0158	0
Channel Connectivity						
Channel Connected? (y/n)	N/A	No	N/A	Yes	N/A	Yes
Data collected August 10-11, 2006 (Year 0); October 15 – 17, 2007 (Year 1); and September 13-15, 2008 (Year 2)						

Summary

The Gagnon Project connects a formerly isolated private pond to the mainstem Wenatchee River via a newly excavated connection channel. This project bares some similarity to the nearby Dryden Project (04-1461) in that substantial amounts of large woody debris have been anchored within the connection channel and pond to provide fish habitat. The Gagnon Project was completed in the late summer of 2007 during the Wenatchee River low water period and was surveyed shortly thereafter. As a result of the Year 1 survey being completed prior to full inundation of the connection channel, fish abundance in the impact reach was depressed. In contrast, the site was surveyed again in 2008 (Year 2) after full inundation and connection with the Wenatchee River. Substantial numbers of coho and Chinook salmon were observed rearing in the impact site in 2008.

06-2190 Riverview Park Restoration

The Riverview Park Restoration Project will provide summer rearing habitat and high flow winter refuge for salmon through creation of a new off-channel area from the main stem of the lower Green River and just downstream from the mouth of Mill Creek (lower Mill Creek - Auburn). Improvements include the placement of LWD, spawning gravel, and riparian plantings. The project is a Green Duwamish Ecosystem Restoration Project and is consistent with the WRIA 9 Salmon Conservation and Recovery Strategy. As stated in the Salmon Habitat Plan, the project is a top tier priority action and is located within a priority area since the project provides much needed salmon habitat and refuge in a key reach of the Green River and the mouth of lower Mill Creek. The Riverview Park Restoration Project is expected to benefit approximately 500 meters of river.

Survey crew in control reach in Year 0 (2008)

Control reach in Year 0 (2008)

Project Location

The project is located within the City of Kent, in King County Washington. Riverview Park is within WRIA 9 (Green/Duwamish). The control reach is located on the mainstem of the Green River and is approximately 450 meters in length. The impact reach is located within Riverview Park and is 243 meters long.

Project Objective

The goal of the project is to connect isolated freshwater in-stream habitat to increase the range and distribution of salmon. The objective of the project is to increase access to freshwater in-stream side channels, oxbows, and other channels. As the local sponsor, the City of Kent is working closely with the U.S. Army Corps of Engineers to complete the project. The primary contact for this project is Alex Murillo with the City of Kent.

Project Data

Table 4-63 summarizes the data collected during Year 0 monitoring of the Riverview Park Project.

MC-6 Channel Connectivity

Table 4-63. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007/2008)	
	Control	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	352.49	0
Mean Residual Pool Depth (cm)	78.33	0
Riparian Characteristics		
Canopy Density (1-17)	13.73	4.91
Riparian Vegetation Structure (%)	54.5	9.1
Fish Data		
Chinook Juveniles (fish/m^2)	0	0
Coho Juveniles (fish/m^2)	0	0
Steelhead Parr (fish/m^2)	0.0021	0
Channel Connectivity		
Channel Connected ? (y/n)	N/A	No
Data collected July 23, 2007 and August 25, 2008 (Year 0)		

Summary

The impact reach for this project was surveyed in July of 2007. The impact reach is currently located within a field in Riverview Park, and therefore, does not contain water. As a result, neither a physical habitat nor fish survey could be conducted during Year 0 monitoring and the results shown in Table 4-58 reflect values of zero.

During the summer of 2007, an attempt was made to utilize a tributary to the Green River as the control reach for the project; however, conditions were not suitable for surveying. As a result, it was necessary to establish the control reach along the mainstem of the Green River. Flows did not allow a survey of the control reach until August of 2008. Depths and flows within this reach of the Green River required that a raft be utilized for the physical habitat survey and that the snorkel survey be conducted from upstream to downstream.

06-2239 Fender Mill Floodplain Restoration – Phase I

The Fender Mill Floodplain Restoration Project is designed to address the following limiting factors affecting recovery of anadromous fish identified in the Methow Subbasin Plan: 1) alteration and reduction of riparian habitat; 2) habitat connectivity; and 3) instream and floodplain habitat degradation. The project is intended to provide off-channel rearing habitat and high flow refugia through a "Minimum Tool" approach. This approach essentially seeks to remove human caused or created barriers and elements (dikes, roads, etc.) that have resulted in isolation of historically active channels. The project has been developed to create low gradient side channels to improve connection of the river to the flood plain and to provide smaller velocity channels that are shaded to protect redds and juveniles, thus, providing optimum rearing habitat for all salmon. The Fender Mill Project is expected to benefit approximately 2,414 meters of stream.


Impact reach in 2007 (Year 0)


Control reach in 2007 (Year 0)

Project Location

The Fender Mill Floodplain Restoration Project is located on the Methow River, just downstream of the Weeman Bridge, between the towns of Winthrop and Mazama, in Okanogan County. The project site is in Township 35N, Range 20E, and Section 15, within the Methow River Basin (WRIA 48). The project is located on lands owned by the USFS, Methow Salmon Recovery Foundation, and Isaacson, a private landowner. Both the impact reach and the control reach measure approximately 150 meters in length.

Project Objective

The goal of this project is to re-introduce and utilize natural stream processes to ultimately restore habitat for salmon and other native species in the Methow River. The project will allow high river flows to enter two or three separate side channels. The side channels will provide flow to low areas that are currently charged by groundwater and retain ponded water throughout a significant portion of the year. Removal of existing berms and structures is required and minor modifications are expected to provide equipment access to the site. The

MC-6 Channel Connectivity

Methow Salmon Recovery Foundation sponsors this project and Chris Johnson serves as the primary contact.

Project Data

Table 4-64 summarizes the data collected during Year 0 monitoring of the Fender Mill Project.

Table 4-64. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007)	
	Control	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	19.91	0
Mean Residual Pool Depth (cm)	13.27	0
Riparian Characteristics		
Canopy Density (1-17)	4.18	13.59
Riparian Vegetation Structure (%)	45.5	40.9
Fish Data		
Chinook Juveniles (fish/m^2)	0.0419	0
Coho Juveniles (fish/m^2)	0	0
Steelhead Parr (fish/m^2)	0.0011	0
Channel Connectivity		
Channel Connected ? (y/n)	N/A	No
Data collected July 26, 2007 through August 10, 2007 (Year 0)		

Summary

Data collected at the Fender Mill Floodplain Restoration in 2007 site indicate a lack of use by fish at the site currently due to the disconnection from the river. When the project is completed and connection is re-established, it is expected that fish use of the area will occur. Subsequent surveys will be able to document the effects of the project. The project was not implemented in 2008; therefore, monitoring was not conducted. Year 1 monitoring of this site is scheduled for 2009.

06-2277 Upper Klickitat River Enhancement Phase II

The Upper Klickitat River Enhancement Project addresses limiting habitat features identified in the project reach associated with pool frequency and quality, channel confinement, and floodplain connectivity. The project will involve the construction of 35 LWD jams, the reconnection and creation of 2,000 feet of side channel habitat, and stabilization of almost a half mile (cumulative) of stream bank. Channel complexity will be increased via enhancement of existing pools, construction of new pools, and construction of multiple LWD jams. Summer steelhead in the river are listed as ESA-threatened and spring Chinook are listed as WDFW-depressed. Both stocks are identified as a Tier 1 priority species in the Recovery Strategy and will benefit from improved rearing, holding, and spawning conditions. The Upper Klickitat River Enhancement Phase II is expected to benefit approximately 3,701 meters of river.

Control reach in 2007 (Year 0)

Impact reach in 2007 (Year 0)

Project Location

The Upper Klickitat Enhancement Project is located in Yakima County on the upper Klickitat River (WRIA 30), within Township 10N, Range 13E, and Sections 20 and 21, in Klickitat County. The project site is located on Yakima Nation property, along the Upper Klickitat River, between RM 70.0 – 70.2 and RM 72.8 – 74.9, and is approximately 150 meters long. The control reach is also 150 meters in length.

Project Objective

The Upper Klickitat River Enhancement Project will enhance spawning, rearing, and holding habitat for spring Chinook and steelhead along roughly 2.3 miles, between RM 70 and 75, of the Klickitat River. The project is located within the “Upper Klickitat Mainstem: McCreedy Creek (RM 70) to Diamond Fork” reach that is ranked in the top tier of priority geographic areas identified in the Klickitat Lead Entity Region Salmon Recovery Strategy. This project is sponsored by the Yakama Nation and Will Conley serves as the primary contact person.

MC-6 Channel Connectivity

Project Data

Table 4-65 summarizes the data collected during Year 0 monitoring of the Upper Klickitat River Enhancement Project.

Table 4-65. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2007)	
	Control	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	27.13	3.73
Mean Residual Pool Depth (cm)	18.09	2.49
Riparian Characteristics		
Canopy Density (1-17)	10.23	12.05
Riparian Vegetation Structure (%)	50.0	68.2
Fish Data		
Chinook Juveniles (fish/m^2)	0	0
Coho Juveniles (fish/m^2)	0	0
Steelhead Parr (fish/m^2)	0.0658	0
Channel Connectivity		
Channel Connected? (y/n)	N/A	No
Data collected July 12 - 13, 2007 (Year 0)		

Summary

Data collected during the pre-project survey indicate that the impact reach is currently a dry channel, providing no fish habitat. Construction of off-channel habitat will provide additional habitat capacity to the system and is expected to result in increases in the local abundance of juvenile salmonids once the project is in place. The Upper Klickitat project was not completed in 2008; therefore, monitoring was not conducted. Year 1 monitoring is scheduled for 2009.

07-1691 Lockwood Creek Phase 3

The Lockwood Creek Phase III Restoration Project will address degraded floodplain, riparian and instream habitat conditions stemming from historical anthropological disturbance. Agricultural practices beginning with timber harvest and ending with cessation of active floodplain farming several decades ago. Beginning in 2000, restoration of this important salmon spawning stream began with removal of a barrier at the confluence with the East Fork Lewis River near La Center, Washington. Since then, restoration has progressed upstream several miles to the project site. Restoration will include placement of large wood complexing and creation of off-channel rearing habitat, followed by riparian vegetation restoration. The site contains over 2,000 feet of stream channel and covers 12 acres of floodplain habitat at the junction of Riley and Lockwood creeks. The ESA listed salmon species using Lockwood creek include Chinook, coho and steelhead. The project will be conducted on private land in partnership with Clark Public Utilities Environmental Services Division and is expected to directly benefit over 600 meters of stream.

Impact reach at Transect A in Year 0 (2008)

Control reach at Transect A in Year 0 (2008)

Project Location

Lockwood Creek is a tributary to the East Fork of the Lewis River and is located near the town of La Center, Washington. From La Center, the project is located approximately 1.9 miles east on Lockwood Creek Road. The impact and control reaches both measure approximately 150 meters in length and are located just upstream from the Lockwood Road crossing on the Harrison property.

Project Objective

The LCFEG has sponsored this work to restore Lockwood Creek. The project will include placing tree root wads and logs in the creek to create areas for fish to rest, forage, and hide from predators; creating off-channel rearing habitat; and planting the creek banks. The site contains nearly 0.4 mile of stream and covers 12 acres of floodplain habitat. The creek is home to Chinook, coho and steelhead, all of which are listed under the federal ESA. Restoration of this important salmon spawning stream began in 2000 with removal of a barrier at the confluence with the east fork of the Lewis River near La Center. The contact persons for this project are Tony Meyer of the LCFEG and Jeff Wittler of Clark Public Utilities.

Project Data

Table 4-66 summarizes the data collected during Year 0 monitoring of the Lockwood Creek Phase 3 Project.

Table 4-66. Summary Statistics for Pre-Implementation (Year 0) Monitoring

	Year 0 (2008)	
Variable	**Control**	**Impact**
Stream Physical Characteristics		
Mean Residual Pool Vertical Profile Area (m^2/reach)	20.07	2.85
Mean Residual Pool Depth (cm)	13.38	1.90
Riparian Characteristics		
Canopy Density (1-17)	15.77	12.27
Riparian Vegetation Structure (%)	90.9	72.7
Fish Data		
Chinook Juveniles (fish/m^2)	0	0
Coho Juveniles (fish/m^2)	0.0533	0
Steelhead Parr (fish/m^2)	0.0012	0
Channel Connectivity		
Channel Connected ? (y/n)	N/A	No
Data collected on May 1-2, 2008 (Year 0)		

Summary

The impact site is currently a shallow marsh adjacent to, but lacking surface connection with, Lockwood Creek and is therefore devoid of fish. This area will be excavated and connected directly to Lockwood Creek to provide off-channel rearing habitat for juvenile salmonids. Juvenile coho salmon may benefit greatly from this project in that they are known to rear extensively in off-channel habitat and were also by far the most abundant species observed during the control site snorkel survey.

4.1.7 Spawning Gravel Projects

One Spawning Gravel Project was monitored in the 2008 field season out of three active projects. Monitoring for this project includes gravel present, substrate, and spawner and redd abundance. Table 4-67 identifies the variables measured for Spawning Gravel Projects.

Figure 4-72 shows the locations of all of the Spawning Gravel Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A includes the sampling schedule for all active projects in the program.

4.1.7.1 Protocol Description

Gravel Present After Placement

Crawford (2008g) was used to assess the success of gravel placement projects. Prior to gravel placement, the boundaries of the control and impact areas were designated and gravel within these areas were measured. Spawner surveys were conducted in control and impact reaches. After gravel placement, the total area of new gravel was determined and spawner surveys were conducted. Spawning gravel projects will be considered effective if a 20 percent improvement is detected in each parameter: embeddedness, fines, and number of redds and spawners and if *t*-test results are significant. Also, for the project to be considered effective requires that 50 percent of gravel placed remains in place over a 10-year timeframe. The amount of gravel remaining could be compared against stream flows or percent exceedence data to normalize for high flows.

Substrate

Substrate monitoring will be conducted as in Section 4.1.2.1.

Spawner and Redd Abundance

Spawner and redd abundance monitoring will be conducted as in Section 4.1.1.1.

4.1.7.2 Decision Criteria

Table 4-67 shows the summary statistics and decision criteria that are used to evaluate Spawning Gravel Projects. Spawner and redd surveys are limited to a single target species for each project identified.

4.1.7.3 Project-Specific Summaries

Projects that involve gravel placement are monitored prior to implementation of the project (Year 0) and for a period of ten years following implementation. Post-project monitoring is conducted at the control site and impact site in Years 1, 3, 5, and 10. Summary statistics for the Spawning Gravel Projects are presented on the following pages. Only one of the projects was monitored in 2008; however, data from all three of the active Spawning Gravel Projects are presented below.

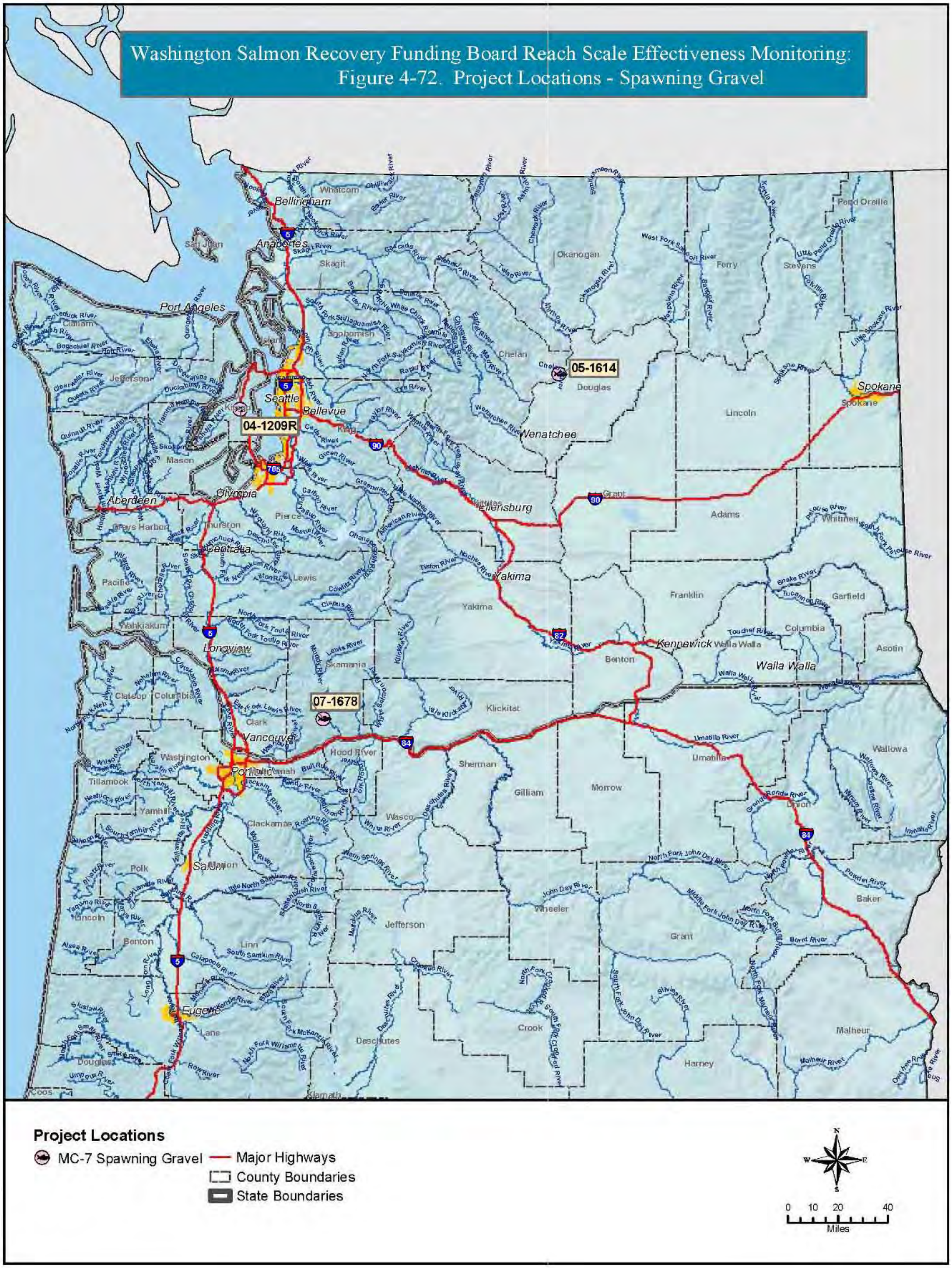
MC-7 Spawning Gravel

Table 4-67. Decision Criteria and Statistical Test Type for Spawning Gravel Projects

Monitoring Parameter	Variable	Unit	Test Type	Decision Criteria
Reach Layout	Length of stream affected by project	m	None	None
	Length of sample reach	m	None	None
	Average width of sample reach	m	None	None
Gravel Placement	Measure of gravel present after placement	m^2	Count of acres of gravel remaining	≥ 50% of gravel area is remaining by Year 10
In-Stream Habitat	Mean percent of the study substrate in fines	%	paired *t*-test	Alpha =0.10 for one-sided test Detect a decrease between treatment and control by Year 10
	Mean percentage of the substrate that is embedded within the study reach	%	paired *t*-test	Alpha =0.10 for one-sided test Detect a decrease between treatment and control by Year 10
Adult Fish Abundance (Note: Only one target species is monitored for abundance)	Chinook salmon redds or Chinook spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Coho salmon redds or coho spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Steelhead redds or coho salmon spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Bull trout redds or bull trout spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Pink salmon redds or pink salmon spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Chum salmon redds or chum salmon spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10
	Sockeye salmon redds or sockeye salmon spawner abundance	#/km	paired *t*-test	Alpha =0.10 for one-sided test Detect an increase between treatment and control by Year 10

Source: Crawford 2008g

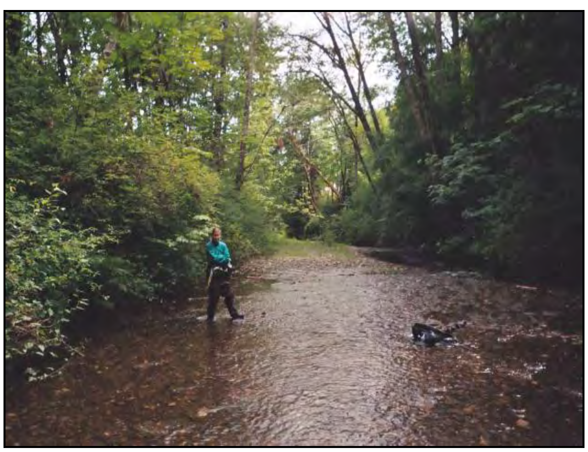
MC-7 Spawning Gravel



04-1209 Chico Creek In-Stream Habitat Restoration

Chico Creek, which flows to Dyes Inlet in Kitsap County, supports one of the largest runs of fall chum salmon in the south Puget Sound, as well as, coho, steelhead, cutthroat trout and an occasional stray Chinook salmon. The stream channel within the impact reach has been channelized and disconnected from its historic floodplain. Large woody debris and riparian vegetation within the project reach is severely limited by adjacent land use. A set of concrete box culverts exists beneath Golf Course Hill Road. The culverts created a fish passage issue, which was addressed by the placement of a series of log weirs. These weirs provided adequate passage, but were spaced too closely together, creating a mechanism for the structure to be undermined or washed out. They have also promoted the development of overly wide and shallow channel morphology. The weirs are located within a historic reach of quality salmon spawning habitat.

This project was initially planned as a single project, but has since been phased due to funding issues. Phase I of the project was completed in 2008 and involved the restoration of the downstream portion of the creek by reconstructing the stream channel and installing temporary log weirs to assist in fish passage. Gravel from the old channel will be relocated into the newly constructed channel. The riparian zone was also enhanced with native conifer tree species and shrub vegetation. Large woody debris was placed within the channel to provide in-stream habitat, maintain stream meander, and stabilize bed material. Phase II is expected to be constructed within two years after completion of Phase I and will address upstream channel restoration. Phase II will also include the removal of existing log weirs immediately below the box culvert to help establish a more natural stream gradient, meander pattern, and floodplain dimension. Phase III of the project is scheduled for construction after 2010 and will involve the restoration of the box culvert. This impact reach of the project is 250 meters in length and is expected to restore productive spawning habitat, provide high flow refuge, and facilitate upstream migration to 25,749 meters of the upper watershed.



Top of control reach during summer survey

Middle of impact reach looking downstream

MC-7 Spawning Gravel

Project Location

This project is located in Kitsap County on Chico Creek, a tributary to Dyes Inlet. The work will take place between RM 0.5 and 0.8 located mostly within property owned by Kitsap Golf and Country Club. The upstream end of the impact reach is at the box culverts. The downstream end is the second footbridge downstream from the culverts. The control reach begins upstream of the culvert and ends just downstream of the road bridge.

Project Objective

The upstream culverts block some of the downstream movement of gravel substrate. In addition to other channel modifications, gravel addition will jumpstart more suitable spawning bed formation. This project will add gravel to the stream bed after construction and add wood to supplement available gravel in order to increase spawning area. The target species for this project is chum salmon. Kitsap County sponsors this project and Sue Donahue is the primary contact. The project is located on property owned by Kitsap Golf and Country Club and Kitsap County.

Project Data

Table 4-68 summarizes the data collected during Year 0 and Year 0* monitoring of the Chico Creek Project.

Table 4-68. Summary Statistics for Pre-Implementation (Year 0 and Year 0*) Monitoring

	Year 0 (2005)		Year 0* (2006)	
Variable	Control	Impact	Control	Impact
Substrate Data				
Gravel Present after Placement (m^2)	N/A	N/A	N/A	N/A
% Study Substrate in Fines	0	0	0	2.0
Mean % Substrate Embeddedness	26.6	32.6	29.3	19.4
Fish Data				
Chum Redds (redds/km)	265	615	420	785
Chum Spawners (fish/km)	4,260	8,580	8,730	16,770

Data collected June 20, 2005 and spawner data through January 12, 2006 (Year 0) and on July 29, 2006 and spawner data through January 5, 2007 (Year 0*).
Year 0 indicates second year baseline data.

Coho salmon were also seen spawning in both reaches at lower densities. These numbers are recorded but not reported here because chum salmon is the species of interest.

Summary

Implementation at Chico Creek has been delayed due to a number of factors. In December 2007, flooding of the project area resulted in the need for re-design of the project and additional funds for implementation. The project was re-designed as a phased project consisting of three distinct phases. Phase I was completed in 2008 and Phase II is scheduled for 2009 or 2010. Phase three will not be conducted prior to 2010. Monitoring will be conducted once the project is complete.

05-1614 Beebe Creek Channel Reconfiguration Project

The Beebe Creek Channel Reconfiguration Project provided an opportunity to convert a spring-fed tributary to the Columbia River mainstem into a productive spawning stream and a thermal refuge for juvenile salmonids, while building community support for salmon restoration projects. Beebe Creek is a spring-fed creek that produces consistent quantities of cold water throughout the heat of summer and provides a locally important aquatic habitat that is currently used by steelhead, Chinook, and coho salmon for both spawning and juvenile rearing. Channelized for agricultural purposes, Beebe Creek flowed through a straight, ditch-like course with limited spawning substrates, little overhead cover, and degraded riparian conditions. The restoration resulted in the construction of a new floodplain and hyporheic zone, with the goal of restoring flood plain meander functions, sediment transport functions, dissipation, and water storage to 547 meters of stream. The additional wetland and riparian areas created as a result of this project protect this unique coldwater resource and enhance shoreline habitat complexity along the Columbia River mainstem, providing secondary benefits to terrestrial wildlife and amphibian species in this otherwise arid region.

Impact reach in 2006 (Year 0)

Impact reach in 2007 (Year 1)

Project Location

This project is located on Beebe Creek, a tributary to the Columbia River, near the Town of Chelan at approximately RM 505. The project impact site is 150 meters in length and is situated on WDFW property, in WRIA 47, Chelan County, Washington. The project control site is located on Beebe Creek within the Chelan Hatchery grounds and the impact site is approximately 200 yards to the east of the control site, on the east side of SR 97. The accessibility of Beebe Creek site on SR 97 near Chelan lends itself to interpretive opportunities involving salmon recovery efforts in the upper Columbia Basin.

Project Objective

Beebe Creek is a spring fed system that provides spawning and rearing habitat for steelhead, coho, and Chinook salmon. The Beebe Creek channel was re-routed and reconfigured to create a new floodplain and hyporheic zone, and to enhance channel sinuosity. Lake Chelan

Sportsman's Association sponsored this project, in cooperation with the landowner, WDFW, with the goal of extending the length of the existing stream in the project area by more than double and, in turn, creating and enhancing salmonid spawning and rearing habitat. The contact person for this project is Frank Clark.

Project Data

Table 4-69 summarizes the data collected during Year 0 and Year 1 monitoring of the Beebe Creek Channel Reconfiguration Project.

Table 4-69. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 1) Monitoring

Variable	Year 0 (2006)		Year 1 (2007)	
	Control	Impact	Control	Impact
Stream Physical Characteristics				
Gravel Present after Placement (acres)	N/A	N/A	0.041	0.06
% Study Substrate in Fines	22.0	100.0	30	10
Mean Percent Substrate Embeddedness	61.5	100.0	60.6	38.7
Fish Data				
Steelhead Spawners (fish/km)	80	0	73.33	0
Steelhead Redds (redds/km)	86.67	0	66.67	0
Data collected from March 14, 2006 through May 23, 2006 (Year 0) and March 4, 2007 through May 25, 2007 (Year 1).				

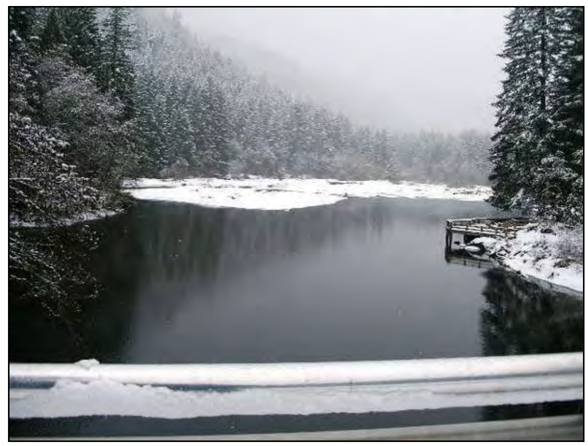
Summary

Data collected at the Beebe Creek Channel Reconfiguration Project indicates that substrate conditions are improving in the impact reach in terms of measured decrease in percent fines and percent embeddedness as compared to a control reach. However, in the first year after construction, spawning activity was not detected in the new channel. Subsequent surveys will indicate whether steelhead spawners begin to utilize the new channel in future years. Monitoring was not conducted at Beebe Creek in 2008.

07-1678 Trout Creek Restoration/Hemlock Dam Project

The Trout Creek/Hemlock Dam restoration work is part of a larger project that removes Hemlock Dam, along with an estimated 50,000 cubic yards of sediment that have accumulated behind the dam. The restoration work involves building a new channel in the reach currently occupied by the reservoir. Trout Creek provides habitat for Lower Columbia River steelhead and once produced a disproportionately large share of the steelhead in the Wind River system. Upstream of the project reach are 15 miles of potentially excellent steelhead habitat, all of which are on national forest lands. Efforts have been underway for the past decade or more to restore healthy habitats in the upper watershed. Lower Trout Creek fish are exposed to a host of hazards resulting from the dam and reservoir, including lethally high water temperatures and habitats devoid of cover and suitable surfaces where organisms can grow. This project will restore natural river processes to 402 meters of lower Trout Creek, reduce water temperatures, restore habitat diversity both in the reach and, in the 2 miles of Trout Creek downstream of the reach, and provide unobstructed passage to upper Trout Creek.

Control site facing downstream at Transect K (2008)



Impact site, Hemlock Dam Reservoir (2008)

Project Location

The project area is located in Skamania County within the Wind River Basin (WRIA 29) in the Trout Creek drainage. The impact reach is located on Crater Creek (tributary to Trout Creek) within Township 4N Range 7E Section 27. The impact reach is 170 meters long and is located at the Hemlock Lake Recreation Area. The control site is located in the free-flowing stretch of Trout Creek immediately upstream from the reservoir.

Project Objective

This project will restore natural riverine and riparian processes in lower Trout Creek. It will reduce peak water temperatures, restore suitable substrates and habitat diversity both in the project reach and in the 2 miles of Trout Creek downstream of the project reach, and will provide unobstructed passage to upper Trout Creek. The landowner is the USFS and the project sponsor is the Mid-Columbia Regional Fish Enhancement Group. Brian Bair and Bengt Coffin are the primary contacts for this project.

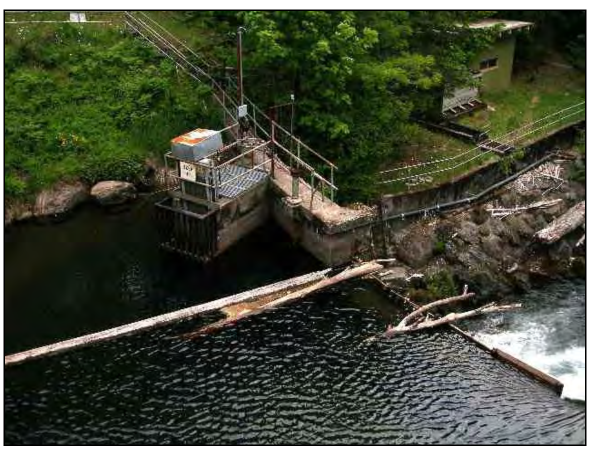
Project Data

Table 4-70 summarizes the data collected during Year 0 monitoring of the Trout Creek/Hemlock Dam Project.

Table 4-70. Summary Statistics for Pre-Implementation (Year 0) Monitoring

Variable	Year 0 (2008)	
	Control	Impact
Stream Physical Characteristics		
Gravel Present after Placement (acres)	N/A	N/A
% Study Substrate in Fines	0	0
Mean Percent Substrate Embeddedness	0	0
Fish Data		
Steelhead Spawners (fish/km)	0	53
Steelhead Redds (redds/km)	29	0
*Data collected from March 9, 2008 through June 18, 2008. See General Description for explanation of variables.		

Hemlock Dam can be seen in the photograph taken in the impact reach in 2008. Hemlock Dam will be removed as part of a large project associated with the Trout Creek restoration.



Impact reach at Transect A in Year 0 (2008)

Summary

This gravel placement project is to occur in conjunction with removal of Hemlock Dam on Trout Creek in the Wind River basin. The reservoir upstream from the dam currently (Year 0) does not provide suitable spawning habitat for anadromous salmonids due to sediment accumulation. Year 0 adult fish counts in the impact reach consisted of steelhead holding in the reservoir either prior to or after spawning at locations upstream.

4.2 FUNCTIONAL DESIGN PROJECTS

4.2.1 In-Stream Diversion Screening Projects

Six In-Stream Diversion Screening Projects were monitored during the 2008 field season out of 10 active projects (3 of the projects are at a single location). These projects do not have a control, but are monitored for function after implementation. Monitoring for the remaining projects will occur as they are implemented and operating and uses criteria to determine level of function.

Figure 4-73 shows the locations of all of the In-Stream Diversion Screening Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A includes the sampling schedule for all active projects in the program.

4.2.1.1 Protocol Description

Diversion Screening

Crawford (2008h) was used to assess compliance with design specifications. Measurable criteria were identified as a means of monitoring the design specifications of Diversion Screening Projects using the engineering drawings or blueprints. NOAA Fisheries criteria were also adapted to measure compliance of Diversion Screening Projects. The number of criteria determines how many of these criteria need to be met to achieve 80 percent compliance. After implementation, site conditions were measured to determine if they were in compliance with the design and with NOAA Fisheries criteria. In-Stream Diversion Screening Projects will be deemed effective if 80 percent of the design specifications are met.

4.2.1.2 Results/Data Summaries/Decision Criteria

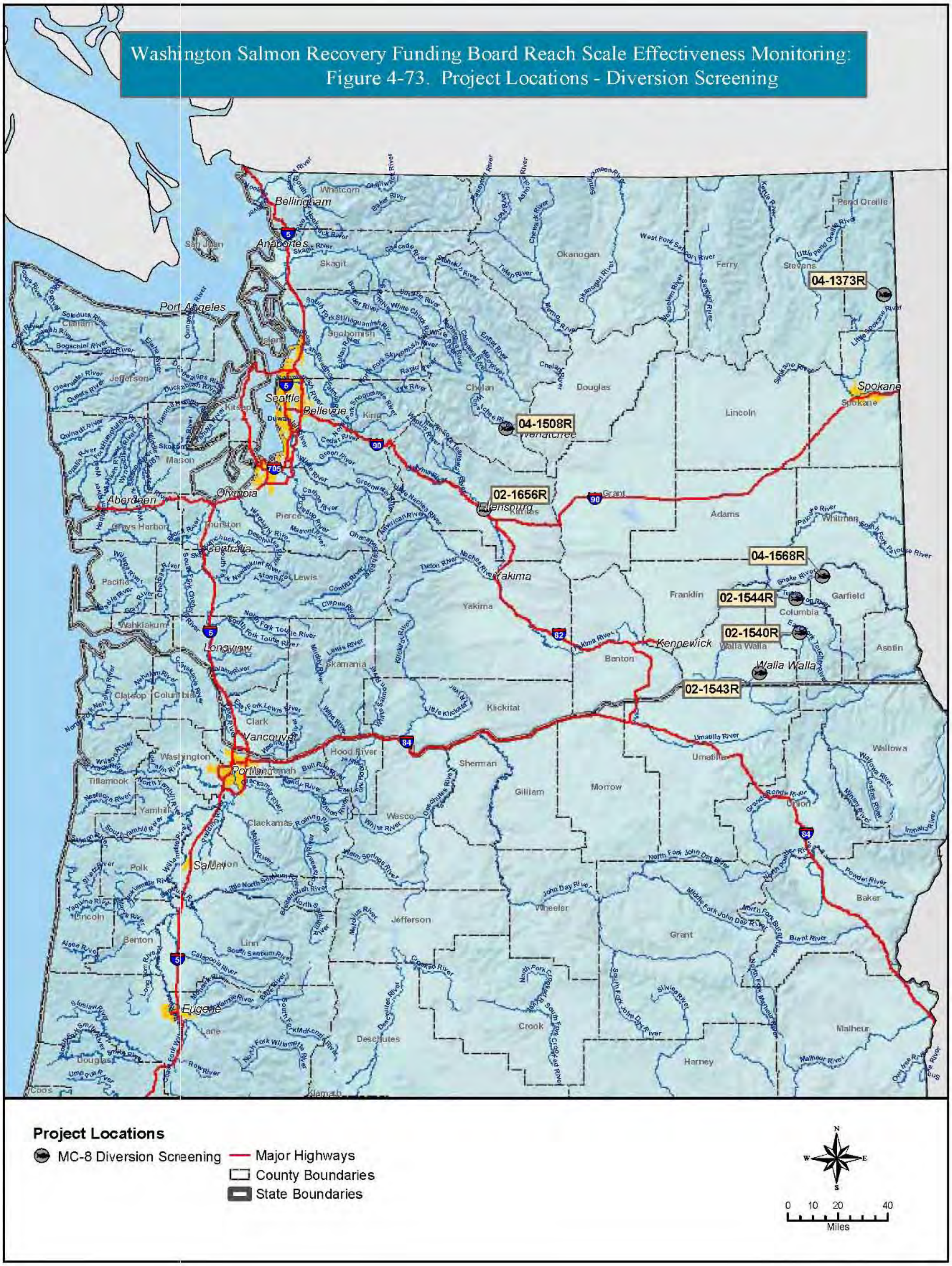
Table 4-71 identifies the decision criteria for testing In-Stream Diversion Screening Projects, and Table 4-72 contains definitions for the variables used in evaluating these projects.

Table 4-71. Decision Criteria for Testing Diversion Screening

Monitoring Parameters	Variable	Unit	Test Type	Decision Criteria
Screen Characteristics	Measure of whether the screen diversion meets design criteria	%	None. Count of functional screen diversions	≥ 80% of projects are intact by Year 5. Intact means that 80% or more of the design criteria are met at inspection.

Source: Crawford (2008h).

MC-8 Diversion Screening



MC-8 Diversion Screening

Table 4-72. Definitions for In-Stream Diversion Screening Variables

Variable	*Explanation*
Parallel Flow	*Where physically practical and biologically desirable, the screen shall be constructed at the point of diversion with the screen face generally parallel to river flow.*
Approach Velocity	*The* approach velocity *shall not exceed 0.40 feet per second (ft/s) for* active screens, *or 0.20 ft/s for* passive screens.
Uniform Flow	*The screen design shall provide for nearly uniform flow distribution (see Section 16) over the screen surface, thereby minimizing approach velocity over the entire screen face.*
Sweeping Velocity vs. Approach Velocity	*Screens longer than 6 feet shall be angled and shall have sweeping velocity greater than the approach velocity.*
Sweeping Velocity Decrease	*Sweeping velocity shall not decrease along the length of the screen.*
Screen Mesh Size	*Circular screen face openings shall not exceed 3/32 inch in diameter. Perforated plate openings shall be punched through in the direction of flow. Square screen face openings shall not exceed 3/32 inch on a side.*
Corrosion Resistant	*The* screen media *shall be corrosion resistant and sufficiently durable to maintain a smooth uniform surface with long-term use.*
Gaps	*Other components of the screen facility (such as seals) shall not include gaps greater than the maximum screen opening defined above.*
Maximum Withdrawal	*The rate of diversion is less than 3 cubic feet per second.*
Debris Accumulation	*End of Pipe Screen Location: When possible, end of pipe screens shall be placed in locations with sufficient ambient velocity to sweep away debris removed from the screen face.*
Clearance	*End of pipe screens shall be submerged to a depth of at least one screen radius below the minimum water surface, with a minimum of one screen radius clearance between screen surfaces and natural or constructed features. For approach velocity calculations, the entire submerged effective area can be used.*

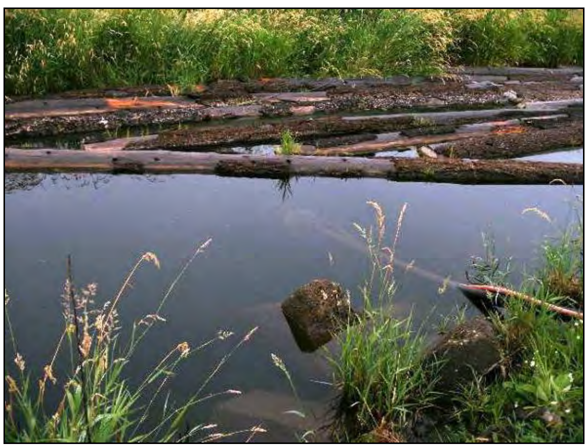
Source: NOAA Fisheries 2004

4.2.1.3 Project-Specific Summaries

Projects that involve diversion screening are monitored for a period of five years following implementation. Post-project monitoring will be conducted at the screening site during Years 1, 2, and 5. Summary statistics for In-Stream Diversion Screening Projects are presented below. Only 6 projects were sampled in 2008; however, the results from 9 of the 10 active projects are shown below. These projects do not have control sites and no baseline data are collected. The tenth active project has not been sampled yet.

02-1540 Touchet River Screens - Phase 2

The Touchet River Screening Project provided cost share funding to landowners involved in the Columbia Conservation District and WDFW Voluntary Screen Compliance Program. The Columbia Conservation District continues to take the lead in Columbia County in recruiting landowner involvement as part of the overall Walla Walla Basin Planning efforts. The entire Touchet River Subbasin within Columbia County is identified in WRIA 32 Limiting Factor Analysis, DOE 2514 Watershed Planning and Northwest Power Planning Council Subbasin Planning efforts as spawning and rearing reaches for ESA listed steelhead and bull trout. The Scope of this project includes assessment of current diversion screen conditions, design of compliant screening condition and flow meter installation to meet compliance conditions. All screening cost share requests must receive Washington State Department of Ecology (Ecology) water right verification and meet WDFW, National Marine Fisheries Service, and USFWS screen design requirements for involvement. This is a critical component of the various planning efforts in Southeast Washington and provides the landowner cost share funding incentive during depressed agriculture economic times.



Touchet site irrigation intake screen in Year 1 (2008)

Data collection at the Touchet site in Year 1 (2008)

Project Location

The project is located in the Walla Walla subbasin (WRIA 32) in Columbia County within Township 10N, Range 39E, and Section 32. The irrigation pump intake screen monitoring site is located on the Korsberg property.

Project Objective

The objective of this project is to reduce the potential “take” conditions, thus increasing spring and fall Chinook, steelhead, and bull trout juvenile survival during rearing and migration. Additionally, reduced streambed disturbance has created more stable spawning habitat. Partners include WDFW, Ecology, Walla Walla Community College, and landowners. The Columbia Conservation District sponsored this screening project and Terry Bruegman is the primary contact.

MC-8 Diversion Screening

Project Data

Table 4-73 summarizes the data collected during Year 1 monitoring of the Touchet project.

Table 4-73. Summary Statistics for Post-Implementation (Year 1) Monitoring

Variable	NOAA Criteria Compliant? Year 1 (2008)
Diversion Screen Characteristics	
Parallel Flow	N/A
Approach Velocity	Yes
Uniform Flow	Yes
Sweeping Velocity vs. Approach Velocity	N/A
Sweeping Velocity Decrease	N/A
Screen Mesh Size	Yes
Corrosion Resistant	Yes
Gaps	Yes
Maximum Withdrawal	Yes
Debris Accumulation	Yes
Clearance	Yes
Data collected on July 22, 2008 (Year 1)	

Summary

Data collected at the Touchet screening project identifies the proportion of characteristics that are in compliance with NOAA Fisheries standards. Of the applicable characteristics measured, all were found to be in compliance with the standards, exceeding the success requirement of 80 percent. This project is somewhat unique in that irrigation water is withdrawn from a pond with surface connection to the Touchet River, but not within the river channel. As a result, standards related to screen placement and river flow (sweeping velocity, parallel flow) were not applied.

02-1543 Walla Walla Fish Screening Project

Entrainment in irrigation withdrawals is a source of mortality for juvenile salmonids rearing in the streams and ditches that supply Mill Creek water to the numerous small irrigators in the cities of Walla Walla and College Place. Low flows in the Walla Walla River between the state line and Mill Creek confluence has resulted in conditions that block access to spawning areas by adult steelhead and reintroduced spring Chinook salmon. Low-flow conditions also eliminate this reach as rearing habitat for salmonids. This multi-phase project included the installation of fish screens and meters on 100 small urban irrigation pump diversions of fish-bearing streams and ditches in and around the two urban areas.


Water pump at Walla Walla site


Fish screen at Walla Walla site

Project Location

This project includes multiple locations in Walla Walla County in the cities of Walla Walla and College Place (WRIA 32). The project inspected was on Garrison Creek at the Schlegel property.

Project Objective

The objective of this project was to install meters on pump diversions that will allow irrigators to avoid exceeding their wake allocation. The intent was an increase in the discharge of Yellowhawk Creek and Garrison Creek into this critical reach of the Walla Walla River. The Walla Walla County Conservation District sponsors this project and Greg Kinsinger is the primary contact.

Project Data

Table 4-74 summarizes the data collected during Year 1 and Year 2 monitoring of the Walla Walla project.

MC-8 Diversion Screening

Table 4-74. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring

Variable	NOAA Criteria Compliant?	
	Year 1 (2005)	**Year 2 (2006)**
Diversion Screen Characteristics		
Parallel Flow	Yes	Yes
Approach Velocity	Yes	Yes
Uniform Flow	Yes	Yes
Sweeping Velocity vs. Approach Velocity	N/A	N/A
Sweeping Velocity Decrease	Yes	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	Yes	Yes
Debris Accumulation	Yes	Yes
Clearance	Yes	Yes
Data collected May 25, 2005 (Year 1) and September 14, 2006 (Year 2).		

Summary

Data collected at the Walla Walla screening project identifies the proportion of characteristics that are in compliance with NOAA Fisheries standards. Of the characteristics measured, 100 percent were in compliance with the standards in 2005 and 2006. In both years, the success requirement of being in compliance with 80 percent or more of the NOAA Fisheries criteria was met. Monitoring was not conducted at the Walla Walla site in 2008. Year 5 monitoring is scheduled for 2009.

02-1544 Tucannon River Screens - Phase 2

The Tucannon River Subbasin has been identified as containing spawning and rearing habitat for ESA-listed spring and fall Chinook salmon, steelhead, and bull trout. Regionally, fish barriers and screens have been identified as the highest priority for action due to the potential for "take" and the immediate and long term benefits that may result from restoration. Fall Chinook are believed to migrate out of the system prior to irrigation season and are not impacted. The Tucannon River screening project included an assessment of current screen conditions, design for compliance with NOAA Fisheries criteria, and flow meter installation to meet compliance conditions.

Upper fish screens on the Tucannon River in Year 1 (2007)

Lower fish screen site surveyed in Year 2 (2008)

Project Location

The project is located in the Tucannon subbasin (WRIA 35) in Columbia County. The monitoring site is within Township 12N, Range 39E, and Section 30. The upper screens are located on the right bank of the Tucannon River just upstream from Territorial Road and the lower screens are located just downstream from Territorial Road also on the right bank. The project site is on lands owned by Frame LLC.

Project Objective

The objective of this project is to reduce the potential "take" conditions, thus increasing spring and fall Chinook, steelhead, and bull trout juvenile survival during rearing and migration. Additionally, reduced streambed disturbance has created more stable spawning habitat. The Columbia Conservation District sponsored this screening project and Terry Bruegman is the primary contact.

Project Data

Table 4-75 summarizes the data collected during Year 1 and Year 2 monitoring of the Tucannon project.

MC-8 Diversion Screening

Table 4-75. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring:

Variable	NOAA Criteria Compliant?	
	Year 1 (2007)	Year 2 (2008)
Diversion Screen Characteristics		
Parallel Flow	Yes	Yes
Approach Velocity	Yes	Yes
Uniform Flow	Yes	Yes
Sweeping Velocity vs. Approach Velocity	N/A	N/A
Sweeping Velocity Decrease	No	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	Yes	Yes
Debris Accumulation	Yes	Yes
Clearance	Yes	Yes
Data collected on June 29, 2007 (Year 1) and June 25, 2008 (Year 2)		

Summary

Data collected at the Tucannon screening project identifies the proportion of characteristics that are in compliance with NOAA Fisheries standards. Of the characteristics measured, 90 percent were in compliance with the standards in 2007 and 100 percent were in compliance in 2008. In both years, the success requirement of being in compliance with 80 percent or more of the NOAA Fisheries criteria was met. Due to excessively high river flows and associated water depths in 2008, re-surveying of the upper Tucannon River screens on the Frame property was not possible. A second set of screens had been installed at shallower depths downstream and these were surveyed in Year 2.

02-1656 Dry/Cabin Creek Fish Screening Project

The Dry/Cabin Creek Fish Screening Project site includes a spring-brook waterway known as Cabin Creek and Dry Creek, which is a tributary to the Yakima River at RM 157. From the project site downstream to a side channel of the Yakima River is rearing habitat for juvenile spring Chinook salmon and resident fish (rainbow trout). The irrigation diversion structures previously blocked access to approximately 1.9 kilometer of rearing habitat.

The Kittitas County Conservation District sponsored this project as part of the YTAHP. The project is an exceptional opportunity to provide immediate benefits to juvenile salmonids, while taking advantage of the resources and expertise provided through the YTAHP.

Fish screen in Year 2 (2006)

Project Location

The project is located in WRIA 39 in Kittitas County on the Taylor property at 3012 Highway 10.

Project Objective

This project addressed unscreened, impassable irrigation water diversions that serve an inefficient irrigation system. Major tasks included the installation of a fish screen, fish passage structure, mini-pivot irrigation systems, and site restoration by planting appropriate riparian tree and shrub species. Kittitas County Conservation District sponsored this project and Anna Lael serves as the primary contact.

Project Data

Table 4-76 summarizes the data collected during Year 1 and Year 2 monitoring of the Dry/Cabin Creek Project.

MC-8 Diversion Screening

Table 4-76. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring

Variable	NOAA Criteria Compliant?	
	Year 1 (2005)	**Year 2 (2006)**
Diversion Screen Characteristics		
Parallel Flow	Yes	Yes
Approach Velocity	Yes	Yes
Uniform Flow	Yes	Yes
Sweeping Velocity vs. Approach Velocity	Yes	Yes
Sweeping Velocity Decrease	Yes	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	Yes	Yes
Debris Accumulation	Yes	Yes
Clearance	No	Yes
Data collected on September 27, 2005 (Year 1) and September 13, 2006 (Year 2).		

Summary

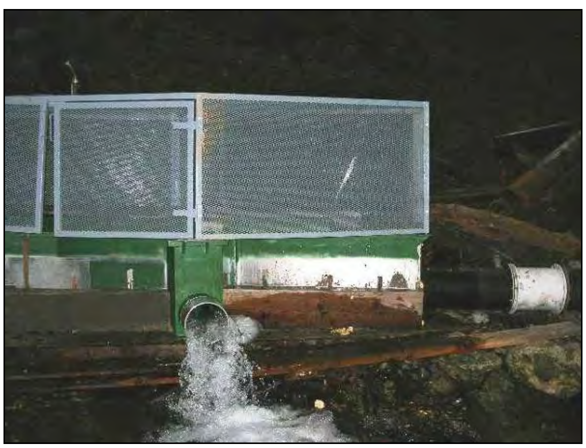
Data collected at the Dry/Cabin Creek screening project identifies the proportion of characteristics that are in compliance with NOAA Fisheries standards. Of the characteristics measured, 90 percent were in compliance with the standards in 2005 and 100 percent were in compliance in 2006. In both years, the success requirement of being in compliance with 80 percent or more of the NOAA Fisheries criteria was met. Monitoring was not conducted at the Dry/Cabin Creek site in 2008. Year 5 monitoring is scheduled for 2009.

04-1373 Indian Creek Diversion Screening

The Indian Creek Diversion Screening Project is identified in the Pend Oreille Lead Entity Strategy as the second priority action in the Indian Creek Subbasin, a high priority area in WRIA 62. The project occurred in conjunction with other Indian Creek fish passage improvements through funding from the Family Forest Fish Passage and Landowner Incentive programs. The Limiting Factors Report for WRIA 62 lists Indian Creek as recoverable habitat. Indian Creek is proposed to be designated bull trout critical habitat by the USFWS. Other native salmonids present in Indian Creek, which also benefited from this project, include westslope cutthroat trout and mountain whitefish.

Diversion screening at the Roy property in Year 2 (2008)

Diversion screening at the McDaniel property (lower site) in Year 2 (2008)



Diversion screen and bypass system at the McDaniel property (upper site) in Year 2 (2008)

Project Location

This project consisted of three screens, one located on property owned by Richard Roy and two located on property owned by Stan McDaniel. The sites are in Pend Oreille County, within the Pend Oreille River subbasin (WRIA 62), all within Township 32N, Range 45E, and Sections 20 and 29. The Indian Creek Diversion Screening Project was sponsored by the Pend Oreille Conservation District and Andy Albrecht serves as the primary contact.

MC-8 Diversion Screening

Project Objective

Three insufficiently screened water diversions were screened to meet WDFW and USFWS screening requirements. The objective of this project was to reduce mortality of fry, juvenile, and adult salmonids, including ESA-listed bull trout, caused by water withdrawal and diversion from Indian Creek in the Pend Oreille watershed (WRIA 62). This project also improved fish passage at one of the diversions. Water quantity in Indian Creek was improved by increasing diversion efficiency.

Project Data

Tables 4-77, 4-78, and 4-79 summarize the data collected during Year 1 and Year 2 monitoring at all three of the Indian Creek Projects.

Table 4-77. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring at the Indian Creek Diversion Screening Project (Roy property)

	NOAA Criteria Compliant?	
Variable	**Year 1 (2007)**	**Year 2 (2008)**
Diversion Screen Characteristics		
Parallel Flow	No	No
Approach Velocity	Yes	Yes
Uniform Flow	Yes	Yes
Sweeping Velocity vs. Approach Velocity	N/A	N/A
Sweeping Velocity Decrease	Yes	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	Yes	Yes
Debris Accumulation	Yes	Yes
Clearance	No	No
Data collected on August 20, 2007 (Year 1) and July 23, 2008 (Year 2)		

MC-8 Diversion Screening

Table 4-78. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring at the Indian Creek Diversion Screening project (McDaniel property site 1-lower site)

Variable	NOAA Criteria Compliant? Year 1 (2007)	NOAA Criteria Compliant? Year 2 (2008)
Diversion Screen Characteristics		
Parallel Flow	Yes	Yes
Approach Velocity	*NT	*NT
Uniform Flow	*NT	*NT
Sweeping Velocity vs. Approach Velocity	N/A	N/A
Sweeping Velocity Decrease	*NT	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	*NT	*NT
Debris Accumulation	Yes	Yes
Clearance	Yes	No
Data collected on August 20, 2007 (Year 1) and July 23, 2008 (Year 2) *NT=Data not taken because screen not in operation at the time of the survey		

Table 4-79. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring at the Indian Creek Diversion Screening project (McDaniel property site 2-upper site)

Variable	NOAA Criteria Compliant? Year 1 (2007)	NOAA Criteria Compliant? Year 2 (2008)
Diversion Screen Characteristics		
Parallel Flow	*NT	Yes
Approach Velocity	*NT	Yes
Uniform Flow	*NT	Yes
Sweeping Velocity vs. Approach Velocity	*NT	Yes
Sweeping Velocity Decrease	*NT	Yes
Screen Mesh Size	Yes	Yes
Corrosion Resistant	Yes	Yes
Gaps	Yes	Yes
Maximum Withdrawal	Yes	Yes
Debris Accumulation	*NT	Yes
Clearance	N/A	Yes
Data collected on August 20, 2007 (Year 1) and July 23, 2008 (Year 2) *NT=Data not taken because screen not in operation at the time of the survey		

Summary

Data collected at the three Diversion Screening Projects associated with the Indian Creek Project document the number of characteristics that were in compliance with the NOAA fisheries guidance. In 2008, the screening project at the Roy property had 80 percent of the measured characteristics in compliance. The screen at Site 1 on the McDaniel property had 86 percent of the characteristics in compliance. The screen at Site 2 on the McDaniel property had 100 percent of the measured characteristics in compliance with NOAA Fisheries guidance in

2008. Some characteristics were not measured as the screens were not operational at the time of the survey and others were not applicable to certain screens.

The passive circular screen on the Roy property was installed perpendicular to stream flow. The landowner commented that gravel and debris accumulate under this configuration requiring that the screen be manually cleaned every 3 to 4 days.

MC-8 Diversion Screening

04-1508 Jones-Shotwell Screen and Diversion

As part of this project, the Jones-Shotwell Ditch Board has modernized their diversion facilities to comply with NOAA Fisheries criteria, improve fish passage, and enhance the habitat for threatened and endangered salmonid species at their diversion site in Monitor, Washington. The pre-existing diversion features consisted of a rock wing dam, a 600-foot-long man-made diversion channel, a traveling belt screen, and a forebay water surface control check structure. Replacing the rock wing dam with a permanent rock structure has allowed the district to divert water without having to rebuild its in-stream diversion annually. Reworking the diversion channel, including removal of some concrete structures and adding habitat elements, has eliminated the need to periodically excavate the channel to remove the continuously deposited sand and silts. These actions will improve valuable salmonid habitat over time. The forebay structure was a passage barrier to adult salmon attempting to enter the diversion channel from the downstream end. Building passage over the structure has allowed downstream access to the diversion channel. The WDFW requested upstream passage for salmonids at this forebay check structure.

Jones-Shotwell irrigation diversion system in Year 1 (2008)

Project Location

The project is located in WRIA 45 in Chelan County on the lower Wenatchee River. The Jones-Shotwell site is east of Leavenworth and the project is located on Washington Department of Fish and Wildlife property.

Project Objective

The existing fish screens are at the end of their useful life and do not comply with the current NOAA Fisheries juvenile passage and protection criteria. The objective of this project was to replace the existing screens to prevent entrainment and impingement of juvenile salmonids, which is critical considering the habitat value that WDFW places on the diversion channel. The Cascadia Conservation District is the project sponsor and Mike Rickel is the primary contact.

MC-8 Diversion Screening

Project Data

Table 4-80 summarizes the data collected during Year 1 monitoring of the Jones-Shotwell Project.

Table 4-80. Summary Statistics for Post-Implementation (Year 1) Monitoring

Variable	NOAA Criteria Compliant? Year 1 (2008)
Diversion Screen Characteristics	
Parallel Flow	Yes
Approach Velocity	Yes
Uniform Flow	Yes
Sweeping Velocity vs. Approach Velocity	N/A
Sweeping Velocity Decrease	Yes
Screen Mesh Size	Yes
Corrosion Resistant	Yes
Gaps	Yes
Maximum Withdrawal	Yes
Debris Accumulation	Yes
Bypass Outfall Depth	Yes
Data collected on May 28, 2008 (Year 1)	

Summary

Data collected at the Jones-Shotwell Screen and Diversion project identifies the proportion of characteristics that are in compliance with NOAA Fisheries standards. Of the characteristics measured, 100 percent are in compliance with the standards, exceeding the success requirement of 80 percent.

04-1568 Garfield County Irrigation Screening Project

The Garfield County Screening Project was intended to provide cost share funding to landowners involved in the Pomeroy Conservation District and WDFW Voluntary Screen Compliance Program. The project resulted in the installation of 30 screens located throughout Garfield County on the Pataha, Deadman, Meadow, and Alpowa Creeks. These four creeks are identified in the WRIA 35 Limiting Factor Analysis, Pataha Model Watershed Plan, and the Northwest Power and Conservation Council Subbasin Planning efforts as containing spawning and rearing habitat for ESA-listed steelhead.

Fish screen on Meadow Creek in 2006 (Year 1)

Deadman Creek pump in 2007 (Year 2)

Project Location

The Garfield Diversion Screening Project is located on property owned by Klaveano Ranches in WRIA 35, Garfield County, Washington. The Deadman Creek site is within Township 13N, Range 40E, and Section 11 and the Meadow Creek site is within Township 13N, Range 40E, and Section 22.

Project Objective

The scope of this project included assessment of screen conditions, design for compliant screen condition, and screen installation that meets compliance conditions. The program required Ecology water right verification and designs needed to meet WDFW and NOAA Fisheries screen design requirements. This project was sponsored by Pomeroy Conservation District and Duane Bartels serves as the primary contact.

Project Data

Table 4-81 summarizes the data collected during Year 1 and Year 2 monitoring of the Garfield County project.

MC-8 Diversion Screening

Table 4-81. Summary Statistics for Post-Implementation (Year 1 and Year 2) Monitoring

Variable[1]	NOAA Criteria Compliant?			
	Year 1		Year 2	
	Meadow Creek	Deadman Creek	Meadow Creek	Deadman Creek
Diversion Screen Characteristics				
Parallel Flow	Yes	Yes	Yes	Yes
Approach Velocity	Yes	Yes	Yes	Yes
Uniform Flow	Yes	Yes	No	No
Sweeping Velocity vs. Approach Velocity	N/A	N/A	NA	NA
Sweeping Velocity Decrease	No	Yes	Yes	Yes
Screen Mesh Size	Yes	Yes	Yes	Yes
Corrosion Resistant	Yes	Yes	Yes	Yes
Gaps	Yes	Yes	Yes	Yes
Maximum Withdrawal	Yes	Yes	Yes	Yes
Debris Accumulation	No	No	No	No
Clearance	No	No	No	No
Data collected on July 14, 2006 for both creeks (Year 1) and June 21, 2007 for both creeks (Year 2).				

Summary

Due to agricultural run-off and erosion, both Deadman Creek and Meadow Creek experience an exceptionally high silt load and growth of aquatic vegetation. As a result these screens must be cleaned daily during the irrigation season to remain functional. Consequently, both sets of screens have been found to be out of compliance with several criteria resulting in a compliance rating of 70 percent. However, impingement velocities have been also been found to be negligible and juvenile fish have been observed in close proximity to the screens without impingement. Additional maintenance at these screens would improve the compliance rating for future monitoring events. Monitoring was not conducted at the Garfield County sites in 2008 and Year 5 monitoring is scheduled for 2010.

4.3 HABITAT PROTECTION PROJECTS

4.3.1 Protocol Description

Habitat Protection Projects focus on preserving existing high-quality habitat without additional action. To evaluate these projects, multiple indicators of ecological health are tracked through time to see if these indicators are maintained or improved. This project category is divided into freshwater and estuarine projects, depending on the type of habitat present on the landscape. Different indicators are measured for each project type.

While none of the Habitat Protection Projects were monitored in 2008, there are a total of 10 active projects. Figure 4-74 shows the locations of all of the Habitat Protection Projects currently being monitored for effectiveness under the SRFB Coordinated Monitoring Program. Appendix A shows the sampling schedule for all active projects in the program.

4.3.1.1 Freshwater Habitat Protection Projects

No freshwater acquisition projects were monitored during the 2008 field season. Monitoring in previous years for these projects included stream morphology, fish and macroinvertebrate assemblages, riparian vegetation, and upland vegetation. Details on the protocol used are found in Crawford and Arnett (2008). Success determination for acquisitions will be based on the number of indicators that are maintained or show a significant increase over time.

Stream Morphology

Stream morphology was monitored using the same procedures in Section 4.1.2.1.

Substrate

Substrate was monitored using the same protocols as described in Section 4.1.2.1.

Large Woody Debris

Large woody debris was monitored using the same protocols as described in Section 4.1.2.1.

Slope Measurements

Slope was measured using the same protocols as described in Section 4.1.2.1.

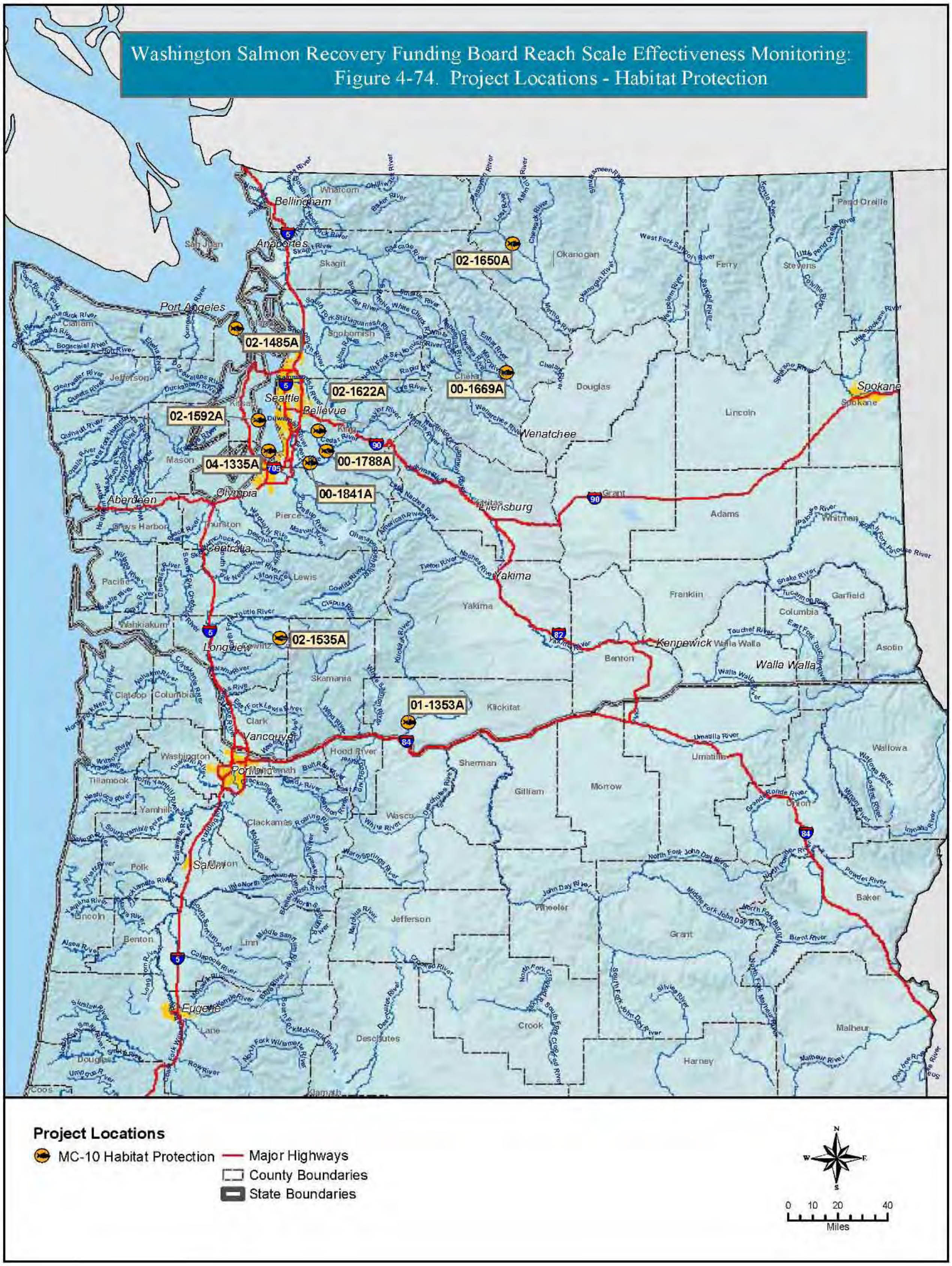
Riparian Vegetation Structure

Riparian vegetation structure was monitored using the same protocols as described in Section 4.1.2.1.

Shading

Shading was monitored using the same protocols as described in Section 4.1.2.1.

MC-10 Habitat Protection



Actively Eroding Stream Banks

Protocol for Monitoring Effectiveness of Habitat Protection Projects (Crawford and Arnett 2004 (revised 2008)) was used to estimate the percent of the linear distance of the channel on both stream banks at each transect where active erosion is occurring at the active channel height. This procedure is described in Section 4.1.3.1. Projects will be considered effective if low levels are maintained or if there is a 20 percent decrease over the baseline mean value in percent of the linear distance of stream bank where active erosion is occurring in the project area by Year 12 and if trend analysis identifies a declining trend.

Fish Species Assemblages

Protocol for Monitoring Effectiveness of Habitat Protection Projects (Crawford and Arnett 2004 (revised 2008)) was used with modification to assess fish assemblages in acquisition properties. This protocol describes one-pass electrofishing or snorkel surveys for monitoring fish species assemblages. In each of the acquisitions, endangered species present prevented the use of electrofishing due to the chance of harming listed species. Instead, snorkel surveys were used at all sites to survey fish populations to enable comparisons among sites. Traditional snorkel surveys were combined with quadrat sampling snorkel surveys. Traditional snorkel surveys were conducted as described in the protocol from the bottom of the reach to the top, counting all fish observed. Quadrat surveys involved placing a 30-cm square quadrat on the substrate and lifting rocks one at a time while a pair of snorkelers viewed the quadrat. Each snorkeler had a small aquarium net and the nets were used to capture fish hiding in the benthos (mainly sculpin). Fish captured were identified using viewing boxes and then returned to the stream. The quadrat was set down eight times in riffle habitat within the sample reach. This process was used to assess the diversity of the fish assemblage without the potential for harming listed fish. All Habitat Protection Projects were sampled this way to allow for comparison of data across sites. Fish were identified, length was measured or estimated, and any external anomalies were noted. For any unknown fish species, voucher specimens were collected and/or species photographed for future identification. Fish were classified and data were analyzed according to Mebane's Fish Index of Biotic Integrity Procedures (C. Mebane, personal communication, November 2004). Fish species assemblage scores can be interpreted using the grading system in Table 4-82. Projects will be considered effective if high ratings are maintained or if there is a 20 percent increase in fish species assemblage scores over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows an increasing trend in this value over time.

Table 4-82. Fish Species Assemblage Grading System

Score	Rating	Description
75-100	Good	Possessing or approaching biological integrity. Minimal disturbance. Hosts a diverse and abundant assemblage of species.
50-75	Fair	Somewhat lower quality waters where socially desirable alien species are present, reflecting relatively high-quality physical and chemical habitats. Native cool water species are dominant, but generally tolerant species occur more frequently.
<50	Poor	Poor quality habitat. Cold water and sensitive species are rare or absent, and generally tolerant species predominate.

Source: Mebane et al. 2003

Macroinvertebrate Species Assemblages

At the sample reach within the acquisition, eight D-frame kick net samples were collected according to the EMAP protocols for targeted riffle samples (Peck et al. 2003; Crawford and Arnett 2008). These samples were then combined for the entire reach. Invertebrates were separated from the substrate with a sieve and samples were preserved using 99 percent ethyl alcohol. Samples were sent to Aquatic Biology Associates (Corvallis, Oregon) for identification of species. Multimetric Index (MMI) metrics based on family, tolerance scores of species, functional feeding groups, long-lived taxa, and taxa richness were calculated by the lab. Projects will be considered effective if highscores are maintained or if there is a 20 percent increase in the macroinvertebrate multimetric index over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows and increasing trend in this value over time. Table 4-83 identifies the grading system used for the MMI.

Table 4-83. Macroinvertebrate Multimetric Index Grading System

Narrative Assessment	Puget Lowlands	Cascades	Columbia Plateau
Good	>30	>28	>34
Fair	20-30	23-28	23-33
Poor	<20	<23	<22

Source: Wiseman 2003

Upland Plants

Crawford and Arnett (2008) describes the details for monitoring upland vegetation in Habitat Protection Projects. The methodology described below is designed to quantitatively characterize the vegetation of a parcel.

Major vegetation polygons were delineated by visual inspection of orthophotos in GIS format (ArcView or ArcMap). The level of resolution of this delineation depended on the type of vegetation, but did, at a minimum, distinguish between forested, shrub steppe, and grassland communities. Within these vegetation types, stands that were visually distinct due to differences in stand age, level of disturbance, and dominant species were also separated. Polygons were rated using a rating system from the Washington Natural Heritage Program to assess the level of disturbance in upland vegetation. Table 4-84 identifies the rating system used.

In GIS format, transects were mapped within the vegetation types and geographical coordinates of the endpoints of each transect were determined. In situations where vegetation boundaries were expected to change, the transects were located to span ecotones.

Table 4-84. Rating Criteria for Vegetation Quality

Rating		Description
A	Excellent	Plant association is pristine, appears to have experienced little or no present or past disturbance by post-industrial humans, is a large stand, or exhibits exceptional species diversity.
B	Good	Plant association is in good to very good condition. Species composition and diversity are within the range expected for the type.
C	Moderate	Plant association is somewhat degraded or recovering. While species diversity is typically low, environment and species composition are similar to published source.
D	Poor	Plant association is degraded by logging, grazing, development, or by non-native species, although it is still recognizable as a described community.
E	Extirpated	Plant association is completely altered and unrecognizable. Non-natives dominate.

Source: Adapted from Washington Natural Heritage Program Field Methodology (NatureServe 2002)

In the field, the baseline transects were located and marked, and forest plots and transect segment starting points were randomly located along these transects. Ability to relocate transect origins was of primary importance, and the location of endpoints was modified based on landmarks in the field to facilitate relocation. GPS coordinates of origin stakes for transects were recorded, along with datum used.

As shown in Figure 4-75, Transect type A is used to characterize vegetation within polygons. Transect type B is used to monitor changes in location of polygon boundaries. In forested polygons, circular plots would be randomly located at points on type A transects.

For grassland plots, each transect segment starting point was a random point that was established along the baseline transect, at minimum intervals of 10 meters. Plots were established as ten 1-meter segments of the baseline transect extending for 10 meters beyond each designated transect segment starting point. Each 1-meter section of the transect was established as a plot, in which species composition and cover were recorded. In addition to species cover, cover of mosses and lichens (not by species) and bare ground were recorded. Average height by vegetation type was recorded within each plot. Shrub plots were monitored in the same manner as the grassland plots.

In forest plots, circular plots centered on points randomly selected along the transects were established as described above. These plots were marked with a single marker, eliminating the need for recording, marking, and geo-referencing the corners of the plot. For sampling trees, a 1/10-acre circular plot was used, and all trees were recorded by species, diameter-at-breast-height (dbh) size class, and average tree height by canopy layer. Projects will be considered effective if there is a 20 percent decrease in percent cover of non-native herbaceous vascular plant species and non-native shrub species over the baseline mean value in the project area by Year 12. Projects will be considered effective if high levels are maintained or if there is a 20 percent increase in basal area and stem count of conifers per acre and basal area and stem count of deciduous trees per acre over the baseline mean value in the project area by Year 12. Additionally, these variables will be evaluated using a trend analysis to see if values are increasing over time.

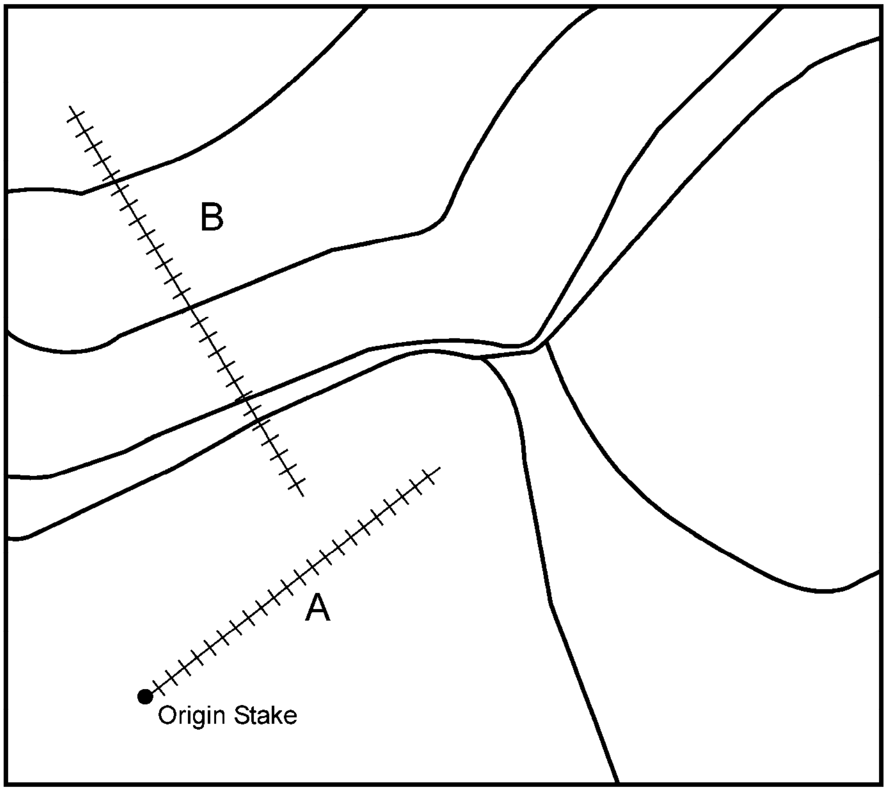


Figure 4-75. Diagrammatic Vegetation Polygons Showing Transect Locations

4.3.1.2 Estuary Habitat Protection Projects

Crawford and Arnett (2008) describes the details for monitoring intertidal vegetation and conditions in Habitat Protection Projects. A permanent intertidal baseline transect (called intertidal transect) was located such that the transect lay perpendicular to the shore and so it crossed the various intertidal elevations. Beach slope and percent fines were monitored as indicators of changes in beach physical conditions. The locations of boundaries of major changes in vegetation along baseline transects were recorded, including boundaries between vegetation; areas of algae, kelp, or eelgrass; bare ground; and substrate classes. Transect segments (of homogenous vegetation) were located along the baseline transect or perpendicular to the baseline depending on the size and shape of the estuary. Species composition and percent cover were recorded for herbaceous vascular plants and percent cover was recorded for algae, kelp, and eel grass in each of ten plots established in each of the transect segments. The type of substrate present was also recorded for each transect segment.

Linear Extent of Algae Along the Intertidal Transect

The length of each algae patch along the intertidal transect was determined by measuring the distance of the beginning and the end of each algae patch from the origin point of the transect. The sum of the lengths of each patch was calculated as the linear extent of algae along the intertidal transect. Projects will be considered effective if high levels of algae are maintained or if there is a 20 percent increase in the linear extent of algae along the intertidal transect over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a if trend analysis shows an increasing trend in this value over time.

Percent of the Length of the Intertidal Transect with Algae

The linear extent of algae along the intertidal transect divided by the total length of the intertidal transect was used to determine the percent of the length of the intertidal transect with algae. Projects will be considered effective if high levels of algae are maintained or if there is a 20 percent increase in the percent of the length of the intertidal transect with algae over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows an increasing trend in this value over time.

Linear Extent of Vascular Plants Along the Intertidal Transect

The length of each vascular plant patch along the intertidal transect was determined by measuring the distance of the beginning and the end of each vascular plant patch from the origin point of the intertidal transect. The sum of the lengths of each patch was calculated as the linear extent of vascular plants along the intertidal transect. Projects will be considered effective if high levels of vascular plants are maintained or if there is a 20 percent increase in the linear extent of vascular plants along the intertidal transect over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if trend analysis shows an increasing trend in this value over time.

Percent of the Length of the Intertidal Transect with Vascular Plants

The linear extent of vascular plants along the intertidal transect divided by the total length of the intertidal transect was used to determine the percent of the length of the intertidal transect with vascular plants. Projects will be considered effective if high levels of vascular plants are maintained or if there is a 20 percent increase in the percent of the length of the intertidal transect with vascular plants over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows an increasing trend in this value over time.

Percent Slope

A clinometer was used to measure percent slope from mean high tide to mean low tide along the intertidal transect perpendicular to the shore.

Linear Extent of Fine Sediment Along the Intertidal Transect

The total length of fine sediment was determined by measuring the distance along the intertidal transect of the beginning and end of fine sediment from the origin point of the transect. If the fine sediment was patchy, the sum of the lengths of each patch would be used. Projects will be considered effective if low levels of fine sediment are maintained or if there is a 20 percent decrease in the linear extent of fine sediment along the intertidal transect over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows a decreasing trend in this value over time.

Percent of the Length of the Intertidal Transect with Fine sediment.

The linear extent of fine sediment along the intertidal transect divided by the total length of the intertidal transect was used to determine the percent of the length of the intertidal transect with algae. Projects will be considered effective if low levels of fine sediment are maintained or if there is a 20 percent decrease in the percent of the length of the intertidal transect with fine sediment over the baseline mean value in the project area by Year 12. Data will also be evaluated to determine if a trend analysis shows a decreasing trend in this value over time.

Results/Data Summaries/Decision Criteria

Table 4-85 identifies the summary statistics for Habitat Protection Projects.

Table 4-85. Response Variable Decision Criteria for Habitat Protection

Monitoring Parameters	Variables	Unit	Test Type	Decision Criteria
Riparian Condition	Mean canopy density at the bank densiometer reading	1-17 score	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Three-layer riparian vegetation presence (proportion of reach)	%	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Proportion of the reach containing actively eroding stream banks	%	Linear regression or non-parametric test	Alpha =0.10. Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
Stream Morphology	Mean residual pool vertical profile area	m^2	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Mean residual depth	cm	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Percent substrate embedded	%	Linear regression or non-parametric test	Alpha =0.10. Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Percent substrate as fines	%	Linear regression or non-parametric test	Alpha =0.10. Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Log_{10} of the Volume of Large Wood	Log10($m^{3)}$	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
Stream Animal Assemblages	Macroinvertebrate Multimetric Index	MMI score	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Fish species Assemblages	FI score	Linear regression or non-parametric test	Alpha =0.10. Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
Upland Habitat	Absolute percent cover of non-native vascular plant species	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12

Table 4-85. Response Variable Decision Criteria for Habitat Protection (continued)

Monitoring Parameters	Variables[1/]	Unit	Test Type	Decision Criteria
Upland Habitat (continued)	Relative percent cover of non-native vascular plant species	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Absolute percent cover of non-native shrub species	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Relative percent cover of non-native shrub species	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Basal area of conifers per acre	ft^2/acre	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Stem count of conifers per acre	#/acre	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Basal area of deciduous trees per acre	ft^2/acre	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Stem count of deciduous trees per acre	#/acre	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
Estuary Habitat (only)	Percent of the length of the intertidal transect with algae	%	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Linear extent of algae along the intertidal transect	m	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Percent of the length of the intertidal transect with vascular plants	%	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Linear extent of vascular plants along the intertidal transect	m	Linear regression or non-parametric test	Alpha =0.10 Detect an increase between Base Year 0 and Year 3, 6, 9, or 12
	Percent slope from mean high tide to mean low tide or low water	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Percent of the length of the intertidal transect with fine sediment	%	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12
	Linear extent of fine sediment along the intertidal transect	m	Linear regression or non-parametric test	Alpha =0.10 Detect a decrease between Base Year 0 and Year 3, 6, 9, or 12

Source: Adapted from Crawford and Arnett (2008)

4.3.2 Project-Specific Summaries

Habitat protection projects are monitored prior to the acquisition (Year 0) and are currently planned to be monitored for a period of twelve years post-acquisition, during Years 3, 6, 9, and 12. Data for the Habitat Protection Projects are shown below.

00-1669 Entiat River Habitat Acquisition

The Chelan-Douglas Land Trust has acquired and permanently protected from development nearly three miles of some of the most important salmonid spawning and rearing habitat on the Entiat River. The Entiat River is one of four upper Columbia River tributaries that support anadromous Pacific salmonids and is critical to efforts to recover salmon in this region. The project reach of the river has some of the best spawning gravels, pools, and rearing habitat due to the low river gradient in this area. This stretch of river was previously in mostly private ownership and would have been subject to rapid residential and recreational development, if not protected.

Entiat River at Transect A in 2004 (Year 0)

Entiat River at Transect A in 2007 (Year 3)

Project Location

This project is located in Chelan County on the Entiat River (WRIA 46) between RM 16 and 26. The project is located on the Thomas property on the mainstem Entiat River, just upstream from Stormy Creek, within Township 27N, Range 19E, and Section 22. Monitoring is conducted along approximately 500 meters of stream.

Project Objective

This project permanently protected almost three miles of some of the most important salmonid spawning and rearing habitat on the Entiat River. These properties all occur in the "stillwaters" region of the Entiat between RM 16 and 26. Spring and summer Chinook, steelhead, and non-anadromous bull trout all utilize this stretch of river. The Chelan-Douglas Land Trust sponsored this project and Gordon Congdon is the primary contact. The Entiat River project was also supported by a variety of groups including Chelan County, Ecology, WDFW, USFS, USFWS, NOAA Fisheries, and Trout Unlimited.

Project Data

Table 4-86 summarizes the data collected during Year 0 and Year 3 monitoring of the Entiat Acquisition Project.

Table 4-86. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	16.98	19.16
Mean Residual Pool Vertical Profile Area (m^2)	395.06	270.35
Mean Residual Depth (cm)	79.01	54.07
Log10 of Volume of LWD (m^3)	0.87	1.17
Percent Fines (%)	26.0	22.0
Percent Embedded (%)	66.91	69.73
Riparian Characteristics		
Canopy Density (1-17)	9.64	6.46
Riparian Vegetation Structure (%)	59.1	59.10
Bank Erosion (%)	29.25	42.00
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	106.2	34.5
Non-native Herbaceous Relative Cover (%)	61.3	24.6
Non-native Shrub Absolute Cover (%)	0	0
Non-native Shrub Relative Cover	0	0
Coniferous Basal Area (ft^2/acre)	0	0
Coniferous Density (stems/acre)	0	0
Deciduous Basal Area (ft^2/acre)	0	0
Deciduous Density (stems/acre)	0	0
Stream Organism Indices		
Fish Species Assemblage Index	Too few fish	84
Macroinvertebrate Multimetric Index	42	36
Data collected August 31 - September 1, 2004 and September 15, 2004 (Year 0) and July 10, 2007 and September 10 - 11, 2007 (Year 3)		

Upland Vegetation Data Summary

The project includes two properties, Cottonwood Flats and Stormy Creek, acquired by Chelan-Douglas Land Trust, that are now open to the public. They are along the Entiat River, 16 to 17 miles up Entiat River Road. The herbaceous non-natives decreased between 2004 and 2007 (from approximately 106.2 to 34.5 percent absolute cover) and the shrubs and trees are establishing well (see photo comparisons). No non-native shrubs were observed onsite. While tree species within the transects are establishing well, they have not reached the height or diameter required to classify them as trees, thus the values of zero reported in Table 4-86. While the herbaceous layer may continue to be influenced by non-natives, the native trees and shrubs should, over time, be dominant and provide improved habitat.

Cottonwood Flats Property

More than half of Cottonwood Flats has steep slopes, disturbed primarily by fire. The flat area by the river was cleared and is now recovering. The shrub growth is evident in Photos 1 and 2. While not yet recovered, the native shrubs and trees are establishing well. Table 4-87 is keyed to the polygon numbers on the site vegetation map, Figure 4-76.

Table 4-87. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	D/E	Transect 2 is in this polygon and is representative of the areas that were herbaceous in the cleared areas and now have shrub growth. This area is within the floodplain or meander zone of the river and included a mature cottonwood forest until the late 1990s. A bridge and dirt road were constructed and the trees cleared in an attempt to build a housing project. Permits were not obtained because of the inability to build a septic system in that floodplain. Two portions of the road have since been removed and were found to be at least partial wetlands. The removal area closest to the bridge is dominated by non-natives, particularly *Phalaris arundinacea* (reed canarygrass). The area that was removed on the southern part of the loop road was inundated and dominated by *P. arundinacea*, *Scirpus microcarpus*, *Carex retrorsa*, and *C. vesicaria.* In 2004, the former roadbed that remains was beginning to show plant growth including several native sedges. Three years later, in 2007, there were dense shrub and small tree coverage in places; however, they were small in height and dbh. In 2004, black cottonwood and willow saplings were present in most areas and dense in some. In 2007, an increase in cottonwood and willow cover was seen in most areas (see photos below) and accounts for much of the decrease in non-native herbs. While this area had been heavily altered, it is recovering and the willows and cottonwoods are expected to establish a forest not profoundly different from the historical conditions. However, the non-native species are expected to remain. The Condition Class is still D/E, but the conditions have improved over the past three years with some shrub and tree growth. The conditions are expected to continue improving rapidly with the protection from further human disturbance. This area is within the meander zone of the Entiat River, downstream and on the outside of a stream meander. It is likely that over long time frames the river meanders will migrate through the property. While this process includes cycles of disturbance, it is part of the natural vegetation cycle within the meander zone.
2	C	This is the steep, rocky, side slope of the Entiat River valley. It is mostly talus with sparse vegetation, shrubs, and occasional trees.
3	B/C	Steep outcrop, sparsely vegetated, occasional burned trees.
4	C	Open coniferous forest, trees mostly dead from burning approximately 13 years ago.
5	C	Steep outcrop, sparsely vegetated, occasional burned trees.

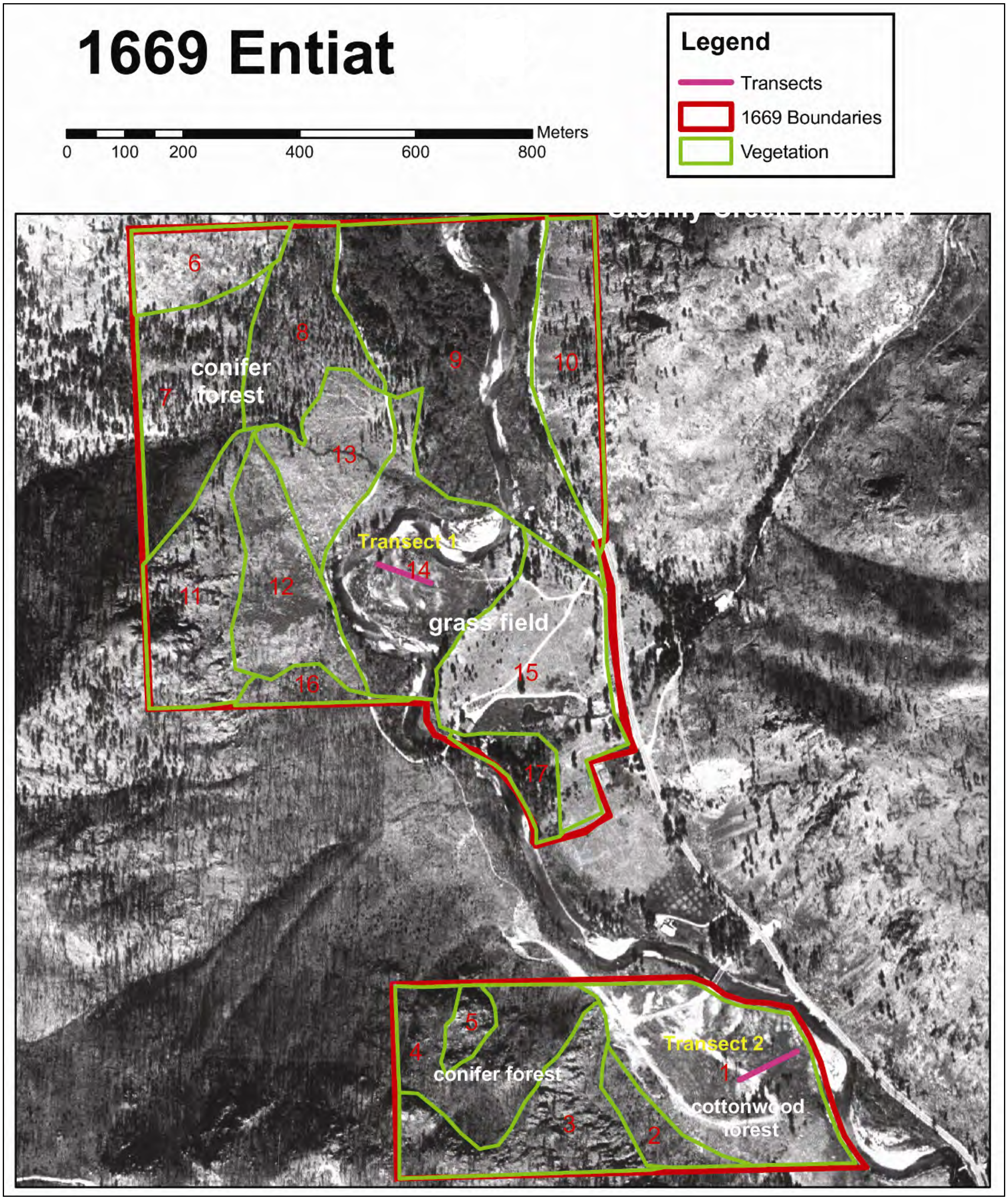


Figure 4-76. Vegetation Polygons and Transects

Stormy Creek Property

The Stormy Creek Parcel has experienced less modification than Cottonwood Flats. The northern boundary, east of the river, is part of an area considered to be a reference reach for the Entiat River. West of the river, there has been logging and fires on the property. The field west of the parking area and an area west of the road at the north boundary were mowed for hay until approximately 2001. In 2004, the northern hayfield was covered with black cottonwood saplings that sprouted naturally. Since the acquisition, volunteers have removed thistle and planted shrubs in the field by the parking area. Photos 3 and 4 show that the ponderosa pines planted in the field are establishing well.

The property on the west side of the river was not visited (access would be over a private bridge), but the following table (Table 4-88) summarizes observations made from the east side of the river and from inspection of aerial photographs and topographic maps and is keyed to the polygon numbers on the site vegetation map, Figure 4-76.

Table 4-88. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
6	C/D	Rock outcrop and talus, sparse vegetation, shrubs, and burned trees. From the aerial photo it appears that some logging may have occurred at this site.
7	C	Sparse conifer forest, likely including a mix of trees that were burned in the fires and trees that survived.
8	C	Sparse conifer forest, likely including a mix of trees that were burned in the fires and trees that survived.
9	C	Mixed forest within the meander zone of the river.
10	C	Steep talus, sparse vegetation, sparse living trees.
11	B/C	Rock outcropping, sparse vegetation, shrubs, and occasional burned trees.
12	C	Rock outcrop and talus, sparse vegetation, shrubs, and occasional trees, including some that burned in the fire.
13	C	Alluvium from the small creek flowing in from the west. Mostly shrubs.
14	D/E	Transect 1 is in this polygon. This area is within the meander zone of the river had and been historically cut for hay. The edges are mostly shrubs and there have been a few plantings. The north section of the oxbow is actively eroding. In 2007, it was still considered Condition Class D/E because the vegetation is remnants of a hay field dominated by non-natives but maintains a high diversity of native species. The condition improvement will continue slowly with tree growth (see photos below). Because this area is within the meander zone of the Entiat River, downstream and on the outside of a stream meander, it is likely that over time the river meanders will migrate through the property. While this process includes cycles of disturbance, it is part of the natural vegetation cycle within the meander zone.
15	E	This grassy field is higher and drier than Polygon 14, and includes sparse coniferous trees, roads, and a house.
16	C	Sparse coniferous forest burned in the fires. Not accessed but expect that the vegetation in this polygon is Class C.

Photo 1. Transect 2 in Polygon 1, Cottonwood Flats. Upland habitat with young willow and cottonwood (2004).

Photo 2. Transect 2 in Polygon 1, Cottonwood Flats. Same view of upland habitat after three years of willow and cottonwood growth (2007).

Photo 3. Transect 1 in Polygon 14, Stormy Creek. Upland habitat in old hay field (2004).

Photo 4. Transect 1 in Polygon 14, Stormy Creek. Same view of upland habitat after three years of ponderosa pine growth (2007).

Summary

Generally, the river habitat conditions at the Entiat River site in 2007 appeared largely unchanged from those of 2004, although enough fish were detected in 2007 for an assemblage score in the good range. In addition to the reach scale effectiveness monitoring being conducted at the project site by Tetra Tech EC and its partner KWA Inc., status and trend monitoring is also being conducted throughout the Entiat Subbasin by federal agencies, including work within the project site. Discussions to coordinate future monitoring activities and resolve any potential conflicts which may arise between the two overlapping monitoring efforts took place in 2007.

The vegetation at the Entiat River Acquisition site appears to be improving quickly, with changes observed in just three years. The improvements in the transect areas are primarily due to the growth of trees and tall shrubs (willow) that shade out non-native vegetation. The trees and shrubs are established now and are likely to survive various conditions, which often threaten new plantings. The areas outside of the transects are steep hills and do not appear to be disturbed by humans. The only threat to continued improvement at this site is a scouring flood event, because both of the transect areas are in the river's flood plain. Continued growth of the vegetation at this site is expected. Monitoring of the Entiat River site was not conducted in 2008; however, Year 6 monitoring is scheduled for 2010.

00-1788 Rock Creek/Ravensdale Retreat Protection Project

The Rock Creek/Ravensdale Retreat Protection Project involved the acquisition of approximately 204 acres along Rock Creek from RM 3.5 to 5.1. The 11-parcel reach includes 1.6 miles of Rock Creek itself, palustrine forested and scrub-shrub wetlands, pond habitats, and second growth coniferous forest. Phase 1 of the project included the purchase of six of the parcels (approximately 100 acres), including one mile of Rock Creek itself, and a complete appraisal of the whole reach. This was accomplished through the funding provided by SRFB, King County Water and Land Resources Division and its partners, the Friends of Rock Creek Valley, and the National Fish and Wildlife Federation. This land will be preserved and protected, not only to benefit Chinook, sockeye, coho, and steelhead, but also to protect an important wildlife corridor used by elk, bear, and cougar.


Rock Creek at Transect F in 2004 (Year 0)


Rock Creek at Transect F in 2007 (Year 3)

Project Location

The Rock Creek Ravensdale Reach project site is located south of Maple Valley and east of Four Corners, in King County, Washington. Rock Creek is a tributary to lower Cedar River and is within WRIA 8. Monitoring is conducted along approximately 150 meters of Rock Creek.

Project Objective

The objective of this project was to make significant progress toward protecting approximately 204 acres along Rock Creek. This initial phase included the acquisition of approximately 100 acres of land, including important spawning habitat, thus benefiting several species of salmonids, as well as protecting a wildlife corridor. Rock Creek provides important tributary spawning habitat in the lower Cedar River. This project was sponsored by King County Water and Land Resources Division and the contact person is Jean White.

Project Data

Table 4-89 summarizes the data collected during Year 0 and Year 3 monitoring of the Rock Creek/Ravensdale Retreat Acquisition Project.

Table 4-89. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	2.58	0.36
Mean Residual Pool Vertical Profile Area (m^2)	0	1.20
Mean Residual Depth (cm)	0	0.80
Log10 of Volume of LWD (m^3)	1.02	0.12
Percent Fines (%)	32.0	48.0
Percent Embedded (%)	87.73	61.36
Riparian Characteristics		
Canopy Density (1-17)	16.86	16.86
Riparian Vegetation Structure (%)	95.5	100
Bank Erosion (%)	0	8.50
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	11.2	9.0
Non-native Herbaceous Relative Cover (%)	5.7	3.8
Non-native Shrub Absolute Cover (%)	5.4	5.2
Non-native Shrub Relative Cover (%)	2.7	2.2
Coniferous Basal Area (ft^2/acre)	74.7	130.0
Coniferous Density (stems/acre)	474.0	469
Deciduous Basal Area (ft^2/acre)	5.1	8.0
Deciduous Density (stems/acre)	213.0	264.0
Stream Organism Indices		
Fish Species Assemblage Index	N/A*	No fish
Macroinvertebrate Multimetric Index	N/A*	24

Data collected on July 14, 2004 (Year 0), July 10, 2007 (Year 3) and August 22, 2007 (Year 3 – vegetation survey).
*N/A – Stream was dry during Year 0 survey

Upland Vegetation Data Summary

The Rock Creek habitat protection site includes areas that were previously harvested, less than 15 years ago in some areas and up to 30 or more years ago in other areas. The area that was harvested over 30 years ago was not notably different in Year 3 than in Year 0. This area is a closed mature forest and continues to mature. The younger re-growth area showed a slight increase in non-native plants growing in the open areas from Year 0 to Year 3. In the shaded areas; however, the number of non-native plants has decreased. As trees and shrubs continue to grow larger and provide additional shade, it is reasonable to expect the cover of non-native plants to decline over time.

The upland vegetation in the Rock Creek site is forested, mostly coniferous with a deciduous forested wetland in the southeast corner. Most of the property was logged, between 40 and 15 years ago. The two transects are within two logged areas, with trees approximately 33 years old and 12 years old. The basal area of both conifer and deciduous trees increased substantially between 2004 and 2007, primarily due to notable growth in the 12-year old clear cut (see Photos 1 and 2). The overall absolute cover of non-native herbaceous and shrub species was slightly less in Year 3 than in Year 0. The non-natives are mostly located in the younger, open clear cut and are expected to decline over time as the remaining open areas are shaded by the trees. Table 4-90 identifies the Condition Class for each polygon mapped in Figure 4-77.

Table 4-90. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	C/D	Mixed deciduous and conifers, shrubby and open areas, at the extreme west end of the property. Altered by logging.
2	C/D	Transect 1 is in this polygon. It is a homogeneous, closed conifer stand, dominated by Douglas-fir, but with abundant smaller western hemlocks. It appears to be a tree plantation formed after a clear cut. A few trees were cored in Year 0, placing the stand age at around 33 years. In Year 3, the conditions were not notably different from Year 0 (see Photos 1 and 2 below). The trees were already mature and the forest was already closed in Year 0. The forest is expected to mature further over the next few decades and develop diverse forest conditions, including openings.
3	D	Transect 2 is in this polygon. This area was clearcut twelve to fifteen years ago and replanted. It is severely altered, but with plant species diversity that is not unusual in early stages of regrowth in a clear cut. There was notable growth in the conifer trees between visits in Years 0 and 3. The cover of non-native herbaceous species in the forest opening increased slightly between Years 0 and 3. The non-natives in this area are mostly species requiring openings and cover of these species is expected to decrease over the next decade if the forest continues to fill in.
4	C	Deciduous forest, including a large wetland and riparian areas dominated by willows along Rock Creek. This area has been harvested and crossed by what appears to be a former spur rail line and logging roads. Conditions in this polygon have improved since the disturbances occurred and recovery is well established.

Photo 1. Transect 2 in more recent clear cut. Photo shows growth in 10-year old clear cut before acquisition (2004).

Photo 2. Transect 2. Same area in transect, showing three more years of growth (2007).

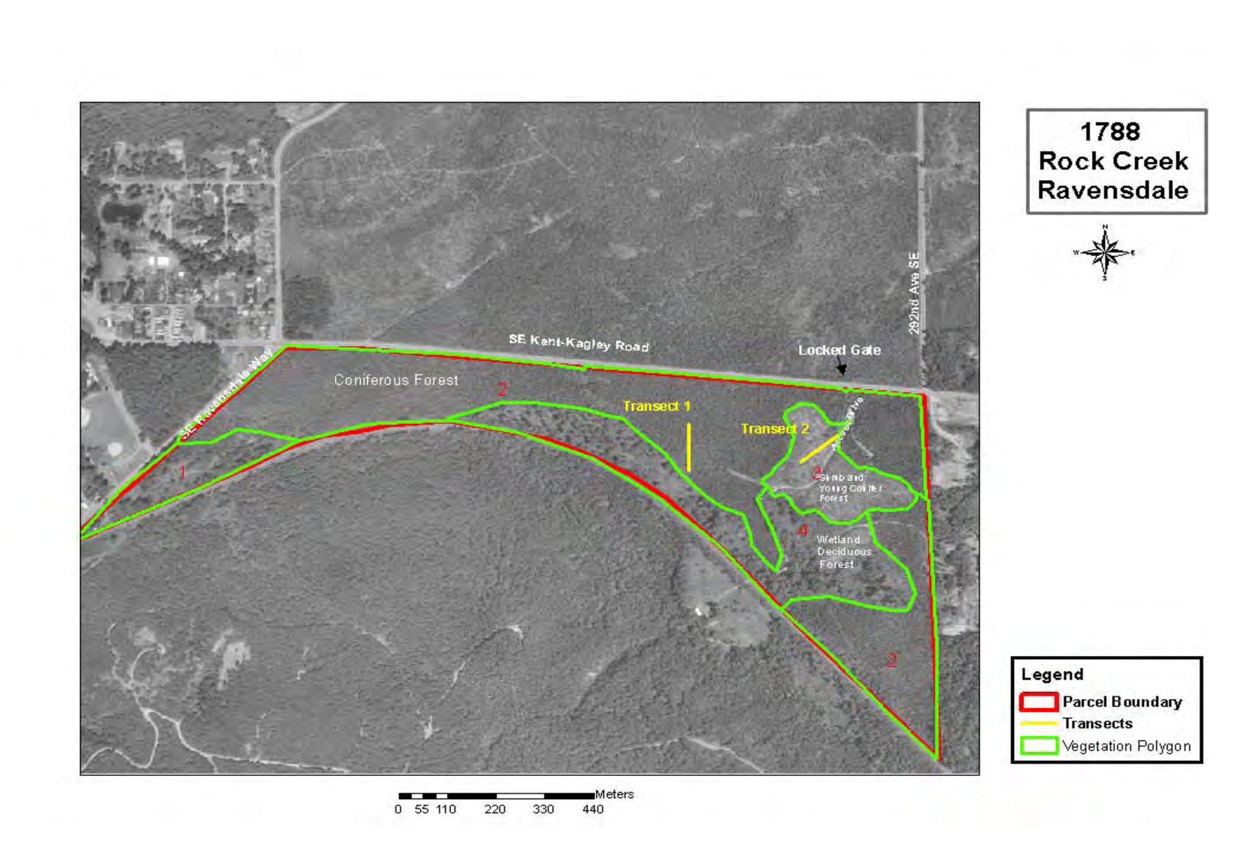


Figure 4-77. Polygons and Transects

Summary

The greatest difference observed between the in-stream surveys from 2004 and 2007 was the presence of flow in Rock Creek. Geomorphic variables increased from 0 (a dry stream) to shallow pools with minimal flows. No fish were observed at the site, but the invertebrate index indicated moderate ecological health. Slight increases in bank erosion and percent fines may be tied to increased flow levels in Rock Creek.

The vegetation at this site includes areas that were previously harvested from less than 15 to over 30 years ago. The area that was harvested over 30 years ago was not notably different in 2007 than in 2004. The area is a closed mature forest and will continue to mature over time. The younger re-growth area showed a slight increase in non-native vegetation in the open areas; however, the non-natives have decreased in shaded areas, as the trees continue to grow larger. As trees continue to grow, additional areas will be shaded, and decline of non-native vegetation is expected. There are a couple of larger open areas in the parcel that may take longer to fill in with native vegetation, but they are also expected to improve over time. Monitoring was not conducted at Rock Creek in 2008; however, Year 6 monitoring of the site is scheduled for 2010.

00-1841 Metzler Park Side Channel Acquisition

The Metzler Park Side Channel project involved the acquisition of property adjacent to Metzler Park, which included over 900 acres of County-owned natural areas, managed exclusively for natural resource protection. The project preserved up to 75 acres of habitat, including portions of two side channels that are hydraulically connected to the Green River, have a wide range of flow conditions, and provide off-channel access to juvenile and adult salmonids.


Impact reach at Transect A in 2007 (Year 3)


Fish use of side channel in 2007 (Year 3)

Project Location

The Metzler Park project is located on a side channel of the Green River, northwest of the town of Enumclaw, in King County. The project is adjacent to Metzler Park, which is owned by the King County Department of Natural Resources and Parks. The project is within WRIA 9 and Township 21 N, Range 6 E, and Section 30. Monitoring is conducted along 250 meters of stream habitat.

Project Objective

The objective of this project was to purchase four parcels located along an existing side channel that provide high-quality riparian habitat adjacent to Metzler Park. This acquisition allows the Green River to continue its natural migration and protects two other side channels that are connected to the Green River from the possible construction of a bank revetment. This project also preserves up to 75 acres of habitat with intact ecological processes including portions of two side channels to the Green River that provide habitat to juvenile and adult salmonids. This project is sponsored by King County Department of Natural Resources and Parks. Josh Kahan, Connie Blumen, and Scott Snider are the contact people for the project.

Project Data

Table 4-91 summarizes the data collected during Year 0 and Year 3 monitoring of the Metzler Park Project.

Table 4-91. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	13.55	13.38
Mean Residual Pool Vertical Profile Area (m^2)	27.00	40.20
Mean Residual Depth (cm)	10.80	16.08
Log_{10} of Volume of LWD (m^3)	0.55	-0.17
Percent Fines (%)	16.0	4.0
Percent Embedded (%)	52.09	49.09
Riparian Characteristics		
Canopy Density (1-17)	17.0	16.96
Riparian Vegetation Structure (%)	100	100
Bank Erosion (%)	2.50	11.75
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	11.7	9.5
Non-native Herbaceous Relative Cover (%)	4.0	4.7
Non-native Shrub Absolute Cover (%)	9.5	5.9
Non-native Shrub Relative Cover (%)	3.3	2.9
Coniferous Basal Area (ft^2/acre)	19.7	23.2
Coniferous Density (stems/acre)	96	70
Deciduous Basal Area (ft^2/acre)	164.5	164.9
Deciduous Density (stems/acre)	348	214
Stream Organism Indices		
Fish Species Assemblage Index	97	100
Macroinvertebrate Multimetric Index	42	34
Data collected August 2, 2004 (Year 0) and August 7 and August 9, 2007 (Year 3)		

Upland Vegetation Data Summary

The Metzler Park habitat protection project is a forested island and the vegetation is a homogeneous, riparian forest. It is a mature black cottonwood (*Populus balsamifera*) forest with fairly high species diversity and few non-native species overall (see Photos 1 through 3). As a whole, the forest showed little change between the Year 0 survey in 2004 and the Year 3 survey in 2007. The overall rating for this parcel is condition class B/C.

Percent cover of non-native species decreased between Year 0 and Year 3 (Table 4-91) and percent cover of non-native species in the surveyed transect remained relatively low when measured in Year 3 (approximately 10 percent absolute cover herbaceous and 6 percent absolute cover shrubs, Table 4-91); however, it appears that the Himalayan blackberry (*Rubus armeniacus*) may be increasing outside of the transect at the forest edges and in openings (see Figure 4-78 for transect location). The blackberry at the origin tree in Year 0 consisted of a few stalks which grew into a shrub thicket by Year 3 (see Photos 4 and 5 and Figure 4-78).

Photo 1. Metzler vegetation. Note blackberry along north side of island (2004).

Photo 2. Typical native vegetation along the transect (2007).

Photo 3. Vegetation in Metzler Park acquisition, from across the river. The vegetation is little changed except where the blackberry is spreading (2007).

Photo 4. Origin tree in 2004. Note open vegetation around tree with a few blackberry branches.

Photo 5. Origin tree in 2007 (transect tape in same position). Blackberry was dense near origin tree.

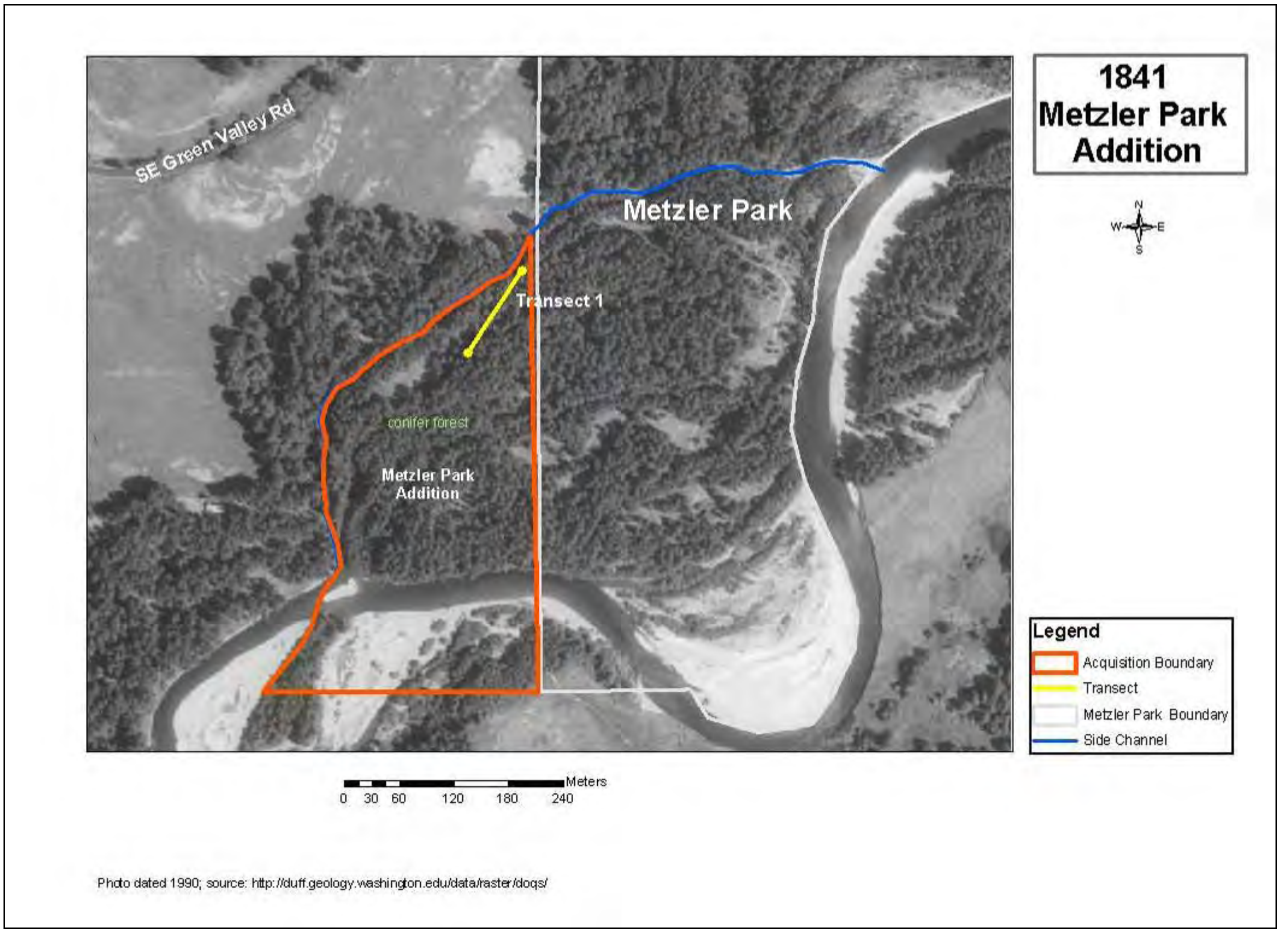


Figure 4-78. Polygon and Vegetation Transect in the Metzler Park Side Channel Acquisition

Summary

General conditions at the Metzler Park Habitat Protection site changed little between 2004 and 2007. Vertical pool profile area and mean residual depth increased, but these variables are very flow dependant so considerable variability is expected. Percent fines decreased but percent eroding banks increased, so some sediment is likely moving through the site into downstream reaches. In general, the ecological health of the site is quite high with top scores for both the fish assemblage and riparian vegetation structure.

The vegetation at this site contains good quality, native species habitat. It is a mature, primarily deciduous forest. There seemed to be an increase in Himalayan blackberry at the site; however, little of it was located within the vegetation plots. As a result, the increase in Himalayan blackberry may not be accurately reflected in the transect data. Overall, the acquisition area appears to encompass good quality habitat and maintains its vegetation rating of condition Class B/C (good to moderate). Monitoring was not conducted at the Metzler Park site in 2008; however, Year 6 monitoring is scheduled for 2010.

01-1353 Logging Camp Canyon (Phase 1) Acquisition

Phase I of the Logging Camp Canyon Acquisition Project involved the purchase of 293 acres of land critical to the long-term protection of steelhead spawning habitat within Logging Camp Creek. The lands had previously been used for timber production and cattle grazing, but natural regeneration of coniferous forest has occurred since that last timber harvest. Logging Camp Creek has been identified as providing one of the last and best areas of quality spawning and rearing habitat accessible to steelhead and coho in the entire Klickitat River watershed. Its mature forest canopy maintains suitable water temperatures, woody debris recruitment, and other watershed functions important to salmonids. The surrounding lands maintain subsurface water recharge, and late season discharge to maintain pools. Additionally, the project established a landowner agreement on 20 acres along the lower stream reach and confluence with the Klickitat River to further protect fish access and habitat quality.

Logging Camp Creek at Transect K in 2004 (Year 0)

Logging Camp Creek at Transect K in 2007 (Year 3)

Project Location

This project is located in Klickitat County, within the Klickitat River Basin (WRIA 30), four miles south of the town of Klickitat. The sample reach is approximately 150 meters long and is located on Logging Camp Creek within Township 4N, Range 13E, at the southeast corner of Section 31. Logging Camp Creek is a tributary to the Klickitat River, entering it at approximately RM 9.5.

Project Objective

Logging Camp Creek has historically provided late season flow and maintained cold water pools for rearing fish. Currently, coho and other salmonid species not specifically native to the Klickitat River system are able to access portions of the tributary creek. These stocks are thought to use the Logging Camp tributary primarily for refugia (both thermal and high flow) and rearing habitat. Some salmon spawning may occur in the lower reaches of the tributary. The objective of this project is to ensure that spawning and rearing habitat will be protected from development and degradation. The Columbia Trust sponsors this project and Ian Sinks is the contact person.

Project Data

Table 4-92 summarizes the data collected during Year 0 and Year 3 monitoring of the Logging Camp Canyon Project.

Table 4-92. Summary Statistics for Pre- and Post-Acquisition Monitoring (Year 0 and Year 3)

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	1.84	2.82
Mean Residual Pool Vertical Profile Area (m^2)	4.91	7.11
Mean Residual Depth (cm)	3.27	4.74
Log10 of Volume of LWD (m^3)	-0.26	0.89
Percent Fines (%)	0	0
Percent Embedded (%)	7.36	35.73
Riparian Characteristics		
Canopy Density (1-17)	16.27	16.64
Riparian Vegetation Structure (%)	95.5	100
Bank Erosion (%)	19.25	10.25
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	23.2	16.8
Non-native Herbaceous Relative Cover (%)	26.5	26.4
Non-native Shrub Absolute Cover (%)	0	0
Non-native Shrub Relative Cover (%)	0	0
Coniferous Basal Area (ft^2/acre)	47.6	53.4
Coniferous Density (stems/acre)	141.0	60.0
Deciduous Basal Area (ft^2/acre)	98.5	80.5
Deciduous Density (stems/acre)	756.0	1525.0
Stream Organism Indices		
Fish Species Assemblage Index	81	Too few fish
Macroinvertebrate Multimetric Index	34	36
Data collected on July 15, 2004 (Year 0) and May 10 - 11, 2007 and June 13-15, 2007 (Year 3)		

Upland Vegetation Data Summary

The Logging Camp Canyon property includes steep canyon slopes with conifer forest, oak forest, and grassland (see Photo 1). While some of the conifer forested areas have been previously logged, they are now maturing. The forested areas on this site include mostly native species and contain very good habitat. The oak forest is a mature forest with a good distribution of tree sizes and the conifer forest is a very dense, maturing forest, with little ground cover, likely due to previous logging (see Table 4-93).

The decline in coniferous tree stem count in 2007 may partially be accounted for by the increased basal area observed in the conifer survey. As trees on the site mature, the basal area is expected to increase while the stem count is expected to decrease. On the other hand, the significant increase in deciduous density is due to the increase in the number of deciduous seedlings observed in forest plots in 2007. Additionally, seedlings in forest plots along Transect 1 were counted in a 10-foot radius and these results were extrapolated to the 37.5-foot radius of the forest plot. This extrapolation could potentially have introduced some error and inflated the seedling count. The number of seedlings found on site; however, is likely to change due to variations in annual conditions (Photos 2 and 3). Seedling success can change significantly from year to year, depending on the prior year's seed production and the temperature or moisture during the sprouting year. A decline in stem counts is expected in both the conifer and deciduous forests as these forests continue to mature and naturally thin.

The grasslands have previously been grazed and there are abundant non-native species onsite; however, there is also a high diversity of native grass and forb species. Absolute cover of non-native herbaceous species measured in the survey decreased slightly from Year 0 to Year 3. The slopes are stabilized and provide a buffer to the grazing and timber land outside the parcel boundaries. Table 4-93 refers to polygons numbered in Figure 4-79.

Table 4-93. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	B	Steep grasslands at the western end of the property, south aspect. Abundant grasses and annual and perennial forb species, including *Lomatium* species, most notably *L. grayi*, with lesser amounts of *L. columbiana* and *L. suksdorfii*, and grasses, similar to the area sampled on Transect 2, with occasional oaks in draws and shrubs in favorable sites. Non-native grasses are abundant in localized places.
2	C/D	Mixed forest, primarily coniferous, dominated by Douglas-fir, with a few oaks, and with scattered shrubby areas. This polygon includes areas that were apparently harvested within the past 10 or 15 years.
3	B/C	This polygon includes Transect 1. It is a developed oak forest (approximately 70 percent cover). Native species of grass, elk sedge, as well as, non-native *Bromus* species are well represented. In more rocky areas, the shrub species are more abundant with higher percent cover.
4	C	This polygon includes Transect 2. This area is a steep, south-facing slope dominated by grasses and forbs species, including *Lomatium* species. Occasional narrow draws reach up the slope and provide corridors of oaks and numerous shrubs. Non-native grasses are abundant, but native species diversity is high and includes *Lomatium suksdorfii*, a sensitive species.
5	D/E	At the top of the steep slopes of Polygon 4 is a relatively level grass field. This area has been intensely grazed by cattle, and appeared to have a higher proportion of non-native grasses and forbs. Most *Lomatium* species abundant on the slope of Polygon 4 were absent, though *Lomatium nudicaule* was present. It is difficult to determine the native vegetation composition here.
6	B/C	This polygon includes Transect 3. This area encompasses a steep stabilized basalt talus with a closed-canopy coniferous forest (more than 90 percent cover), which includes occasional oaks and areas of dense shrubs. The forest appears young, with crowded tree conditions and small trees (less than 5 in. dbh) comprising 30 percent of the total. There are many areas in the dense shade with little ground cover. Presumably all of this forest, dominated by Douglas-fir, has been historically logged, but not as recently as areas in Polygon 2. Vegetation is currently intact, recovering from the historical disturbance.
7	B/C	This polygon includes steep north-facing grassy openings, with numerous grass and forb species, typically surrounded by oaks.
8	B/C	Grassy openings, similar to Polygon 7.
9	A/B	This polygon includes steep, rocky slopes and outcrops, with patches of grasses and forbs interspersed with cliffs. Very high quality vegetation, with few non-native plants and a large population of *Heuchera grossulariifolia* var. *tenuifolia*
10	B/C	This polygon also includes coniferous forest, similar to Polygon 6, but in general it is more level and appears to offer better growing conditions. Vegetation is currently intact, recovering from the historical disturbance.
11	C	This polygon includes a relatively level forested area, beyond the rim of Logging Camp canyon, and includes mixed conifers, predominantly Douglas-fir, with a few oaks. This area has all been logged at one time or another but has grown back to second-growth forest. Disturbance is more recent than the steeper slopes, but the vegetation is recovering.

Photo 1. Site from above, north of stream. Area of stream convergence is in center of photo. Conifer forest along far slope (north facing), oak forest in center and right (south facing) (2007)

Photo 2. Transect 1, oak forest at confluence of two streams (2007)

Photo 3. Little change seen in oak forest at Transect 1 (2007)

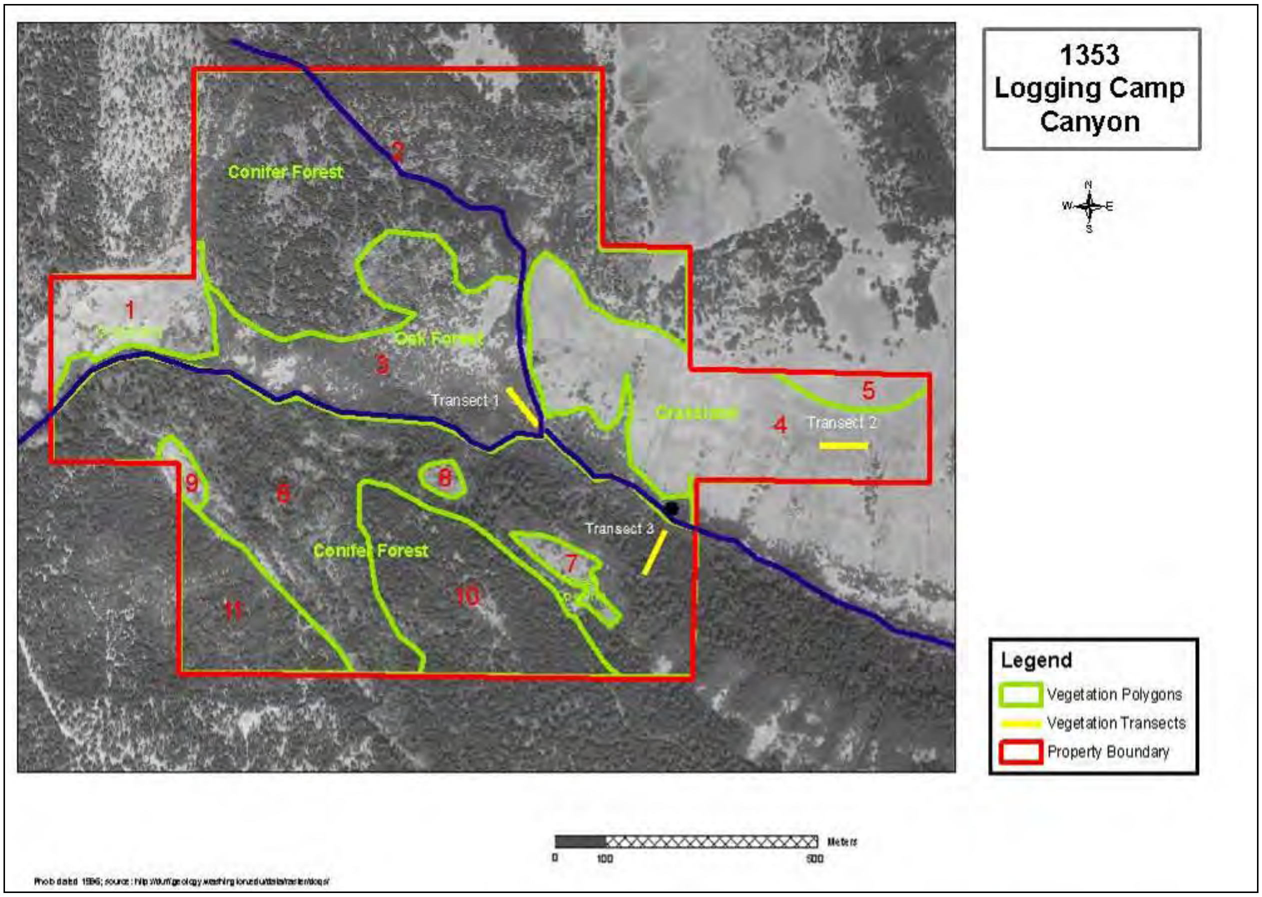


Figure 4-79. Polygons and Transects in the Logging Camp Canyon Acquisition.

Summary

Generally, the stream habitat conditions present in 2007 appeared largely unchanged from those of 2004. Stream flows were slightly higher during the 2007 survey compared with those of 2004, resulting in slight increases in mean residual pool depth and mean vertical pool profile area. Percent embeddedness increased, but the proportion of the reach with eroding banks decreased, which seemingly indicates a potential sediment source upstream. In 2004, the ratings for both the fish assemblage and macroinvertebrates were good. In 2007, there were not enough fish collected to calculate a fish assemblage rating, but the macroinvertebrate index score increased from 34 to 36, indicating maintenance of instream ecological health

The Logging Camp Canyon site is remote and shows very little sign of vegetation disturbance. The non-native vegetation is herbaceous and exists mostly in grassy habitats in the area. Significant changes in the site are not expected over the next three years, as the area is protected and remote, with steep slopes. Rattle snakes, ticks, poison oak, and poison ivy were found to be present during both survey years. Monitoring was not conducted at Logging Camp Canyon in 2008; however, Year 6 monitoring is scheduled for 2010.

02-1485 Chimacum Creek Estuary Riparian Acquisition

SRFB funding of the Chimacum Creek Estuary habitat protection project provided funds to the North Olympic Salmon Coalition to help the WDFW acquire high quality, forested riparian habitat in the Chimacum Creek Estuary. The adjacent riparian habitat and key uplands along the ravine banks and marine headlands are rapidly developing. The project dovetailed with other funding sources to protect the entire estuary, a forested stream reach, and the entire summer chum spawning grounds. These acquisitions resulted in the protection of a core habitat for ESA-listed summer chum and other depressed salmon runs.

Aerial view of acquisition area

View of estuary. Biologist and Project Sponsors are on top of bluff that is acquisition property (2007)

Project Location

The Chimacum Creek Estuary acquisition site is located near the mouth of Chimacum Creek, south of Port Townsend, in Jefferson County. The project is within WRIA 17 and in Township 30N, Range 1W, and Section 35.

Project Objective

This project acquired 15.3 acres of high quality forested riparian habitat in the Chimacum Creek Estuary (see Photo 1). The project protects one of the most undisturbed estuary riparian areas within Hood Canal and the Strait of Juan de Fuca that was at risk of development. This acquisition also protects adjacent marine shoreline by preserving a significant block of steeply sloped marine headlands. The Chimacum Creek project was sponsored by the North Olympic Salmon Coalition and Paula Mackrow is the primary contact.

Project Data

Table 4-94 summarizes the data collected during Year 0 and Year 3 monitoring of the Chimacum Project. This site does not contact aquatic habitat within the project boundaries; therefore, data on estuary characteristics is not collected or reported.

Table 4-94. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Upland Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	1.2	0
Non-native Herbaceous Relative Cover (%)	0.6	0
Non-native Shrub Absolute Cover (%)	0.4	0
Non-native Shrub Relative Cover (5)	0.2	0
Coniferous Basal Area (ft^2/acre)	188.8	244.7
Coniferous Density (stems/acre)	206	190
Deciduous Basal Area (ft^2/acre)	118.1	130.0
Deciduous Density (stems/acre)	386	350
Data collected July 27, 2004 (Year 0) and on July 22, 2007 (Year 3).		

Upland Vegetation Data Summary

Chimacum Creek acquisition is on a bluff above the estuary and does not include the estuary itself, which is protected separately by the Washington Department of Fish and Wildlife. Most of the property is a mature mixed forest with few non-native species and provides a healthy upland buffer to the already protected estuary. The site has changed little since 2004: larger trees are present but there is no measured increase in non-native shrubs or herbaceous species (see Photo 2). There were fewer non-native holly trees accounting for the lower stem count for deciduous plants. Because the holly trees were saplings, they do not factor in the basal area calculation in either year. Polygons described in Table 4-95 below are mapped in Figure 4-80.

Table 4-95. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
Mixed forest	B/C	Transect 1 is in this polygon. Almost all of the property at this site is a dry mixed conifer and broad-leafed forest. There are a few non-native species, including English ivy. While timber harvest occurred in the past the site has not been disturbed for many years and has mostly recovered. The only non-native species observed in plots along Transect 1 in 2004 were tiny vetch (*Vicia hirsute)* and English ivy (*Hedera helix)* There were no non-native species present in the transect in 2007. There were still a few non-native ivy plants outside the transect and the site could decline in condition if the ivy increases or could continue to improve as the forest matures if the ivy is controlled.
Former Cabin Site	D	In the western and northern part of the parcel is the site of a former cabin and clearing. Most of this area has grown up to alder forest, with some non-native species, including holly.

MC-10 Habitat Protection

Photo 1. View of typical vegetation at Chimacum Creek Estuary (2004)

Photo 2. Typical vegetation at Chimacum Creek is unchanged from 2004 (2007)

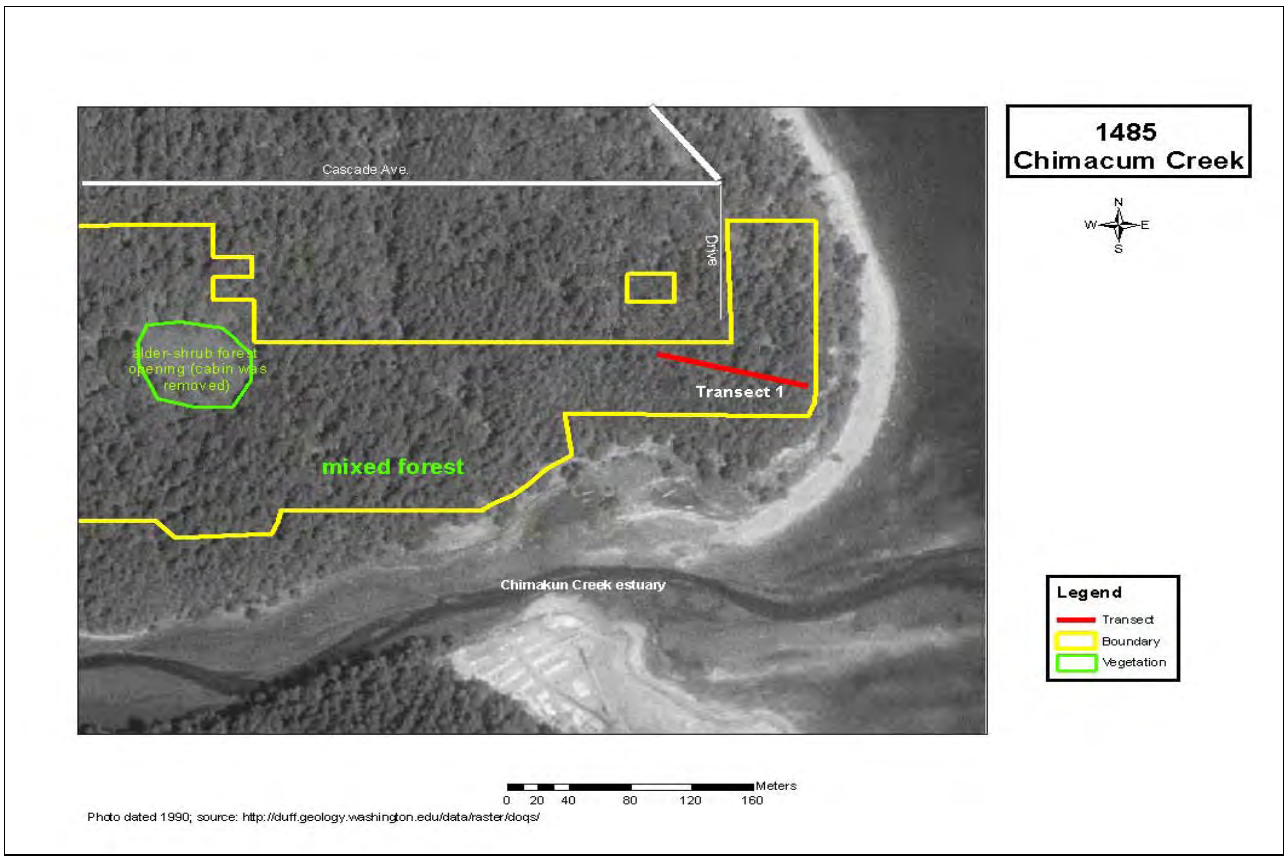


Figure 4-80. Polygons and Transects at Chimacum Creek Estuary Acquisition

Summary

The project site does not include estuary habitat, but is an upland parcel that was acquired to protect the adjacent estuary. As a result, no estuary variables were measured or reported. The site contains good quality vegetation habitat with mixed, mature forest. The site is largely undisturbed with mostly native species present. During the Year 3 survey, a small amount of

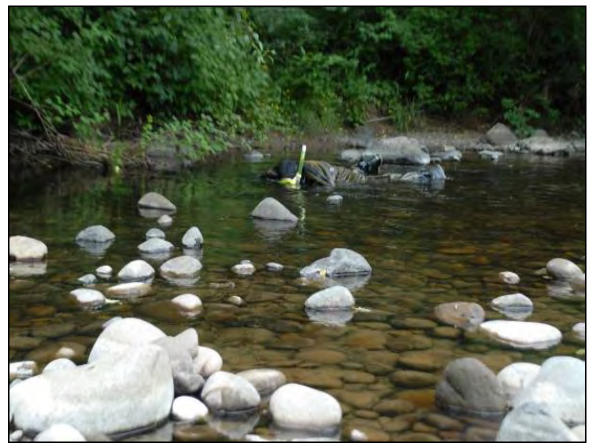
MC-10 Habitat Protection

English ivy was observed that has the potential to threaten the forest; however, it was not located within the project plots. The ivy was also present in Year 0 and it does not appear to have changed substantially over the course of three years. Monitoring was not conducted at the Chimacum Creek site in 2008; however, Year 6 monitoring is scheduled for 2010.

02-1535 WeyCo Mashel Shoreline Acquisition

The WeyCo Mashel Shoreline Acquisition site consists of 65 acres of timberland, previously owned by Weyerhaeuser Company, with old growth trees along the right bank of the Mashel River. The parcel contains excellent riparian habitat, providing shading and LWD to the stream, and protects approximately one mile of Mashel River shoreline. The land within the acquisition site was proposed for inclusion in the Nisqually Mashel State Park; however, Weyerhaeuser Company and state parks were unable to agree on the value of the timber. With support provided by SRFB, the Nisqually River Basin Land Trust purchased the land, thus preserving the site and its excellent salmon spawning and rearing habitat, which is currently utilized by Chinook, pink, and coho salmon, and steelhead. Now that the land has been acquired, it will be transferred to State Parks after first ensuring that all salmonid habitat values, including the timbered stream corridor, will be permanently protected.

Macroinvertebrate collection in Year 3 (2007)



Snorkel survey for juvenile salmonids in Year 3 (2007)

Project Location

The WeyCo Mashel Shoreline Acquisition site is located along the right bank of the Mashel River at RM 2.2-3.2, near Eatonville, in Pierce County, Washington. The Mashel River is a major tributary to the Nisqually River at RM 39.6 and is located within the Nisqually River Basin in WRIA 11. The project site is within the proposed boundary of the Nisqually Mashel State Park and monitoring is conducted over approximately 500 meters of river habitat.

Project Objective

This parcel of land contains 65 acres of timberland with old-growth values. Purchasing the land adds to salmonid habitat preservation and prevented it from being logged and developed. The project sponsor is Nisqually River Basin Land Trust and the contact person is George Walter.

Project Data

Table 4-96 summarizes the data collected during Year 0 and Year 3 monitoring of the WeyCo Mashel Project.

Table 4-96. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	15.10	18.31
Mean Residual Pool Vertical Profile Area (m^2)	92.33	90.61
Mean Residual Depth (cm)	18.47	18.12
Log10 of Volume of LWD (m^3)	1.28	0.97
Percent Fines (%)	0	8.0
Percent Embedded (%)	36.09	55.50
Riparian Characteristics		
Canopy Density (1-17)	13.0	13.75
Riparian Vegetation Structure (%)	81.8	100.0
Bank Erosion (%)	0	12.25
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	0.1	0
Non-native Herbaceous Relative Cover (%)	0.03	0
Non-native Shrub Absolute Cover (%)	0.10	0
Non-native Shrub Relative Cover (%)	0.05	0
Coniferous Basal Area (ft^2/acre)	225.3	317.9
Coniferous Density (stems/acre)	462.0	394.0
Deciduous Basal Area (ft^2/acre)	13.7	15.9
Deciduous Density (stems/acre)	116.0	196.0
Stream Organism Indices		
Fish Species Assemblage Index	97	84
Macroinvertebrate Multimetric Index	28	32
Data collected July 12, 2004 and June 23, 2004 (Year 0) and July 12 - 13, 2007 and September 13, 2007 (vegetation survey) (Year 3).		

Upland Vegetation Data Summary

The WeyCo Mashel property is largely a mixed forest with an eroding cliff at the river. The forest includes developing mature forest characteristics and is predominantly native species (see Photo 1). It provides quality forested upland habitat on the north side of the river. There is a small area at the river's edge in the flood plain that has numerous non-natives species. The property is little changed from 2004 (see Photo 2). The trees have grown larger (basal area of both conifer and deciduous trees has increased), but the cover of non-native species has not increased in the forested polygon. The two vegetation polygons delineated in the WeyCo Mashel Shoreline Acquisition are shown in Figure 4-81 and described in Table 4-97.

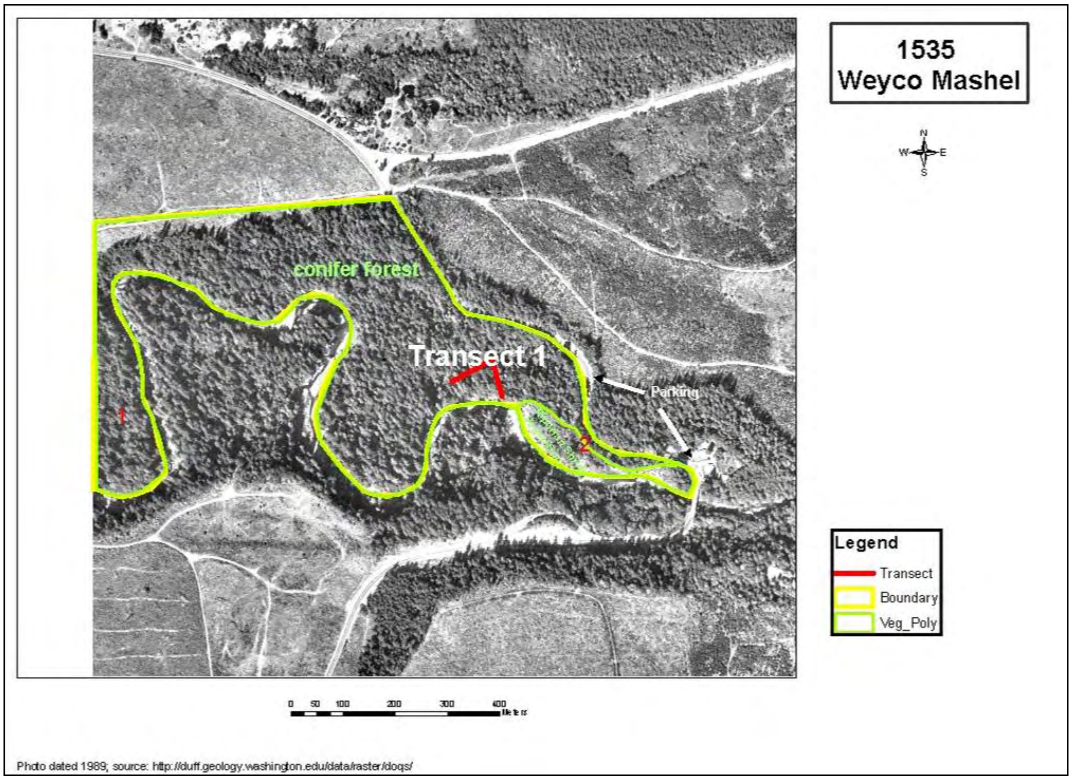


Figure 4-81. Polygons and Transects

Table 4-97. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	B/C	This polygon includes vegetation Transect 1. Most of the project site is a mature, mixed forest that includes conifers and broad-leaved trees. Logging historically occurred on this site, many years ago, and the stand has developed characteristics of a mature forest.
2	C/D	This small polygon close to the Mashel River is predominantly broad-leaved trees, with dense shrubs near the river's edge. Cobbles along the stream bed include numerous non-native species.

MC-10 Habitat Protection


Photo 1. Typical Forested Vegetation (2004)


Photo 2. Typical Forested Vegetation little changed from 2004 (2007)

Summary

Table 4-96 indicates little geomorphic change in the Mashel River between 2004 and 2007. Volume of LWD decreased slightly and percent embeddedness increased slightly, but these changes are not outside the expected range of variation at a normal site. The ratings for both the fish species assemblage and the macroinvertebrate index were fairly consistent and indicate good ecological health for the instream habitat.

The WeyCo Mashel site contains primarily good vegetation habitat with mixed, mature forest. The site appears to be relatively undisturbed and has mostly native species high above the river. The only portion of the site that contains non-native vegetation is a very small area in the floodplain. Monitoring of the WeyCo Mashel site was not conducted in 2008; however, Year 6 monitoring is scheduled for 2010.

02-1592 Curley Creek Estuary Acquisition

The Curley/Salmonberry Creek system, one of the largest watersheds in south Kitsap, supports five species of salmonids: Chinook, coho, chum, steelhead, and cutthroat. Estuaries are critical to the survival of salmon, providing rearing habitat for juveniles, refugia for adults and juveniles, and serving as crucial transition zones for smolts moving from fresh to salt water. Extensive alterations of estuaries and other nearshore areas by humans have seriously harmed these habitats and the species most dependent on them, particularly chum and Chinook, which are both present in the Curley Creek estuary. This project preserved the Curley Creek estuary by acquiring approximately 20 acres that comprise its entire shoreline, the surrounding steep slopes, and six adjacent forested upland parcels.

Estuary shows presence of gravel substrate and moss in the stream (2007).

Forested upland transect - vegetation at top of steep Bluff showing little change since prior visit (2007).

Project Location

The project is located along Curley Creek, near where it flows into Puget Sound, south of the Town of Manchester, in Kitsap County. The acquisition area is located in WRIA 15 and is within Township 24N, Range 2E, and Section 33.

Project Objective

This project preserves the Curley Creek estuary through acquisition of the lands (20 acres) that comprise its entire shorelines, the surrounding steep slopes, and six adjacent upland parcels. Acquisition for conservation and education protects this estuary in its natural state and preserves it for use by salmonids in this system and adjacent nearshore areas. This project is sponsored by the Great Peninsula Conservancy and Kate Kuhlman serves as the contact person.

Project Data

Table 4-98 summarizes the data collected during Year 0 and Year 3 monitoring of the Curley Creek Project.

Table 4-98. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Estuary Characteristics		
Percent Cover Algae (%)	0.86	3.30
Length of Algae (m)	0.50	1.80
Percent Cover Vascular Plant (%)	91.50	95.80
Length of Vascular Plant (m)	53.00	52.20
Percent Slope (%)	3.45	3.50
Percent Fines (%)	7.60	0.90
Length of Fine Sediment (m)	4.40	0.50
Upland Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	2.1	0.04
Non-native Herbaceous Relative Cover (%)	1.0	0.04
Non-native Shrub Absolute Cover (%)	0.9	1.4
Non-native Shrub Relative Cover (%)	0.3	1.2
Coniferous Basal Area (ft^2/acre)	101.7	103.0
Coniferous Density (stems/acre)	64.0	70.0
Deciduous Basal Area (ft^2/acre)	97.7	139.7
Deciduous Density (stems/acre)	326.0	178.0
Data collected July 6, 2004 (Year 0) and on July 13, 2007 (Year 3).		

Estuarine and Upland Vegetation Data Summary

The Curley Creek estuary acquisition includes the portion of the creek that extends to the road and runs along the shore. It includes the creek shorelines and a high quality sedge estuarine wetland that rises approximately two feet above the creek bed. The creek includes gravel and cobble substrate with algae in areas. The estuary vegetation is currently in a relatively natural state and in good condition, without any armoring or other development along the shoreline (see Photo 1). The surrounding steep slopes are comprised of mature mixed forest. The steep slopes may have been logged at one time but are now mature forest. The mixed forest at the top of the west slope was more recently logged and is maturing.

In 2007, all of the non-native vegetation on the site was found in the forested areas. The species identified do not present a threat to the estuarine vegetation, as they don’t establish in saline conditions. The primary threat identified was Himalayan blackberry. Himalayan blackberry was present along Transect 1 in Polygon 1 (see Figure 4-82) and appears to be spreading into the open area onsite that was once an old driveway and parking area (see Polygon 1 description in Table 4-99).

The decline in deciduous stem count at the site is due to the elimination of holly seedlings and saplings that had been growing on the steep, eroding slope. Holly is still present in the forest, but was not present in the surveyed transect during Year 3. Because seedlings and saplings are not counted in the basal area measurement, these results were not affected. The basal area increased, as expected, as the forest is maturing.

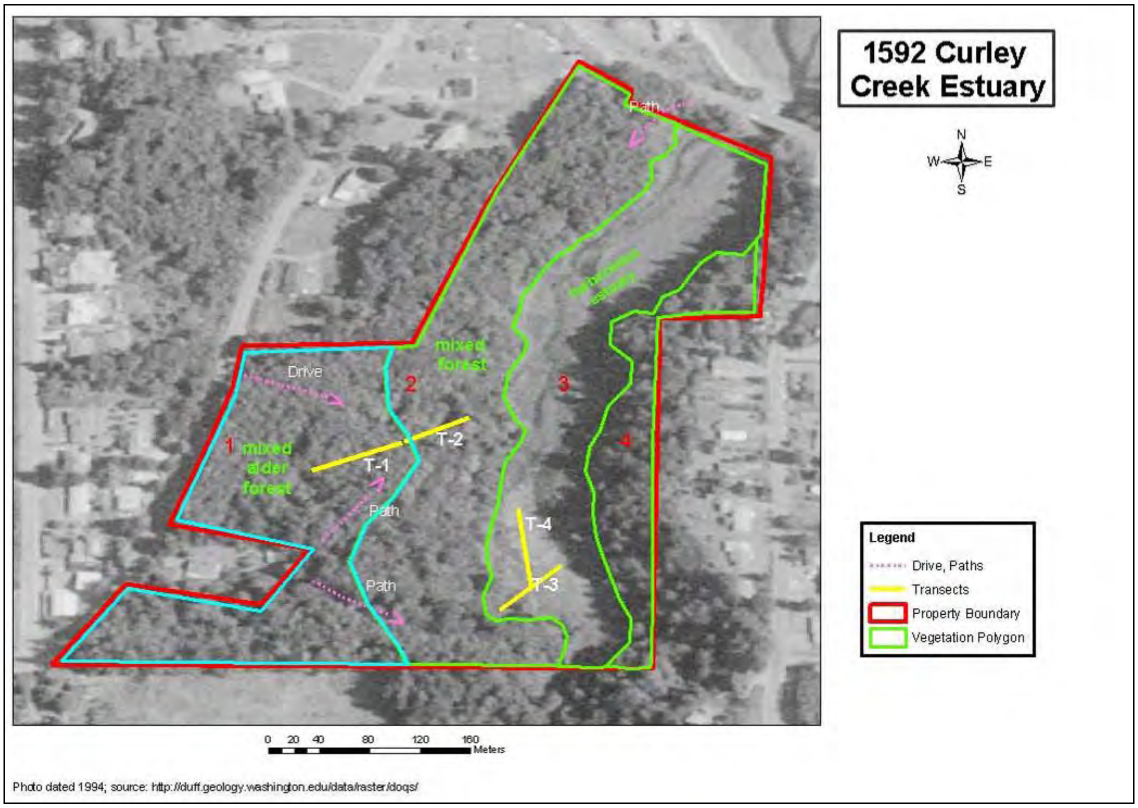


Figure 4-82. Polygons and Transects from the Curley Creek Estuary Acquisition

Table 4-99. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	C	This polygon includes Transect 1. This area includes a predominantly alder forest with salmonberry and trailing blackberry and sword fern common in the understory. It is an early successional stand, but provides forested habitat and is maturing. It includes an old drive off Locker Road and an old footpath. Three years ago, the drive was still cleared but is now being allowed to recover. The edge of the site along Locker Road, the old drive and foot path include the non-native shrub, Himalayan blackberry, which had entered the sampling transect by Year 3 (2007). These non-natives do not threaten the estuary because they are not tolerant of saline conditions.
2	B/C	This polygon includes Transect 2. This area includes a mixed conifer and broadleaf forest on steep slopes with some fairly large trees. The area was probably historically logged, but not as recently as the alder forest in Polygon 1. This polygon includes few non-native species and provides good estuarine wetland habitat.
3	B/C	Includes Transects 3 and 4. This polygon consists primarily of herbaceous marsh vegetation (predominantly grasses and sedges).
4	C	Mixed forest. The forest on the east side of Curley Creek was not surveyed, but it appeared similar in composition and condition to Polygon 2.

MC-10 Habitat Protection

Photo 1. Estuarine Transect -vegetation at Curley Creek prior to acquisition (2004)

Photo 2. Estuarine Transect - vegetation virtually unchanged in three years since acquisition (2007)

Summary

The estuarine portion of the site remained unchanged from Year 0 to Year 3 (see Photo 2, above). It has generally native vegetation and is not likely to change without a major natural event. The steep slopes were also unchanged and remain a native, conifer forest. The flat area at the top of the slope, where there used to be a driveway and parking, has what may be increasing cover of non-native species, specifically Himalayan blackberry. The area with non-native species; however, is a considerable distance from the estuary and those non-native species observed will not grow in the saline environment, so they are not considered a threat to the estuarine habitat. Monitoring was not conducted at the Curley Creek site in 2008; however, Year 6 monitoring is scheduled for 2010.

02-1622 Issaquah Creek Log Cabin Reach Acquisition

The Issaquah Creek Log Cabin Reach Acquisition Project involved the acquisition of eight parcels (152 acres of land) along Issaquah Creek in the Middle Issaquah Creek Basin. The acquisition comprising these lands within the project reach has allowed the protection and preservation of mature forests, wetlands, and riparian corridor along 1.5 miles of both banks of Issaquah Creek. The reach is part of a Regionally Significant Resource Area and provides excellent rearing and spawning habitat. The reach includes areas that offer braided channels and pools with high water refugia for juvenile fish, clean spawning gravel, large woody debris, and a diverse and sinuous riparian corridor. Issaquah Creek supports Chinook, char (possibly ESA-listed bull trout), sockeye, coho, kokanee, steelhead, and cutthroat.

Riparian vegetation in Issaquah Creek Log Cabin Reach in Year 0 (2004)

Issaquah Creek instream habitat in Year 3 (2007)

Project Location

The Issaquah Creek Log Cabin Reach is located approximately 5 miles south of Issaquah, in King County, Washington. The project reach is located on Issaquah Creek, between RM 8.5 and 9.75, in the Middle Issaquah Creek Basin. Issaquah Creek drains into Lake Sammamish and is located within the Greater Lake Washington/Cedar/Sammamish WRIA (WRIA 8). Monitoring is conducted over approximately 310 meters of Issaquah Creek.

Project Objective

The objective of the Issaquah Creek Log Cabin Reach Acquisition Project was to acquire and protect 152 acres of mature forests, wetlands, and riparian corridor along 1.5 miles of both banks of Issaquah Creek. This purchase protected rearing and spawning habitat for several species of salmonids and helped to improve the water quantity and quality for all of Issaquah Creek. The parcels include various habitats and refugia for salmonid species and provide an important link in the wildlife corridor that incorporates Tiger Mountain and Squak Mountain state forests. King County Water and Land Resources Division sponsored this project and the contact person is Mary Maier.

Project Data

Table 4-100 summarizes the data collected during Year 0 and Year 3 monitoring of the Issaquah Creek Project.

Table 4-100. Summary Statistics for Pre- and Post-Acquisition Monitoring (Year 0 and Year 3)

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	5.76	8.84
Mean Residual Pool Vertical Profile Area (m^2)	49.29	34.29
Mean Residual Depth (cm)	15.90	11.06
Log_{10} of Volume of LWD (m^3)	0.57	0.68
Percent Fines (%)	0	20.0
Percent Embedded (%)	44.91	70.36
Riparian Characteristics		
Canopy Density (1-17)	15.09	14.59
Riparian Vegetation Structure (%)	86.4	100.0
Bank Erosion (%)	1.50	25.25
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	68.6	73.4
Non-native Herbaceous Relative Cover (%)	30.7	29.9
Non-native Shrub Absolute Cover (%)	0	0
Non-native Shrub Relative Cover (%)	0	0
Coniferous Basal Area (ft^2/acre)	163.5	194.2
Coniferous Density (stems/acre)	130.0	124.0
Deciduous Basal Area (ft^2/acre)	39.3	68.1
Deciduous Density (stems/acre)	34.0	38.0
Stream Organism Indices		
Fish Species Assemblage Index	93	90
Macroinvertebrate Multimetric Index	42	38
Data collected on July 16, 2004 (Year 0) and July 16 - 17, 2007 and August 7, 2007 (vegetation survey) (Year 3).		

Upland Vegetation Data Summary

This acquisition is primarily forested and grass fields that were formerly mowed. There are also several large thickets of Himalayan and evergreen blackberry at the forest edges and along the paths. After the first visit in 2004, King County made some modifications to restore the vegetation in the park. The log cabin was removed and there are several areas where plantings were placed in black horticulture plastic to control the weeds. Other than these changes, the site is little changed from 2004. The trees in the forested transect are larger, but have similar density. Average absolute cover of non-native herbaceous species in both transects was close to 73 percent. If successful, the effects of the plantings installed by King County will be evident in several years. Table 4-101 corresponds to the numbering on the vegetation map, Figure 4-83.

Table 4-101. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	C	Second-growth mixed forest. When surveyed the river was not crossed; observations were from east side. This polygon includes young, homogenous forest with mixed species.
2	C/D	This polygon includes riparian vegetation, predominantly shrubs and herbaceous species, with scattered coniferous and broad-leaved trees. This area is relatively disturbed by historical development.
3	B	Includes Transect 2. This area is a mature, coniferous forest with openings and old growth characteristics. There is a path into the forest from the north entrance. There is some evidence of past logging, but the areas includes a scattering of fairly large trees and the understory is predominantly native species. Other than tree growth, the vegetation changed little from 2004 to 2007. The number of trees is the same but they are larger (only one more stem per acre but a larger total basal area).
4	C	This polygon includes mixed forest with conifer and broad-leaved species. Past disturbance includes farming and road construction. There are fairly abundant non-native species in some areas, but the area is growing back to primarily native forest.
5	E	Includes Transect 1. This grassy field had been maintained, at least until recently, by mowing and includes a high percentage of non-native species (primarily non-native grasses). Outside the transect and generally at the field edges, are large thickets of Himalayan blackberry. Several areas had been planted with native shrubs on black horticulture plastic to control and replace non-natives. Otherwise, the vegetation changed little between 2004 and 2007 (see photos below).

Photo 1. Grass Transect 1. Mostly non-native grasses. Area Was historically mowed. Note large blackberry patches center left and to right of origin tree in center of photo (2004)

Photo 2. Grass Transect 1. Little changed overall. Note 2 areas with plastic in background where plantings in black plastic have replaced the blackberry (2007)

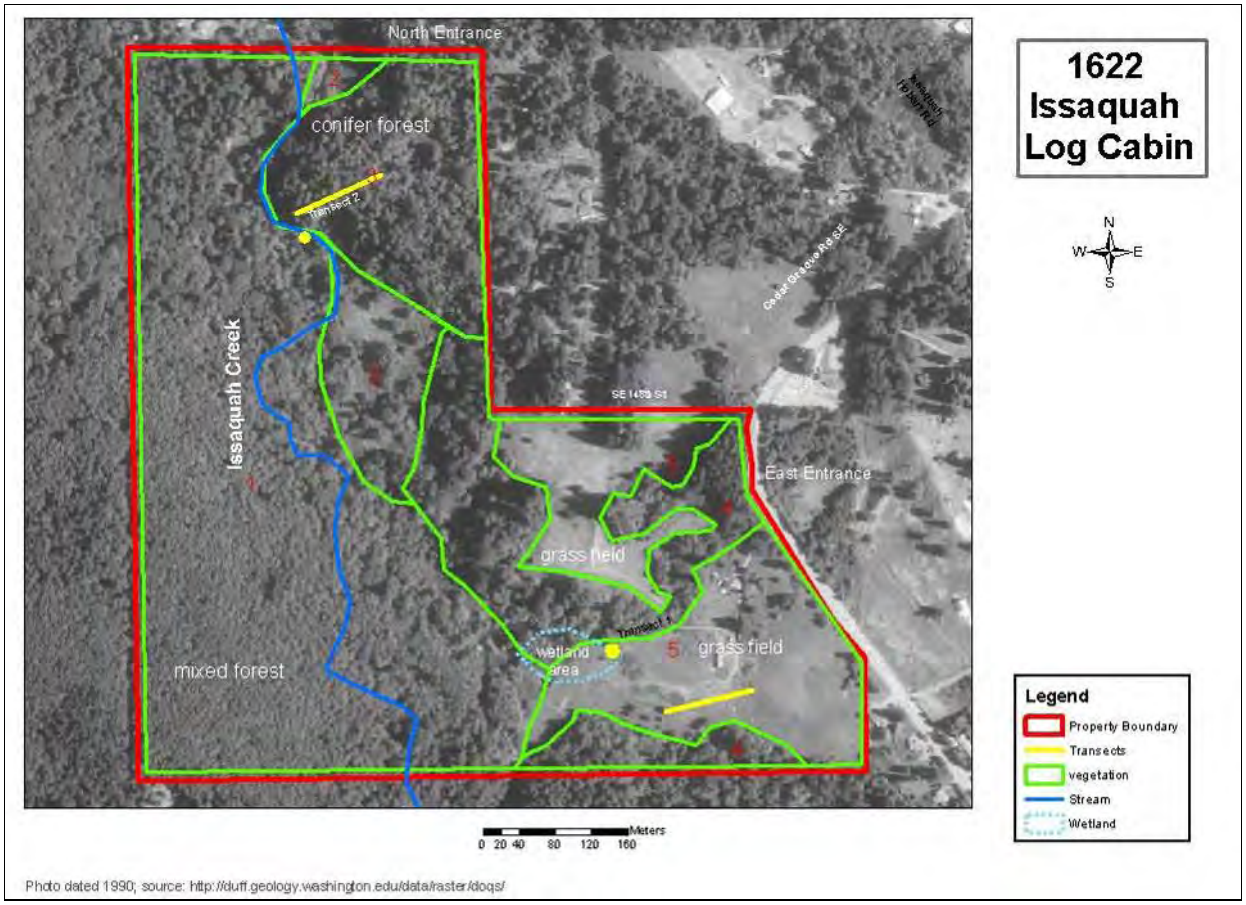


Figure 4-83. Polygons and Transects at the Issaquah Log Cabin Acquisition

Summary

In-stream habitat conditions in Issaquah Creek changed slightly between 2004 and 2007. Small changes in mean vertical pool profile area and residual pool depth are expected due to flow variation. There were slight changes in substrate and bank conditions with percent fines, percent embeddedness, and the proportion of banks with erosion all increasing. Slight decreases in both fish assemblage ratings and the macroinvertebrate index may be related to these changes in substrate conditions.

The vegetation at this site was not notably different in Year 3 than in Year 0. The maturing forest serves as good habitat and is still largely native and continuing to mature. The grass field at the site continues to support mostly non-native grasses, where it was likely mowed or grazed at one time. The non-native blackberry shrubs are dense along path edges and in some open areas. The County has installed plantings to try to shade out and out-compete the dense blackberries in some areas; however, these plantings are not within the project plots and will not be reflected in the data. The potential changes at this site include continued success of the plantings, or possibly the spread of the Himalayan and evergreen blackberry shrubs.

Monitoring of the Issaquah Creek site was not conducted in 2008; however, Year 6 monitoring is scheduled for 2010.

02-1650 Methow Critical Riparian Habitat Acquisition

The Methow Critical Riparian Habitat Acquisition Project provided funding for conservation easement purchases on seven critical properties along the Methow River between the towns of Winthrop and Mazama. These easements instigated protection of the Upper Methow Habitat Block, a corridor of extremely high-quality riparian habitat where side channels, LWD, and spawning areas are abundant. Prior to the acquisition, only 33 acres of private land in the reach were protected. This project protected over 1,000 additional acres and 6.8 miles of riverfront habitat.


Methow River at Transect F in 2004 (Year 0)


Methow River at Transect F in 2007 (Year 3)

Project Location

This project is located in Okanogan County between the towns of Winthrop and Mazama within the Methow River Basin (WRIA 48). The sample stream reach is approximately 500 meters in length and is located on the Tawlks property on the mainstem Methow River within Township 36N, Range 20E, and Section 32. Upland vegetation surveys were also done on the Stean property. Other parcels were acquired on lands previously owned by Brown and Edelweiss.

Project Objective

This project established conservation easements on multiple property parcels on the Methow River between the towns of Mazama and Winthrop to protect the Upper Methow Habitat Block. Steelhead and Chinook are expected to benefit most from this project. The project was sponsored by the Methow Conservancy and Steve Bondi is the primary contact.

Project Data

Table 4-102 summarizes the data collected during Year 0 and Year 3 monitoring of the Methow Critical Project.

Table 4-102. Summary Statistics for Pre- and Post-Acquisition (Year 0 and Year 3) Monitoring

Variable	Year 0 (2004)	Year 3 (2007)
Stream Physical Characteristics		
Reach Width (m)	22.81	37.02
Mean Residual Pool Vertical Profile Area (m^2)	9.65	44.79
Mean Residual Depth (cm)	1.93	8.96
Log10 of Volume of LWD (m^3)	0.71	0.47
Percent Fines (%)	0	0
Percent Embedded (%)	9.46	19.87
Riparian Characteristics		
Canopy Density (1-17)	10.32	12.36
Riparian Vegetation Structure (%)	100	81.8
Bank Erosion (%)	22.5	4.0
Riparian Plant Characteristics		
Non-native Herbaceous Absolute Cover (%)	56.8	35.0
Non-native Herbaceous Relative Cover (%)	68.4	60.6
Non-native Shrub Absolute Cover (%)	0	0
Non-native Shrub Relative Cover (5)	0	0
Coniferous Basal Area (ft^2/acre)	0.8	2.5
Coniferous Density (stems/acre)	14.0	18.0
Deciduous Basal Area (ft^2/acre)	243.8	256.9
Deciduous Density (stems/acre)	278.0	191.0
Stream Organism Indices		
Fish Species Assemblage Index	89	88
Macroinvertebrate Multimetric Index	38	36
Data collected August 11, 2004 through August 12, 2004 (Year 0) and July 20, 2007 through July 25, 2007 (Year 3).		

Upland Vegetation Data Summary

All four properties included in this acquisition project are on the Methow River. Three of the properties (Tawlks, Brown, and Edelweiss) are north of Winthrop and one (Stean) is south of Winthrop. The three properties north of Winthrop are largely undeveloped and adjacent to the river. The Stean property was historically cleared and farmed, leaving the river with a vegetation buffer of only a few feet. The vegetation survey transects are located on the Stean property (forest and grass field) (see Figures 4-84 and 4-85) and on the Tawlks property (grass field with shrub edge) (see Figure 4-86).

In 2004, seedlings were planted along the narrow tree buffer on the Stean property (Table 4-103). During the Year 3 survey in 2007, many of them appeared to have survived, however, they had been heavily browsed by wildlife (Photo 1). All cottonwood volunteer seedlings in the grassy area had also been heavily browsed to a 2-foot shrub form (Photo 2). The browsing is expected to continue unless exclusionary fencing is installed to ensure that deer are unable to access the entire field.

On the Tawlks property, the willows have been expanding into the formerly mowed grass field (Photos 3 and 4) (Table 4-104). As the willows continue to expand, the non-native species in the grass field will presumably decline.

MC-10 Habitat Protection

The decline in the cover of non-native herbaceous species observed in Year 3 is due to greater cover of willows and less non-native grass species in the Tawlks property, but is also influenced by the lower cover of non-native grasses due to a dry summer. The decline in the deciduous basal area and stem count variables is likely a result of old trees and snags falling between the survey years.

Photo 1. *Stean Property.* Plantings browsed to exclosure limits (2007)

Photo 2. *Stean Property.* Grass field transect area. Volunteer cottonwood saplings heavily browsed (2007)

Photo 3. *Tawlks Property*. Grass field Transect 5 (2004)

Photo 4. *Tawlks Property.* Transect 5. Note the willows have started to expand into the far end of the grassy field (2007)

Table 4-103. Polygon Condition Classes and Descriptions (Stean Property)

Polygon	Condition Class	Description
1	C/D	Narrow band of sagebrush steppe along the west side of Highway 20.
2	E	Mix of old gardens, existing farm buildings, a house, driveways, and small fields.
3	E	Grass field, likely recently plowed and planted.
4	E	This polygon includes two areas where riparian plantings have been installed. These areas are formerly grass fields, and a variety of native shrubs and trees were planted here within the past 2 years. Mortality was fairly high in 2004. In 2007, the surviving plantings and the numerous cottonwood volunteer seedlings were very heavily browsed by deer. In the case of the plantings, the browse extended to the exclosures placed around each planting (see Photos 1 and 2). While it is currently Condition Class E, it could potentially improve rapidly if the deer are kept from browsing the plantings and the volunteer cottonwoods.
5	C	This is a narrow band of deciduous trees (primarily black cottonwood) along the immediate bank of the Methow River. The condition class is based on the species composition being similar to what would be normally found in that area, but this is just a narrow band of individual trees.
6	E	Planted (2004) alfalfa field.
7	C	Lithosol outcrop, native vegetation more prevalent here than elsewhere on the parcel, other than the deciduous forest sites. Includes one small swale of Great Basin rye.
8	E	*Includes grass field transect.* Grass field, predominantly non-native species. It includes several cottonwood seedlings or saplins that are heavily browsed to 2 feet high. Because it is no longer mowed, it could support cottonwood, at least in some areas, if deer browse was controlled.
9	C/D	Narrow band of sagebrush steppe between Highway 20 and Witte Road.
10	C/D	*Includes portion of forested transect.* This is a deciduous forest, predominantly cottonwood, between the Methow River and farm fields. The forest is predominantly native trees and shrubs with abundant non-native herbaceous species in the understory.
11	C/D	*Includes portion of forested transect.* This polygon includes a stand of deciduous black cottonwood trees surrounded by previously mowed fields. It is predominantly native trees and shrubs with abundant non-native herbaceous species in the understory.

Table 4-104. Polygon Condition Classes and Descriptions (Tawlks Property)

Polygon	Condition Class	Description
1	C	Stand of second-growth coniferous forest along the highway.
2	E	*Includes grass field Transect 5.* Formerly mowed field with predominantly non-native grasses and some native annuals. Transect 5 was placed in this polygon because the mowing would not continue and the vegetation could, potentially, return over time to previous conditions, similar to vegetation present in portions of Polygon 3. The non-native grasses are still predominant in 2007; however, the willow stand had expanded from Polygon 3 into the grassy field since 2004.
3	B/C	*Includes a portion of Transect 5.* Riparian forest. Diverse and complex mosaic of conifers and deciduous trees, crossed by flowing side channels of the Methow River. Some areas are quite dry, others are wetlands and stream channels. Classified as Condition Class B/C, though this area is of higher ecological importance because of the diversity and the presence of the stream channels. The end of Transect 5 extends into the shrubs in this polygon that are expanding into the grass field.
4	C	Dry coniferous forest on the east side of the Methow River. Not visited at the time of this survey; presumably Condition Class C.

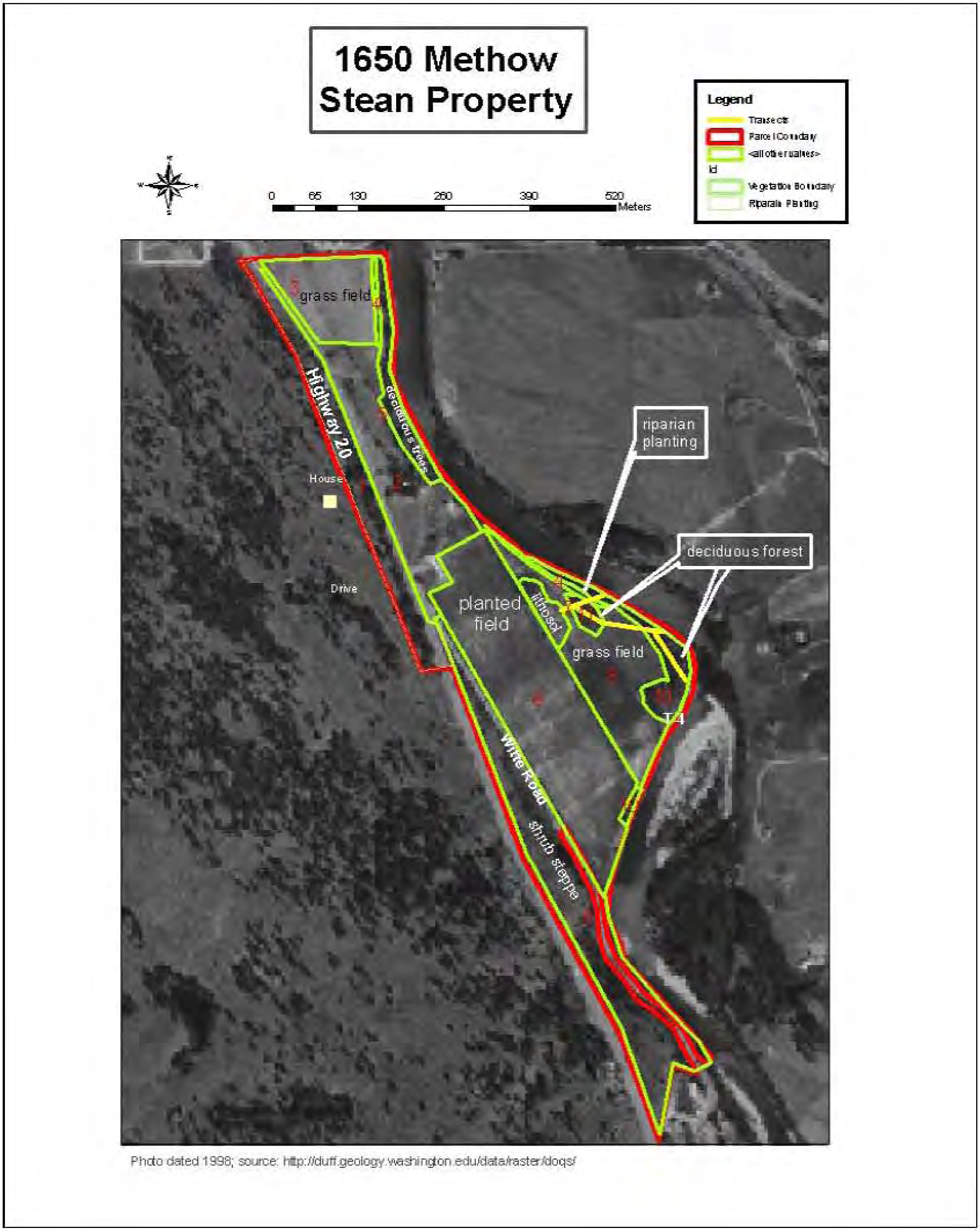


Figure 4-84. Polygons and Transects on the Stean Property

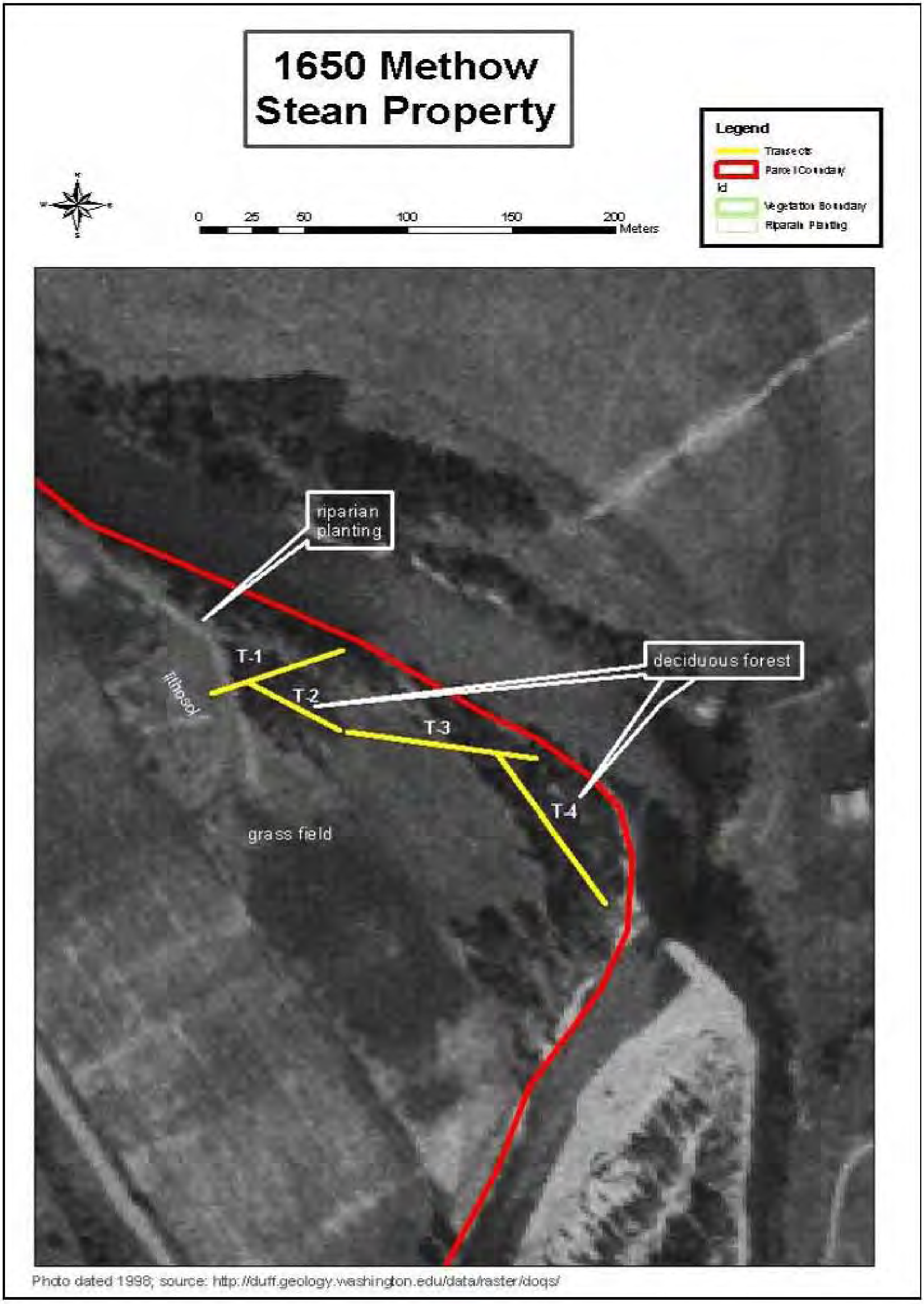


Figure 4-85. Transects on the Stean Property

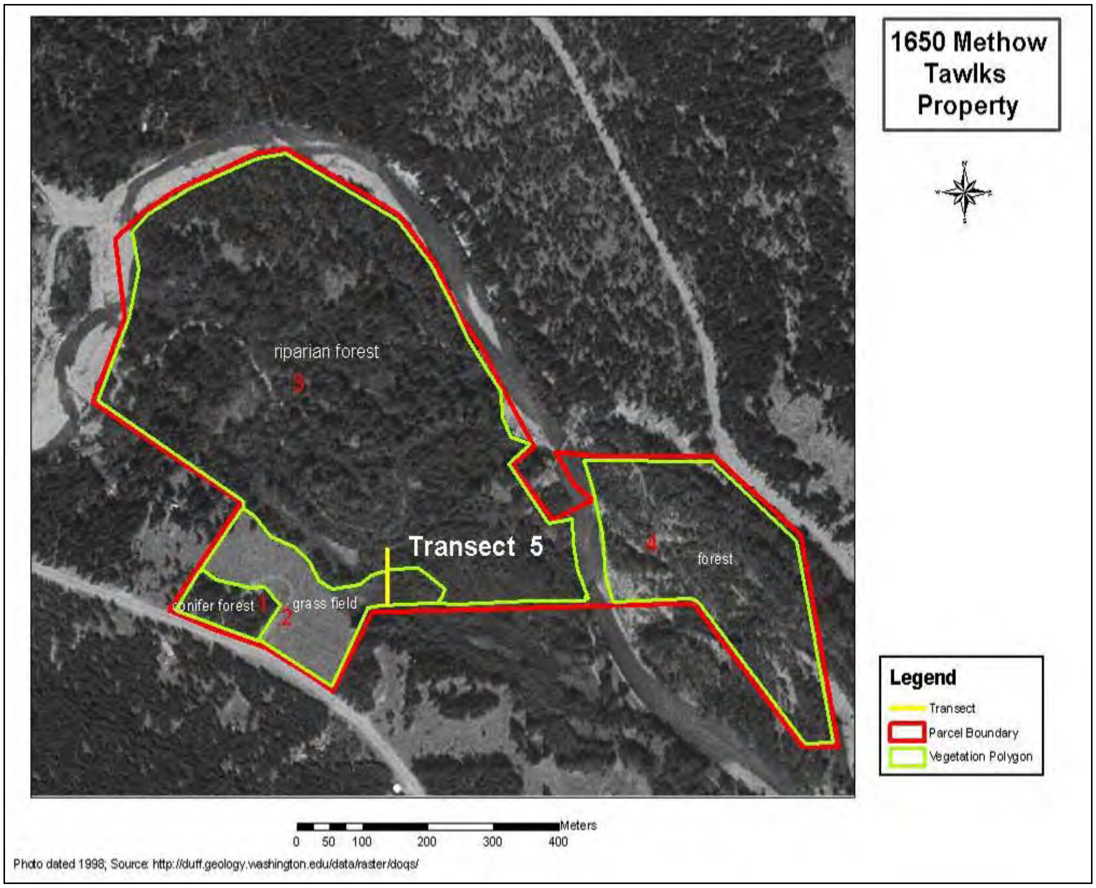


Figure 4-86. Polygons and Transects on the Tawlks Property

Summary

Summer thunder storms and heavy rain resulted in higher stream flows observed during the 2007 survey than were present in 2004. Fish density was lower in 2007 than in 2004, but the total number of salmonids counted each year was very similar. Fish assemblage and invertebrate indices remained stable. Generally, other than higher river flows, the habitat conditions present in 2007 appeared largely unchanged from those of 2004.

The vegetation in the Stean property is largely unchanged and the potential for change is limited. The volunteer cottonwoods and the installed plantings have little chance of growing without protection from deer browse. If deer are excluded from the planted area, there could be improvement in this area over time. If browsing by deer continues a decrease in native plants or in tree cover may be observed as only growth of existing trees will provide cover and growth of new plants may not occur.

The vegetation on the Tawlks property showed signs of change during the 2007 survey, as the willow stand grew into the formerly mowed field. Changes are expected to continue with a slow increase in native vegetation as shrubs shade out the grassy areas which contain abundant cover of non-native herbaceous species.

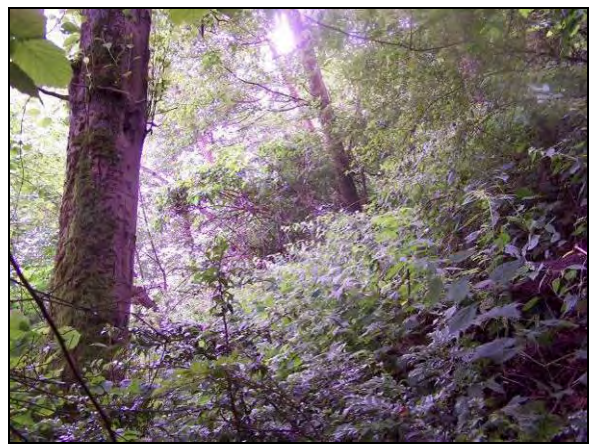
MC-10 Habitat Protection

Monitoring was not conducted at the Methow Critical sites in 2008; however, Year 6 monitoring is scheduled for 2010.

04-1335A Piner Point on Maury Island

The Piner Point habitat protection project is designed to conserve approximately ¼ mile of Puget Sound shoreline and its associated nearshore functions through acquisition of five parcels, approximately 6 acres, along the southeast tip of Maury Island. Historic and current land use practices in the area have degraded nearshore habitats by interrupting habitat forming processes, degrading water and sediment quality, decreasing riparian functions, altering nearshore sand and gravel movement, and introducing non-native species. The Maury Island shoreline includes documented surf smelt spawning grounds, which is an important forage species for salmonids. The overhanging vegetation at the Piner Point site improves the viability of these spawning grounds, provides organic input, and supports large woody debris recruitment, as well as a multitude of other classic riparian benefits. Piner Point is in both a landslide and erosion hazard area, as well as at the center of a littoral drift cell divergence zone, and for these reasons is believed to be critical to nearshore sediment recruitment along Maury Island.

Low tide showing eelgrass beds on west side of property Year 0 (2006)



Forested transect Year 0 (2006)

Project Location

This project is located in King County, near the mouth of Quartermaster Harbor, on the south end of Maury Island at Piner Point.

Project Objective

The objective of the project is to permanently conserve 400 meters of Puget Sound shoreline and associated nearshore functions. Overhanging vegetation and natural erosion provide cover and sediment input important for smelt spawning. These fish are an important forage fish for salmon and have been documented spawning on the Maury Island shoreline. The site consists of a rock and sand beach at the base of a steep, unstable, forest. At low tide, large eel grass beds are exposed. King County Water and Land Resources sponsors this project on King County property and Ray Heller serves as the primary contact.

Project Data

Table 4-105 summarizes the data collected during Year 0 monitoring of the Piner Point Project.

Table 4-105. Summary Statistics for Pre-Acquisition (Year 0) Monitoring

Variable	Year 0 (2006)
Estuary Characteristics	
Percent Cover of Marine Algae (%)	39.83
Length of Marine Algae Along Transect (m)	19.91
Percent Cover of Vascular Plants (%)	0
Length of Vascular Plants Along Transect (m)	0
Slope (%)	10.0
Percent fines (%)	0
Length of Fines Along Transect (m)	0
Upland Plant Characteristics	
Non-native Herbaceous Absolute Cover (%)	0
Non-native Herbaceous Relative Cover (%)	0
Non-native Shrub Absolute Cover (%)	0.3
Non-native Shrub Relative Cover (5)	0.1
Coniferous Basal Area (ft^2/acre)	7.5
Coniferous Density (stems/acre)	4.0
Deciduous Basal Area (ft^2/acre)	263.2
Deciduous Density (stems/acre)	172.0
*Data collected June 14, 2006 (Year 0).	

Estuarine and Upland Vegetation Summary

Vegetation at this site consists of both an upland forest and intertidal zone. Figure 4-87 shows the location of transects sampled in both zones. The upland forest is a mixed broadleaf forest that covers the property above the intertidal zone. It is on a steep (95 percent), unstable slope with sandy soil (see Table 4-106). The dominant tree species are alder (*Alnus rubra*), madrone (*Arbutus menziesii)* and big-leaf maple (*Acer macrophyllum)*. The understory is dominated by hazelnut (*Corylus cornuta)* and stinging nettle (*Urtica dioica)*. Non-native species, including scotch broom (*Cytisus scoparius*) and Himalayan blackberry (*Rubus armeniacus*), appear limited to the area close to the shore.

The intertidal zone is a cobble and sand beach at the base of the steep, eroding slope. Overall, the beach has a slope of approximately 10 percent and green and red algae are both present. On the western third of the intertidal zone, there are eel grass beds at the lower elevations which were observed at low tide on June 14, 2006.

Table 4-106. Polygon Condition Classes and Descriptions

Polygon	Condition Class	Description
1	B/C	Upland mixed broadleaf forest on steep, unstable slopes above the intertidal zone. Dominant species include alder, madrone, big-leaf maple, beaked hazelnut and stinging nettle. Non-native species (primarily Scotch broom and Himalayan blackberry) occur but are not abundant. This polygon includes Transect 1.
2	B	Intertidal zone of cobble and sand beach at the base of a steep, eroding slope. Red and green algae, as well as eel grass beds occur in this polygon. This polygon includes Transect 2. The Transect reaches approximately 50 meters from the base of the forested slope to the water at low tide. Lateral transects were used to measure vegetation. The lateral transects were perpendicular to the baseline transect and extended 10 meters either right or left (facing Puget Sound) of the baseline transect.

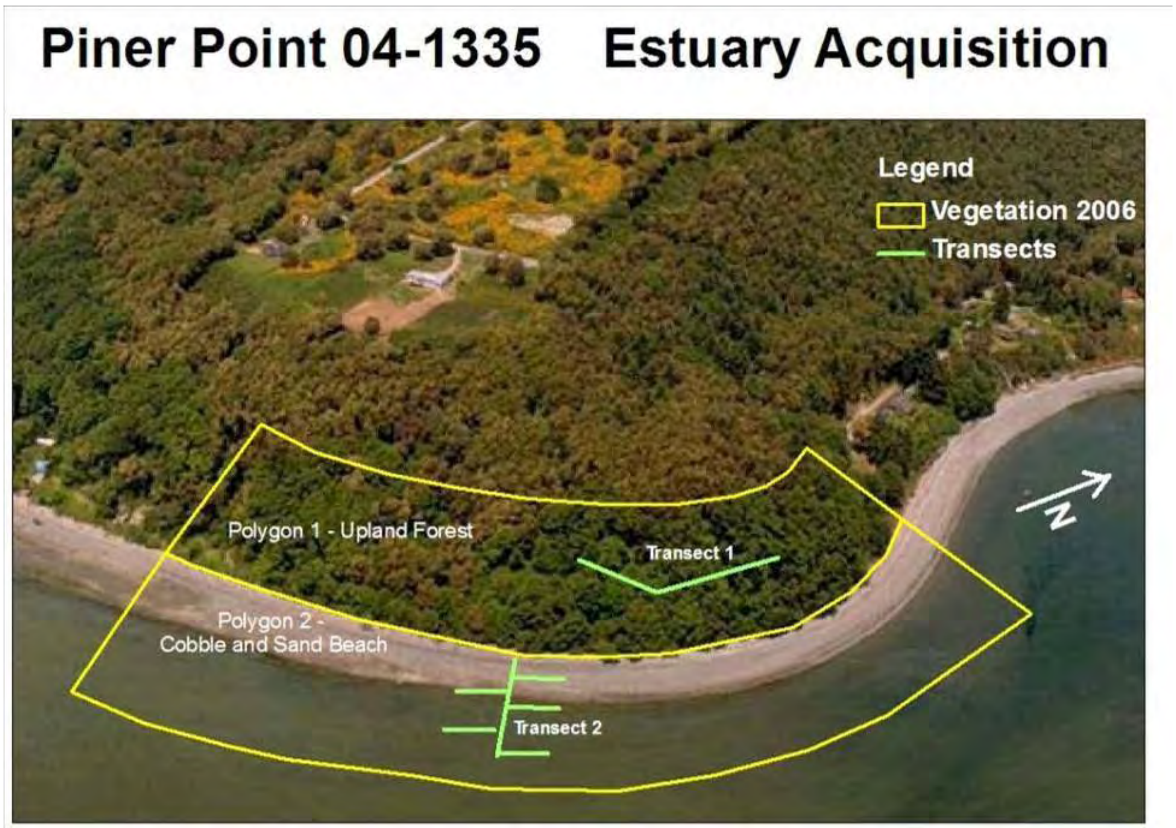


Figure 4-87. Polygons and Transects at the Piner Point Acquisition.

Summary

Piner Point is an estuarine site that was monitored pre-acquisition in 2006. Year 3 monitoring of this site is scheduled for 2009.

5 DATA ANALYSIS

This chapter includes the analyses for each monitoring category where at least two projects in the category have been implemented, and for which post-implementation data have been collected. The first section in this chapter describes the data analysis methods employed for analyzing the data. The second section presents the results from data analysis and evaluation. The third section of the chapter provides a summary of all the results presented in the second section. The fourth section provides recommendations based on the results.

5.1 DATA ANALYSIS METHODS

Analysis of a monitoring category is contingent upon the category containing at least two projects that have been implemented and having at least one year of post-implementation data. Table 5-1 lists the implemented projects in each category and the number of years for which post-implementation data have been collected. The table includes projects that were funded through the OWEB and are part of the data analysis for Livestock Exclusion Projects. Analyses performed on each monitoring category fall under two methods: those that use decision criteria and those that use statistical tests.

5.1.1 Decision Criteria Analysis

Decision criteria were applied to the results from the projects in Table 5-1 in each category to determine project effectiveness for each respective monitoring category. Each monitoring category had several indicators that were evaluated to determine if the decision criteria were met.

Table 5-1. Projects Included in the Data Analyses

Project Number	Project Name	Category	Years of Post-Implementation Data
02-1530	Salmon River Tributary 21-0143 Culvert Barrier	Fish Passage	Years 1 and 2
02-1574	Malaney Creek Fish Passage Project	Fish Passage	Years 1 and 2
04-1470	Hiawatha Fish Passage	Fish Passage	Year 1
04-1485	Fulton Dam Barrier Removal	Fish Passage	Years 1 and 2
04-1489	Chewuch Dam Barrier Removal	Fish Passage	Years 1 and 2
04-1668	Beeville Road MP 2.09	Fish Passage	Years 1 and 2
04-1689	Lucas Creek Barrier Correction	Fish Passage	Years 1 and 2
04-1695	Dekay Road Fish Barrier	Fish Passage	Years 1 and 2
05-1498	Curl Lake Intake Barrier Removal	Fish Passage	Year s1 and 2
02-1444	Little Skookum Valley, Phase II: Riparian	In-Stream Structures	Years 1 and 3
02-1463	Salmon Creek	In-Stream Structures	Years 1 and 3
02-1561	Edgewater Park Off-Channel Restoration	In-Stream Structures	Years 1 and 3
04-1338	Lower Newaukum Restoration	In-Stream Structures	Year 1
04-1448	PUD Bar Habitat Enhancement	In-Stream Structures	Years 1 and 3
04-1575	Upper Washougal River LWD Placement	In-Stream Structures	Years 1 and 3
04-1589	Dungeness River Railroad Bridge Restoration	In-Stream Structures	Year 1
05-1533	Doty Edwards Cedar Creek	In-Stream Structures	Year 1
02-1446	Centralia Riparian Restoration Project	Riparian Plantings	Years 1 and 3
02-1561	Edgewater Park Off-Channel Restoration	Riparian Plantings	Years 1 and 3

Table 5-1. Projects Included in the Data Analyses (continued)

Project Number	Project Name	Category	Years of Post-Implementation Data
02-1623	Snohomish River Confluence Reach Restoration	Riparian Plantings	Years 1 and 3
04-1649	Snow Creek Lower Watershed Site 1A	Riparian Plantings	Years 1 and 3
04-1655	Hoy Riparian Restoration	Riparian Plantings	Years 1 and 3
04-1676	YTAHP Wilson Creek Riparian Restoration	Riparian Plantings	Years 1 and 3
04-1698	Vance Creek Riparian Planting and Fencing	Riparian Plantings	Years 1 and 3
04-1711	Lower Klickitat Riparian Restoration	Riparian Plantings	Years 1 and 3
02-1498	Abernathy Creek Riparian Restoration	Livestock Exclusions	Years 1 and 3
04-1655	Hoy Riparian Restoration	Livestock Exclusions	Years 1 and 3
04-1698	Vance Creek Riparian Planting and Fencing	Livestock Exclusions	Year 1
05-1447	Indian Creek Yates Restoration	Livestock Exclusions	Year 1
05-1547	Rauth: Coweeman Tributary Restoration	Livestock Exclusions	Year 1
206-095	OWEB: Jordan Creek	Livestock Exclusions	Year 1
206-072	OWEB: Grays Creek	Livestock Exclusions	Year 1
206-283	OWEB: Noble Creek	Livestock Exclusions	Year 1
206-283	OWEB: Johnson Creek	Livestock Exclusions	Year 1
206-357	OWEB: Malheur	Livestock Exclusions	Year 1
205-060	OWEB: Bottle Creek	Livestock Exclusions	Year 1
205-060	OWEB: North Fork Clark	Livestock Exclusions	Year 1
02-1561	Edgewater Park Off-Channel Restoration	Channel Connectivity	Years 1 and 2
04-1461	Dryden Fish Enhancement CMZ Project	Channel Connectivity	Years 1 and 2
04-1573	Lower Washougal Restoration-Phase 1	Channel Connectivity	Years 1 and 2
05-1546	Gagnon CMZ Off-Channel Habitat Project	Channel Connectivity	Years 1 and 2
02-1540	Touchet River Screens Phase 2	Diversion Screening	Year 1
02-1543	Walla Walla Urban Fish Screens & Meters	Diversion Screening	Years 1 and 2
02-1544	Tucannon River Screens Phase 2	Diversion Screening	Years 1 and 2
02-1656	Dry/Cabin Crk Fish Passage & Screening	Diversion Screening	Years 1 and 2
04-1373	Indian Creek Diversion Screening	Diversion Screening	Years 1 and 2
04-1373	Indian Creek Diversion Screening	Diversion Screening	Years 1 and 2
04-1373	Indian Creek Diversion Screening	Diversion Screening	Years 1 and 2
04-1568	Garfield County Irrigation Screening Pro	Diversion Screening	Years 1 and 2
00-1669	Entiat River Habitat Acquisition	Habitat Protection	Years 1 and 3
00-1788	Rock Creek/Ravensdale-Retreat	Habitat Protection	Years 1 and 3
00-1841	Metzler Park Side Channel Acquisition	Habitat Protection	Years 1 and 3
01-1353	Logging Camp Canyon – Phase 1	Habitat Protection	Years 1 and 3
02-1485	Chimacum Creek Estuary Riparian Acquisition	Habitat Protection	Years 1 and 3
02-1535	Weyco Mashel Shoreline Acquisition	Habitat Protection	Years 1 and 3
02-1592	Curley Creek Estuary Acquisition	Habitat Protection	Years 1 and 3
02-1622	Issaquah Cr Log Cabin Reach Acquisition	Habitat Protection	Years 1 and 3
02-1650	Methow Critical Riparian Habitat Acquisition	Habitat Protection	Years 1 and 3

The decision criteria were based on the objectives established for each monitoring category and were comprised of two components: 1) decision criteria that are specific to the monitoring category and the type of project design; and 2) an evaluation of the percentage change in the mean difference between impact reaches and control reaches for each indicator in a category. Decision criteria for each indicator were defined in Chapter 4.0.

The following equation was used to determine the percent mean difference (percentage change) for each indicator in all monitoring categories with a BACI sample design:

$$\left(\frac{\text{Mean Difference in Current Year - Mean Difference in Baseline Year}}{\text{Mean Difference in Baseline Year}}\right)\times 100$$

The following equation was used to determine the percent effective for diversion screening design in each year for the Diversion Screening category:

$$\left(\frac{\text{\# of Parameters in Compliance}}{\text{Total Number of Parameters}}\right)\times 100$$

The following equation was used to determine the percent change in the mean between years for each indicator in the Habitat Protection category:

$$\left(\frac{\text{Mean Year 3} - \text{Mean Year 0}}{\text{Mean Year 0}}\right)\times 100$$

5.1.2 Statistical Analysis

Statistical analyses used for data collected following a BACI sample design include the paired *t*-test, the Wilcoxon paired-sample test, and the Normal Approximation for the Wilcoxon paired sample test. The decision to utilize one of the statistical tests versus another was made based on whether or not the data were normally distributed, and the current sample size. When using these tests, each year of post-implementation data (e.g., Years 1, 2, or 3) were compared to the baseline year of data. All tests used an alpha of 0.10.

The first step in the analysis process was to determine if the distribution of differences between each year of post-implementation data and the baseline year for each indicator was normal, as required by the paired *t*-test. In cases where the differences departed substantially from a normal distribution, the Wilcoxon paired-sample test (a non-parametric test), was used to compare the differences. Table 5-2 identifies the indicators that were compared for each monitoring category.

Data collected for Habitat Protection projects follows a before after (BA) study design, and as such, the two-sided *t*-test was used to determine if there was a significant change for the group of projects from the baseline year to Year 3 for each indictor. An alpha of 0.10 was used for the *t*-test.

In addition to performing the appropriate statistical test for each indictor, a power analysis was performed to determine how many samples would need to be collected to detect the current mean difference with 80 percent power.

Table 5-2. Indicators Tested for Each Monitoring Category

Monitoring Category	Indicators Tested
Fish Passage Projects	• Juvenile fish density by species • Number of spawners per kilometer or redds per kilometer by species
In-stream Habitat Projects	• Mean thalweg residual pool vertical profile area • Mean residual depth • Juvenile fish density by species • Log_{10} volume of large woody debris
Riparian Planting Projects	• Linear proportion of actively eroding banks • Mean canopy density along the banks • Proportion of the reach with three-layer riparian vegetation
Livestock Exclusion Projects	• Linear proportion of actively eroding banks • Mean canopy density along the banks • Proportion of the reach with three-layer riparian vegetation
Channel Connectivity Projects	• Juvenile fish density by species • Mean thalweg residual pool vertical profile area • Mean residual depth • Mean canopy density along the banks • Proportion of the reach with three-layer riparian vegetation
Habitat Protection	• Mean thalweg residual pool vertical profile area • Mean residual depth • Log_{10} volume of large woody debris • Proportion of the reach with three-layer riparian vegetation • Mean canopy density along the banks • Linear proportion of actively eroding banks • Percent fines • Percent embeddedness • Conifer basal area and stem count • Deciduous basal area and stem count • Non-native herbaceous plants • Non-native shrubs • Fish Assemblage Index • Macroinvertebrate Metric Index

5.2 ANALYSIS RESULTS AND EVALUATION

The evaluation of effectiveness for each monitoring category consists of the results of the statistical test, and decision criteria related to both the function of the project, and whether a change greater than 20 percent in the mean difference between d_0 and d_1 was observed. The following were the null and alternative hypotheses for each positive indicator in a category that followed the BACI study design:

H_0: The mean difference between Baseline Year (d_0) and Current Year (d_1) ≤ 0
H_A: The mean difference between Baseline Year (d_0) and Current Year (d_1) > 0

Bank erosion is a negative indicator, meaning, that the goal is to reduce the value. For the linear proportion of actively eroding banks the following hypothesis is used:

H_0: The mean difference between Baseline Year (d_0) and Current Year (d_1) ≥ 0
H_A: The mean difference between Baseline Year (d_0) and Current Year (d_1) < 0

The following were the null and alternative hypotheses under the *t*-test for the Habitat Protection category that followed the BA study design:

H_0: There is no mean difference between Baseline Year (d_0) and Current Year (d_1): $\mu = 0$
H_A: There is a mean difference between Baseline Year (d_0) and Current Year (d_1): $\mu \neq 0$

For subsequent years of data collection, Year 2 and Year 3 (d_2 and d_3) were compared to the baseline difference for each test.

5.2.1 Fish Passage Project Results

Data from nine Fish Passage Projects were included in the analyses for juvenile fish densities for Year 0 versus Year 1, and eight were included in the analyses for Year 0 versus Year 2; however, for the analyses of spawners and redds, projects were segregated by target species. Tables 5-3 and 5-4 show the sample size used in the analysis for each year, results from the statistical analysis, and the sample size necessary to detect the current mean difference with 80 percent power. At present, with the current sample size, as determined by the selection of target species for spawners and redds, the Fish Passage Projects monitored in this program do not currently show a significant increase for any of the indicators. However, with the exception of Chinook adults in Table 5-3, and Chinook adults and Chinook redds in Table 5-4, these projects have resulted in an increase of more than 20 percent over baseline, indicating a biologically meaningful improvement as determined by the success criteria in the protocols.

Table 5-3. Summary of Results for Fish Passage Projects Year 0 versus Year 1

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Chum Adults (fish/km)	2	NO	1351.94	102%	11
Chum Redds (redds/km)	2	NO	113.65	90%	13
Chinook Adults (fish/km)	5	NO	-32.15	-67%	22
Chinook Redds (redds/km)	5	NO	3.52	43%	63
Coho Adults (fish/km)	5	NO	43.76	164%	13
Coho Redds (redds/km)	5	NO	14.29	107%	20
Chinook Juveniles (fish/m^2)	9	NO	0.0065	280%	27
Coho Juveniles (fish/m^2)	9	NO	0.0274	218%	20
Steelhead Parr (fish/m^2)	9	NO	0.0356	61%	105

In Table 5-4, chum adults and redds are not presented because only one project where chum were present had been monitored in Year 2. All other species that were reported on in Table 5-3 are reported on in Table 5-4.

Table 5-4. Summary of Results for Fish Passage Projects Year 0 versus Year 2

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Chinook Adults (fish/km)	5	NO	-49.68	-103%	20
Chinook Redds (redds/km)	5	NO	-5.96	-72%	124
Coho Adults (fish/km)	5	NO	11.67	78%	13
Coho Redds (redds/km)	5	NO	18.34	110%	19
Chinook Juveniles (fish/m^2)	8	NO	0.0023	88%	51
Coho Juveniles (fish/m^2)	8	NO	0.0102	87%	195
Steelhead Parr (fish/m^2)	8	NO	0.0683	105%	27

Based on the data collected for each of the individual projects and the mean change for the Fish Passage Projects as a group, there is a decreasing trend in adult Chinook, increasing trend in adult coho, increasing trend in coho redds, and increasing trend in juvenile steelhead upstream of the barrier (Figures 5-1 through 5-4). For all other indicators the trend may remain neutral until either the progeny return or utilization of the upstream habitat changes.

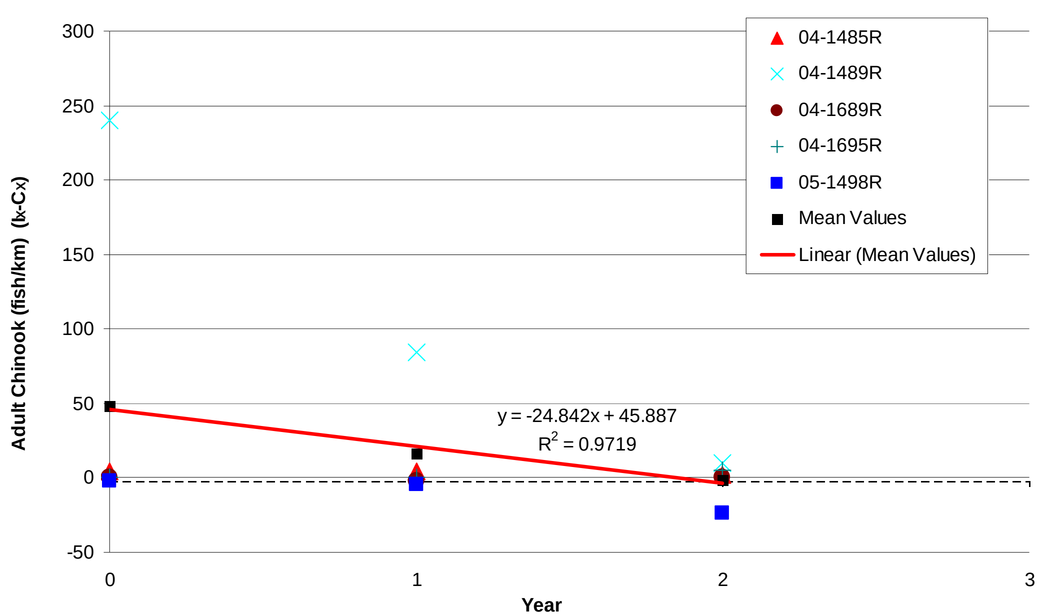


Figure 5-1. Decreasing Trend in Adult Chinook Salmon Upstream of the Barrier Over Each Monitoring Year

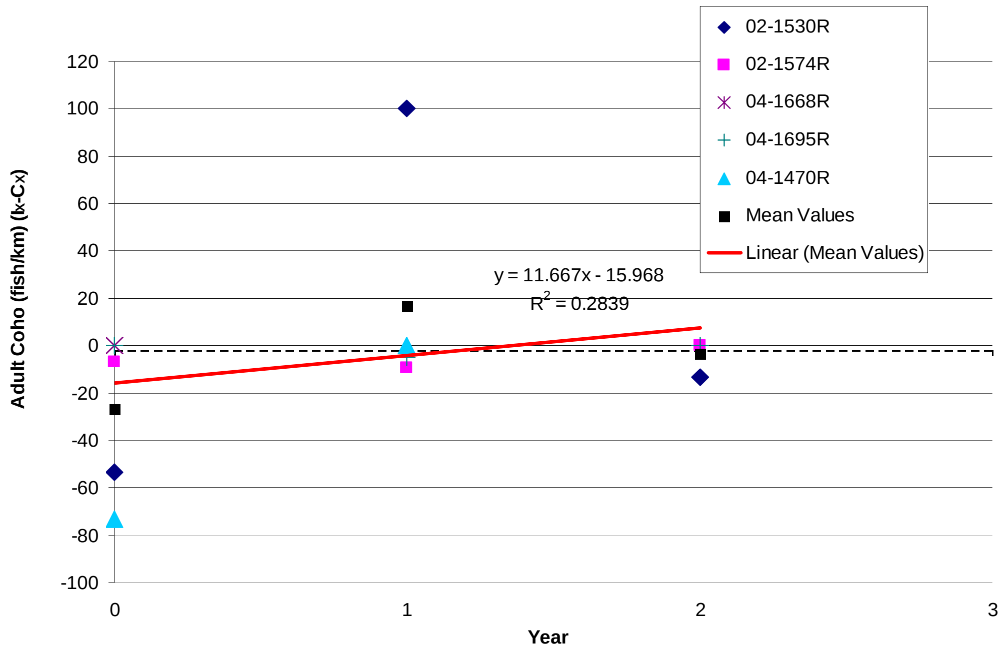


Figure 5-2. Increasing Trend in Adult Coho Salmon Upstream of the Barrier Over Each Monitoring Year

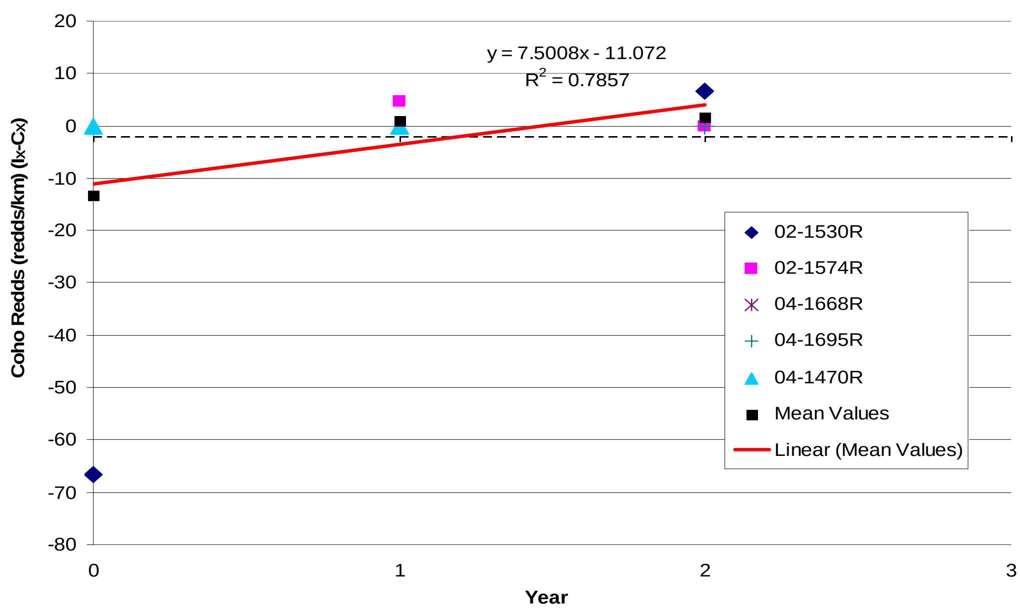


Figure 5-3. Increasing Trend in Coho Redds Upstream of the Barrier Over Each Monitoring Year

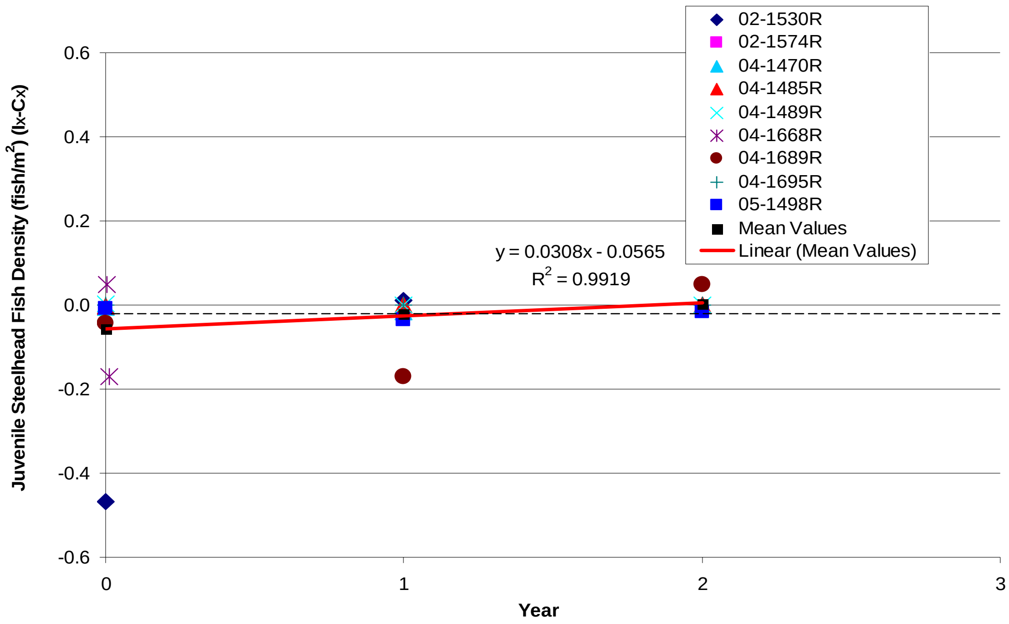


Figure 5-4. Increasing Trend in Steelhead Parr Upstream of the Barrier Over Each Monitoring Year.

For the adult and redd variables analyzed, analyses were hampered by the small sample size (n = 5), due to the need to segregate projects by target (and presence of) species. To provide greater strength in the analyses, a larger number of projects where each of the species is known to be present would need to be sampled. In general, after reviewing the results in Tables 5-3 and 5-4, a sample size of around 25 projects would increase the ability to detect the current mean difference with 80 percent power. Very small numbers of fish counted for some projects, combined with zero values for other projects, result in non-significant findings and require large sample sizes to detect a change. When return timing for each species (e.g. four to six years for Chinook salmon) is compared with the frequency of sampling for the category (Years 0, 1, 2, and 5), the ability to detect project-caused changes in the relative abundance of adult salmon is difficult to statistically evaluate as the monitoring period is equal to or less than one generation time. However, as the question pertaining to adult salmon and spawning is one related to access to habitat upstream of the barrier and not an increase in abundance, future evaluations may be more appropriately focused on whether there were any adult fish upstream of the barrier rather than statistical evaluation (i.e., did any adult fish go upstream of the barrier and spawn in all years after project implementation?) and if the decision criteria related to passage design continued to be met in future years (i.e., are the fish passage design criteria being met?). Using this approach, eight out nine projects (88 percent) show that spawners and redds were detected upstream of the barrier, which meets the success criteria of 80 percent of projects as established in the protocols.

Although the sample sizes for juvenile fish are greater than the sample sizes for the adults and redds, these are smaller than the sample size of approximately 25 that would increase the ability to detect the current mean difference with 80 percent power. In addition, for steelhead parr in Year 0 versus Year 1, and Chinook juveniles and coho juveniles in Year 0 versus Year 2, sample sizes of 105, 51, and 195, respectively, are necessary. However, in the alternate years for each of these cases, the necessary sample size is closer to 20 (27, 27, and 20 for steelhead, Chinook, and coho juveniles, respectively). This large range in the sample size is due to the presence of zero results in some data sets; projects where specific juvenile species have never been observed result in zero values included in the analysis (i.e., the species may not utilize this area of the drainage); and/or the timing of habitat utilization for each species versus surveying timing (i.e., when juvenile salmonids are actually in a drainage versus survey timing in Year 0, 1, 2, and 5). As an example, for west side projects, densities of Chinook salmon juveniles have been an order of magnitude lower than those detected for coho and steelhead. Fish surveys are conducted at low water during the summer to allow for the greatest water clarity and for surveyor safety, however, Chinook are more likely to be using rearing habitat on the west side during the spring, and may not be present during the survey.

As with adult fish, because the monitoring question for Fish Passage Projects is focused on fish accessing the available habitat upstream of the barrier, future evaluations may more appropriately assess the presence of juvenile fish upstream of the barrier and if the decision criteria related to passage design continue to be met in future years. Using this approach, for juvenile fish, eight of nine projects showed that juvenile fish were detected upstream of the barrier, indicating that 88 percent of the projects were effective at allowing juvenile fish passage by Year 3. This approach could be paired with information on the length and quality of habitat upstream of the barrier to determine the habitat value of increasing passage.

Regarding passage design criteria, of the nine Fish Passage Projects included in the analyses, all of them met the passage design criteria in Year 1. As a result, 100 percent of the projects evaluated in this category were considered to be fish passable, thus exceeding the 80 percent criteria. Similarly, of the eight Fish Passage Projects included in the analyses for Year 2, all of them met the passage design criteria. As a result, 100 percent of the projects evaluated in this category were considered to be fish passable, thus exceeding the 80 percent criteria.

5.2.2 In-Stream Habitat Project Results

Eight In-Stream Habitat Projects were analyzed in Year 0 versus Year 1, and five were analyzed in Year 0 versus Year 3 for all indicators identified in Table 5-2. Tables 5-5 and 5-6 show the sample size used in the analysis for each year, results from the statistical analysis, and the sample size necessary to detect the current mean difference with 80 percent power. In-Stream Habitat Projects monitored in this program are currently shown to be effective at increasing mean vertical pool profile area, mean residual depth, and the volume of wood present. In addition, the change over baseline for all three of these indicators is greater than 20 percent in both Year 1 and Year 3. No indicators showed significant change for the project category.

Table 5-5. Summary of Results for In-Stream Habitat Projects Year 0 versus Year 1

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Mean Vertical Pool Profile Area (m^2)	8	YES	27.79	859%	9
Mean Residual Depth (cm)	8	YES	6.08	582%	12
Log10 Volume of Wood (m^3)	8	YES	1.03	332%	4
Chinook Juvenile (fish/m^2)	8	NO	-0.0004	-28%	3083
Coho Juvenile (fish/m^2)	8	NO	-0.0259	-50%	198
Steelhead Parr (fish/m^2)	8	NO	0.0047	67%	491

Table 5-6. Summary of Results for In-Stream Habitat Projects Year 0 versus Year 3

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Mean Vertical Pool Profile Area (m^2)	5	YES	33.28	807%	5
Mean Residual Depth (cm)	5	YES	10.12	1020%	4
Log10 Volume of Wood (m^3)	5	YES	0.80	421%	5
Chinook Juvenile (fish/m^2)	5	NO	-0.0019	-101%	23
Coho Juvenile (fish/m^2)	5	NO	-0.0882	-99%	21
Steelhead Parr (fish/m^2)	5	NO	-0.0259	-207%	14

Although mean vertical pool profile area and mean residual depth were found to significantly increase from Year 0 to Year 1, the result of the sample size calculations for these indicators demonstrates that a sample size of 9 and 12, respectively, are needed to detect the current mean difference with 80 percent power. This suggests that although a significant difference was found, the test has less than 80 percent power to correctly detect the mean difference. However, if the alternative hypothesis is really true (i.e., the mean difference in Year 0 is less than Year 1), there is still a positive probability of being able to detect this effect, even with the current sample size of eight. In other words, the sample size calculations are "what-if" scenarios and do not specify a specific sample size required in order to find a significant effect. Instead, the calculation only estimates the sample size that will have an 80 percent probability of detecting a significant effect. Essentially, the sample size calculations are only estimates, and in this case, the estimates were off-target.

Further supporting this determination is the significant result for these indicators for Year 0 versus Year 3. Because these two indicators are related between years, it would be expected that in Years 1 and 3 the values would increase, as is the case here. Therefore, based on the information available from comparing Year 0 versus Year 1 (Table 5-5) and Year 0 versus Year 3 (Table 5-6), as well as results documented in numerous studies (see Roni 2005 and James 2007 for thorough reviews), it can be concluded that In-Stream Habitat Projects are effective at increasing pool depth in the first years after project implementation.

Based on the data collected for each of the individual In-Stream Habitat projects and the mean change as a group, there is an increasing trend in mean vertical pool profile area, mean residual depth, and the volume of wood present, and a decreasing trend in Chinook, coho, and steelhead parr. Figures 5-5 and 5-6 illustrate the increasing and decreasing trends typical of each of these indicators.

Results from the statistical analyses show that In-Stream Habitat Projects are effective at increasing mean vertical pool profile area, mean residual depth, and the volume of wood present in the first years after project implementation. Future monitoring of these projects will assist in determining if differences in these indicators remain over time. The completion of at least two more projects in this monitoring category and additional years of monitoring will further assist in validating the results for mean vertical pool profile area, mean residual depth, and the volume of wood present.

Reported in Tables 5-5 and 5-6, Chinook and coho juveniles densities decreased in all years. However, steelhead parr increased from Year 0 to Year 1, and decreased from Year 0 to Year 3. Although coho juveniles have been shown to respond positively to increases in pools and wood (Roni and Quinn 2001), the decreasing trend for coho, Chinook, and steelhead parr for these In-Stream Habitat Projects is likely attributed to sample timing, zero results in the data, and combining of multiple project objectives into a single categorical analysis.

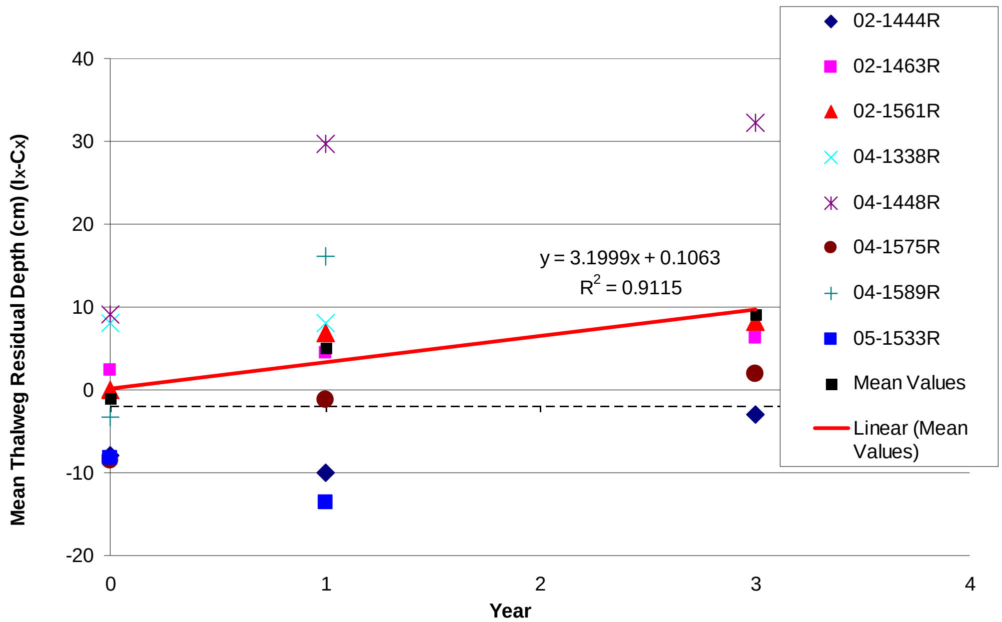


Figure 5-5. Increasing Trend in Mean Thalweg Residual Depth Over Each Monitoring Year

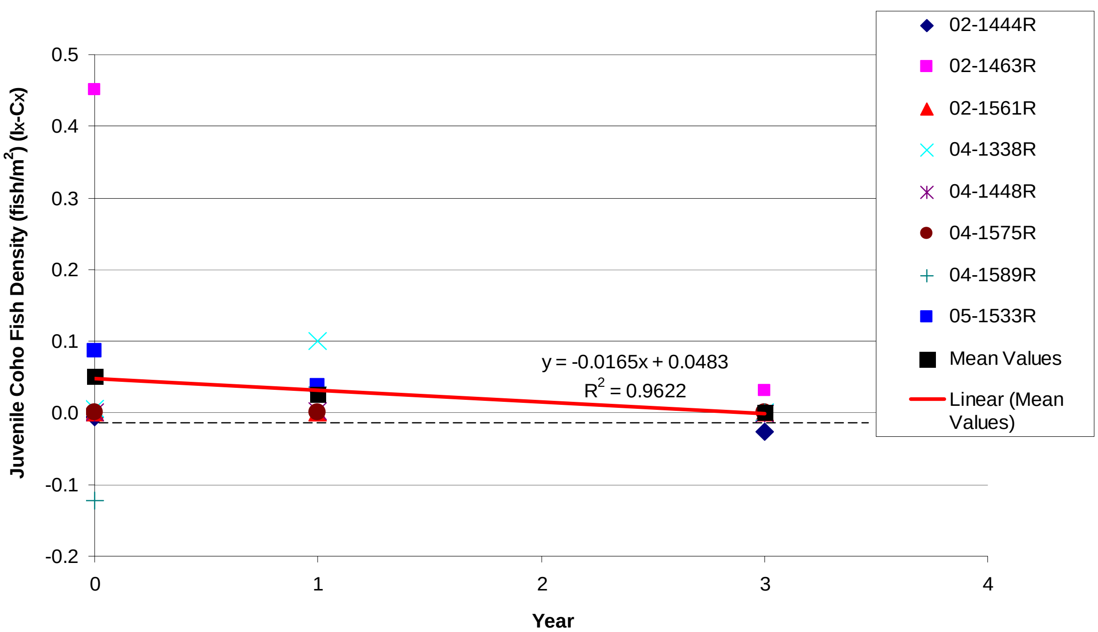


Figure 5-6. Decreasing Trend in Coho Juvenile Density Over Each Monitoring Year.

Juvenile fish sampling for In-Stream Structure Projects occurs once during the summer in Years 0, 1, 3, 5, and 10 and this frequency affects the observed juvenile densities. As described for Fish Passage Projects, use by Chinook juveniles may often occur in the spring, rather than the summer. In addition, each of the In-Stream Habitat Projects has different target species. This results in zero values for species that were not observed during the survey, indicating that there is too much inherent variability.

Adding to these confounding factors in the analysis are the differences between the types of In-Stream Habitat Projects. Specifically, the eight projects included in the analysis for Year 0 versus Year 1 are comprised of projects targeted for different species, which are intended to perform different functions (e.g., aggrading the channel versus localized pool formation), and constructed of varying materials and activities (e.g., wood, boulders, pool construction by machinery, development of pool-riffle sequences, etc.). Last, and most important, each of the projects included in this category are located in different geographic, geomorphic, and hyrologic settings. Although increasing the spatial distribution of the sample size likely increases the robustness of the study design, including projects comprised of such varying geographic, geologic, and hydrologic characteristics likely confounds interpretation of the results.

To adequately detect increases in fish density due to In-Stream Habitat Projects, it is likely more appropriate to segregate the projects in this monitoring category based on some basic groupings such as similarities in geography, geology, hydrology, project type, and target fish species. Although this will greatly increase the number of projects needed to be sampled within this monitoring category as a whole (around 30 would likely be adequate (Roni 2001)), it would assist in adequately addressing the question of increases in fish density due to In-Stream Habitat Projects. Over time, if the current sample size is maintained and not segregated, the current trend for coho, Chinook, and steelhead parr will likely either continue to decrease or be maintained over time primarily due to the confounding information obtained from surveying these In-Stream Habitat Projects.

Regarding the decision criteria outlined in Chapter 4.0 for In-Stream Habitat Projects, eight projects have Year 1 and Year 3 data collected. Of the 261 Artificial Instream Structures (AIS) placed at those project sites, 228, or 85.5 percent, of the AIS have remained within the impact reaches as of Year 3. As a result, the In-Stream Habitat Projects currently exceed the 50 percent criteria for AIS remaining in place.

5.2.3 Riparian Planting Project Results

Eight projects were included in the analyses for Riparian Planting Projects for Year 0 versus Year 1, and seven projects for Year 0 versus Year 3 (see Tables 5-7 and 5-8). Between Year 0 and Year 1, Riparian Planting Projects were effective at increasing the proportion of the reach with three-layers of vegetation. In addition, the change over the baseline for this indicator was greater than 20 percent in Year 1. All other indicators for this project category did not show a significant change between Year 0 and Year 1 or Year 0 and Year 3. These projects will require additional years of monitoring to show significant change in the indicators tested.

Although the proportion of the reach with three-layers of vegetation showed a significant increase from Year 0 to Year 1, the result of the sample size calculation for this indicator demonstrates that a sample size of 17 is needed to detect the current mean difference with 80 percent power. This suggests that although a significant difference was found, the test has less than 80 percent power to detect the current mean difference. However, if the alternative hypothesis is really true (i.e., the mean difference in Year 0 is less than Year 1), there is still a positive probability of being able to detect this effect, even with the current sample size of eight.

Table 5-7. Summary of Results for Riparian Planting Projects Year 0 versus Year 1

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Linear Proportion of Actively Eroding Banks (%)	8	NO	-2	-22%	306
Riparian Vegetation Structure (%)	8	YES	14.68	40%	16
Mean Canopy Density (1-17)	8	NO	-1.20	-40%	87

Table 5-8. Summary of Results for Riparian Planting Projects Year 0 versus Year 3

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Linear Proportion of Actively Eroding Banks (%)	6	NO	5	58%	52
Riparian Vegetation Structure (%)	6	NO	3.77	12%	145
Mean Canopy Density (1-17)	6	NO	-1.19	-35%	45

For all of the indicators in this monitoring category, a larger number of projects would be needed to detect the current mean difference with 80 percent power (see Tables 5-7 and 5-8). The necessity of the larger sample size is likely due to the varied and relatively slow rate at which plant growth occurs, and thus, the ability to detect change with the current sample size after only the first few years of project implementation is limited. In addition, many of the plantings at each of the sites are not located directly along the stream banks, but instead in the floodplain. Therefore, these plantings have little effect in the short term on indicators such as stream canopy cover, but over time will likely have a greater effect on the riparian cover and stream bank conditions.

Reviewing the linear proportion of actively eroding banks in Tables 5-7 and 5-8 demonstrates that between Year 0 and Year 1 mean bank erosion decreased, and between Year 0 and Year 3 the mean bank erosion increased. It is assumed that over time, as vegetation becomes established along the banks the trend for this indicator should be declining. In contrast, the current trend for the linear proportion of actively eroding banks is increasing (Figure 5-7). This suggests that the projects in this monitoring category currently have little to no effect on the bank conditions, as the mean at first decreased and then increased in spite of presumed plant growth. As stated above, many of the plantings at each of the sites are not located directly along the stream banks, and therefore only over a longer period of time will the analysis be adequate to evaluate the relationship between plantings and this indicator.

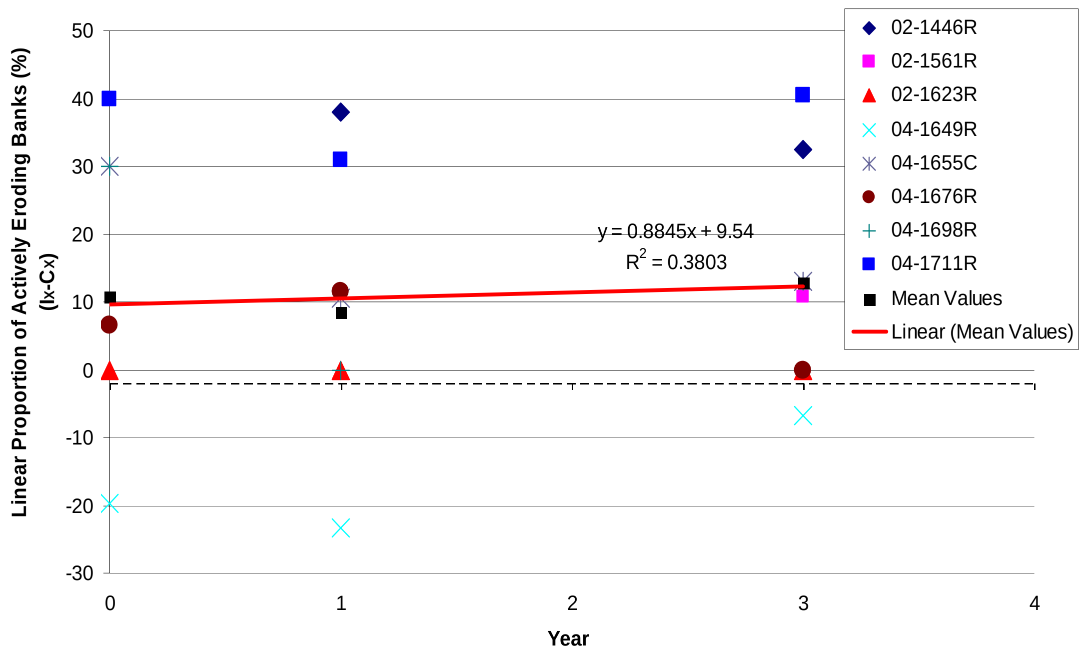


Figure 5-7. Increasing Trend in Bank Erosion Over Each Monitoring Year

Although the mean difference for riparian vegetation structure increased significantly between Year 0 and Year 1, it was not significant for Year 0 versus Year 3. The trend, however, for the proportion of the reach with three-layers of riparian vegetation is generally increasing (Figure 5-8). Over time, as the plantings become established and mature, it is expected that this indicator will continue to increase.

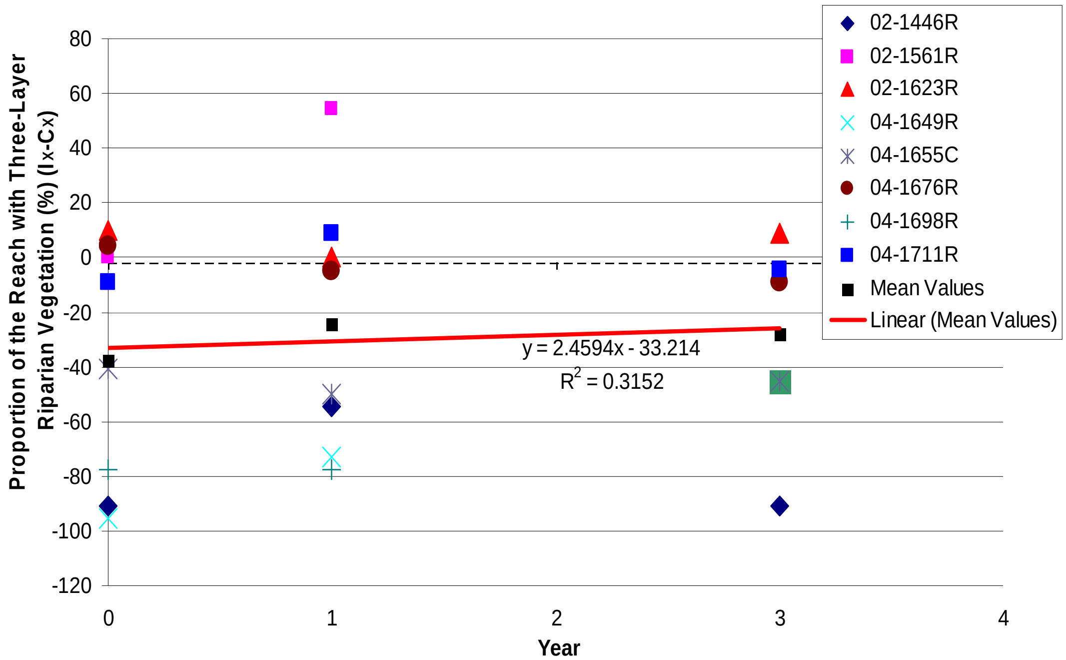


Figure 5-8. Increasing Trend in the Proportion of the Reach with Three-Layer Riparian Vegetation Over Each Monitoring Year

For the mean canopy density along the banks the trend is currently decreasing. If it is assumed that over time the proportion of the reach with three-layers of riparian vegetation will increase, the mean canopy density along the banks will likely trend in the positive direction lagging slightly behind this riparian vegetation indicator. This lag time can be attributed to the time needed for the riparian vegetation to mature to the mid- to upper-canopy levels in order to have a greater effect on the canopy cover along the banks.

Over time, as the plantings mature and the vegetation becomes established, the linear proportion of actively eroding banks will likely decrease and the proportion of the reach with three-layers of riparian vegetation and mean canopy density along the banks will likely increase. The results of the current analysis for Year 0 versus Year 1 (Table 5-7) and Year 0 versus Year 3 (Table 5-8) only display a short-term picture for these types of projects.

Regarding survival of riparian plantings (see Chapter 4.0 for decision criteria), the eight project sites sampled exceeded the average of 50 percent survival criteria. The average percent survival in Year 1 was 91.8 percent with a minimum of 61.8 and a maximum of 100 percent survival. Survival of planted species declined between Year 1 and Year 3. The seven project sites sampled in Year 3 showed an average survival of 70.8 percent, with a minimum value of 47.1 and a maximum value of 88.9 percent survival. Only one site did not reach the 50 percent survival criteria. The high mortality observed among the riparian plantings in this project were presumably due to herbicide drift from an adjacent property that caused high mortality in the riparian plantings at this site.

5.2.4 Livestock Exclusion Project Results

Twelve Livestock Exclusion Projects were included in the analyses between Year 0 and Year 1, including seven projects funded through the OWEB as part of the Coordinated Monitoring Program for Livestock Exclusions. Table 5-9 shows the results for those indicators that show significant change for Year 0 versus Year 1. Livestock Exclusion Projects included in this program were effective at significantly reducing bank erosion. In addition, this reduction is more than 20 percent of the baseline.

Two Livestock Exclusion Projects were included in the analyses between Year 0 and Year 3 (Table 5-10). As Year 3 data has only been collected for 2 of the 12 projects included in the Year 0 versus Year 3 analyses, the sample size is currently not large enough to detect any significant differences.

Table 5-9. Summary of Results for Livestock Exclusion Projects Year 0 versus Year 1

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Linear Proportion of Actively Eroding Banks (%)	12	YES	-23	-169%	12
Riparian Vegetation Structure (%)	12	NO	-1.9	-9.3%	64
Mean Canopy Density (1-17)	12	NO	-0.41	-15%	330

Table 5-10. Summary of Results for Livestock Exclusion Projects Year 0 versus Year 3

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Linear Proportion of Actively Eroding Banks (%)	2	NO	-8	-53%	13
Riparian Vegetation Structure (%)	2	NO	-2.3	-11.2%	10
Mean Canopy Density (1-17)	2	NO	-0.52	-9%	14

Based on the results from the sample size calculations, a larger number of projects are necessary to detect the current mean difference with 80 percent power for all indicators in all years except the linear proportion of actively eroding banks where there was a significant decrease between Year 0 and Year 1 (Tables 5-9 and 5-10). To detect a significant decrease for bank erosion over time, the current sample size of 12 is likely adequate, although additional analyses with Year 3 data will provide further guidance. For the other two indicators, a larger number of projects (64 for riparian vegetation structure and 330 for mean canopy density along the banks) are needed. This large number of samples needed to detect the current mean difference with 80 percent power is likely due to the variability in growth rate of vegetation following the exclusion of cattle from a project reach. In addition, the variability described in Chapter 4.0 related to the sampling efforts for these indicators likely affects the ability to detect change over time. Therefore, due to this variability, a larger sample size is necessary to detect the small amount of change in the mean. More years of data collection at these 12 sites will also help clarify potential trends in these indicators.

As previously noted, there was a significant decrease in the linear proportion of actively eroding banks between Year 0 and Year 1 (after the livestock had been excluded). Although there was not a significant decrease between Year 0 and Year 3, due to the small sample size (n = 2 currently for Year 3), the general trend is decreasing (Figure 5-9) and, over time, the amount of bank erosion is expected to continue to decrease.

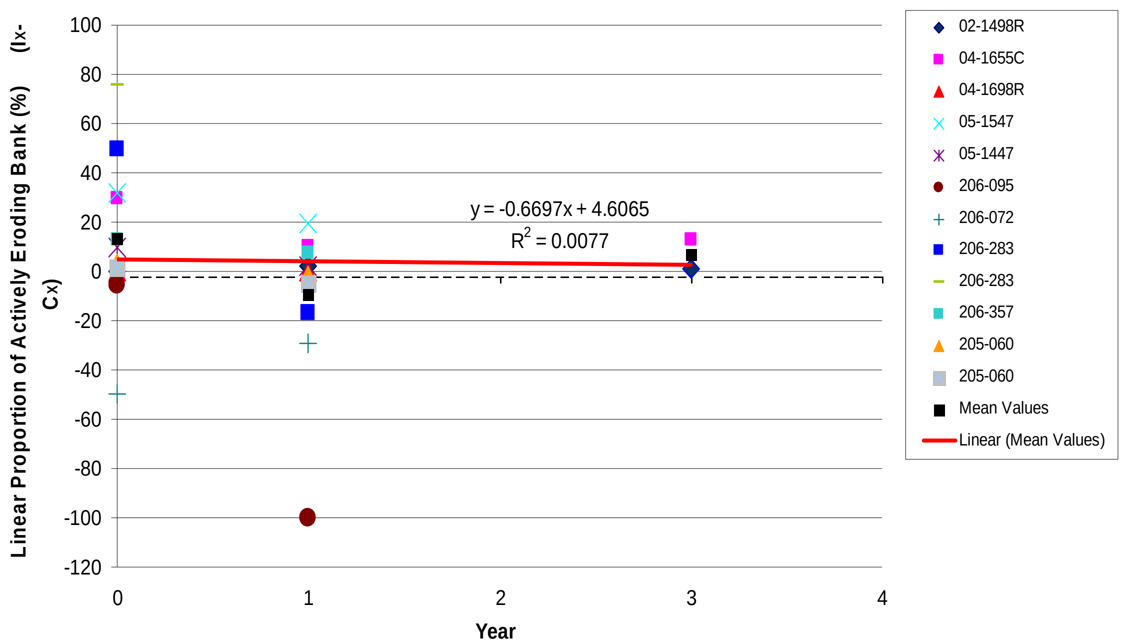


Figure 5-9. Decreasing Trend in Bank Erosion Over Each Monitoring Year

Figure 5-10 demonstrates the decreasing trend for the proportion of the reach with three-layer riparian vegetation. Similar to this indicator, the mean canopy density along the banks has generally decreased from Year 0 to Year 3. However, as there were only two Livestock Exclusion Projects monitored in 2008 for Year 3 data, these trends are inconclusive. For these two indicators, a greater sample size is necessary to understand the general trends. Over time, as livestock continue to be excluded, it is expected that vegetation will become established along the banks and there will be a positive trend for these indicators.

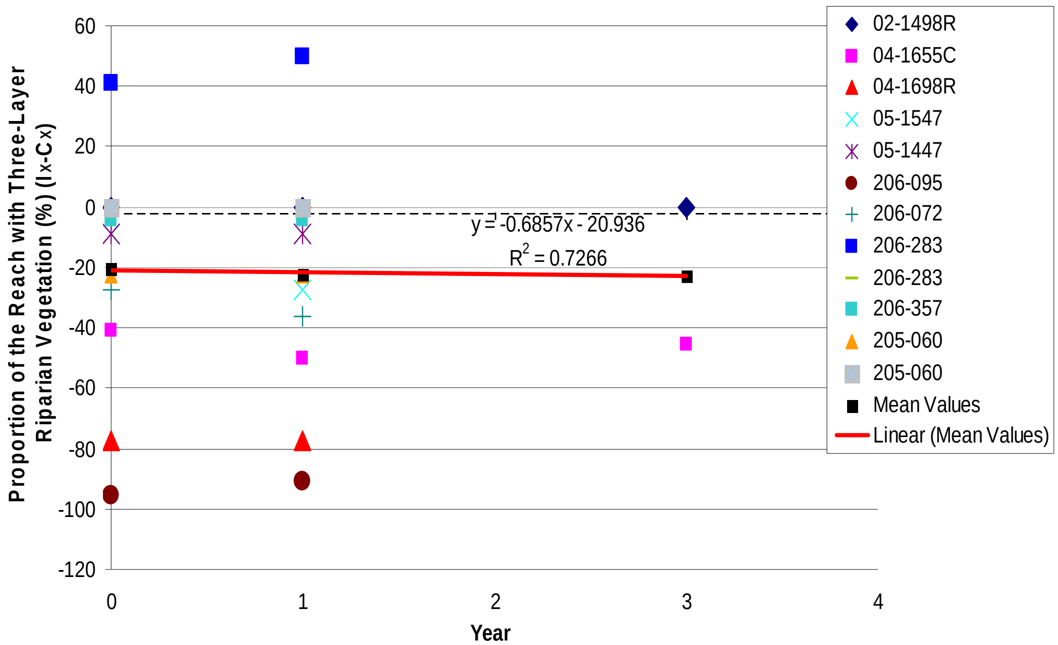


Figure 5-10. Decreasing Trend in the Proportion of the Reach with Three-Layer Riparian Vegetation Over Each Monitoring Year

Of the 12 projects included in the analysis for Year 1, 10 are considered functioning, as they meet the functional exclusion criteria. With 83.3 percent of the projects evaluated as functional, the Livestock Exclusion Projects, as a category, exceed the 80 percent success criteria for Year 1.

Of the two projects included in the analysis for Year 3, both of the projects are considered functioning and therefore exceed the 80 percent success criteria for Year 3.

5.2.5 Channel Connectivity Project Results

Four projects were included in the analyses between Year 0 and Year 1, and Year 0 and Year 2, for Channel Connectivity Projects. Tables 5-11 and 5-12 show the results from indicators where significant differences were detected. Channel Connectivity Projects monitored as a part of this program were effective at significantly increasing mean vertical pool profile area and mean residual depth between Year 0 and Year 1, and mean residual depth between Year 0 and Year 2. For both of these indicators, the percentage increase over baseline was more than 20 percent in both years.

Table 5-11. Summary of Results for Channel Connectivity Projects Year 0 versus Year 1

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Mean Vertical Pool Profile Area (m^2)	4	YES	43.10	58%	4
Mean Residual Depth (cm)	4	YES	30.38	289%	4
Riparian Vegetation Structure (%)	4	NO	-2.25	-22%	2173
Mean Canopy Density (1-17)	4	NO	-4.19	-488%	18
Chinook Juvenile (fish/m^2)	4	NO	-0.0790	-94%	24
Coho Juvenile (fish/m^2)	4	NO	0.1351	1030%	15
Steelhead Parr (fish/m^2)	4	NO	0.0150	97%	18

Table 5-12. Summary of Results for Channel Connectivity Projects Year 0 versus Year 2

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Mean Vertical Pool Profile Area (m^2)	4	NO	47.52	64%	9
Mean Residual Depth (cm)	4	YES	30.24	288%	3
Riparian Vegetation Structure (%)	4	NO	-24.98	-244%	6
Mean Canopy Density (1-17)	4	NO	-3.23	-377%	35
Chinook Juvenile (fish/m^2)	4	NO	-0.0571	-68%	57
Coho Juvenile (fish/m^2)	4	NO	0.1237	942%	10
Steelhead Parr (fish/m^2)	4	NO	0.0109	71%	18

The sample size estimated to detect the current mean difference with 80 percent power for riparian vegetation structure and mean canopy density along the banks displays variability between years (Tables 5-9 and 5-10). This variability in the sample size is likely due to two factors: the excavation of the new side channel in some projects and, therefore, the removal of vegetation; and the variability in growth rate of vegetation following the excavation. In addition, the variability described in Chapter 4.0 related to the sampling efforts for these indicators likely affects the ability to detect change over time. Due to the variability expressed within the sample size calculation, these indicators may be more relevant to evaluate in future years, once the vegetation in the new channel has adequately established.

For juvenile fish species, sample size calculations suggest that around 20 projects would provide the ability to detect the current mean difference with 80 percent power; although Chinook juveniles likely require an even larger sample size to detect an effect. Similar to Fish Passage Projects and In-Stream Habitat Projects, the range in the predicted sample size for these indicators is likely due to the distribution of fish species across the projects.

Based on the data collected for each of the four Channel Connectivity Projects, and the mean change as a whole, there is a increasing trend in mean vertical pool profile area, mean residual depth, and coho juveniles, and a decreasing trend in Chinook juveniles (Figures 5-11 through 5-13). Although the general trend for steelhead parr is positive, this is due to no steelhead parr being observed in the impact reach and smaller numbers of steelhead parr observed in the control reach over time and, therefore, a result of subtracting fish density values in each control reach from each impact reach (Figure 5-14).

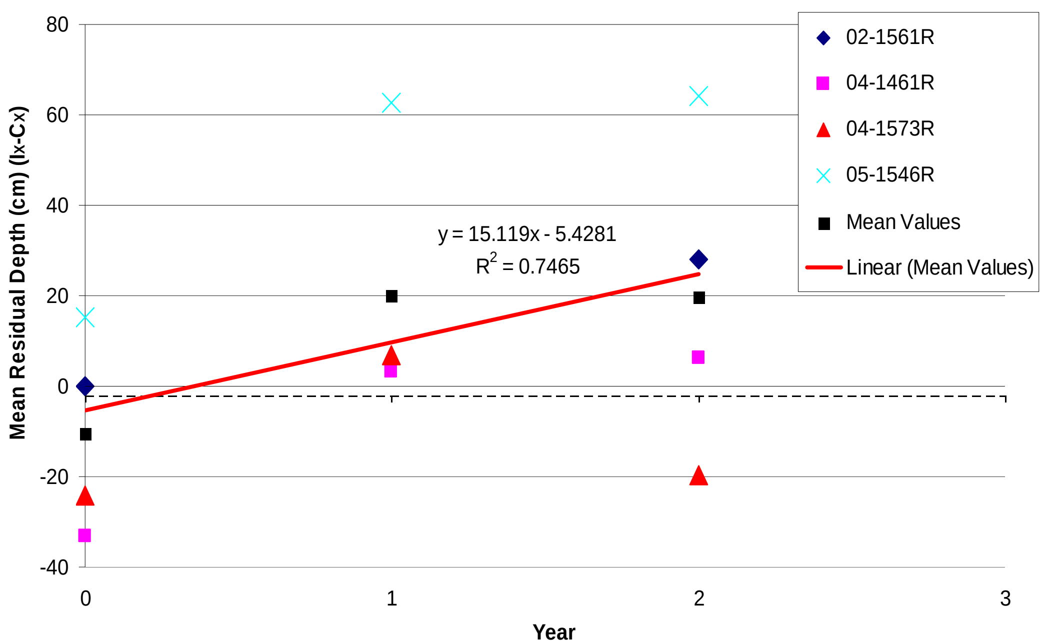


Figure 5-11. Increasing Trend in Mean Residual Depth Over Each Monitoring Year

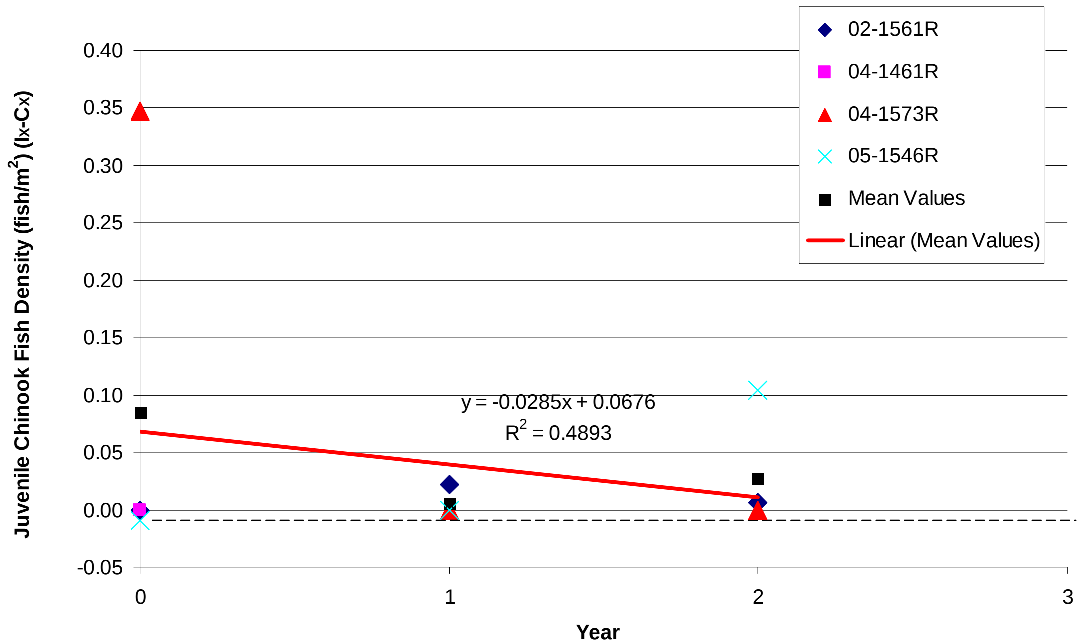


Figure 5-12. Decreasing Trend in Juvenile Chinook Over Each Monitoring Year

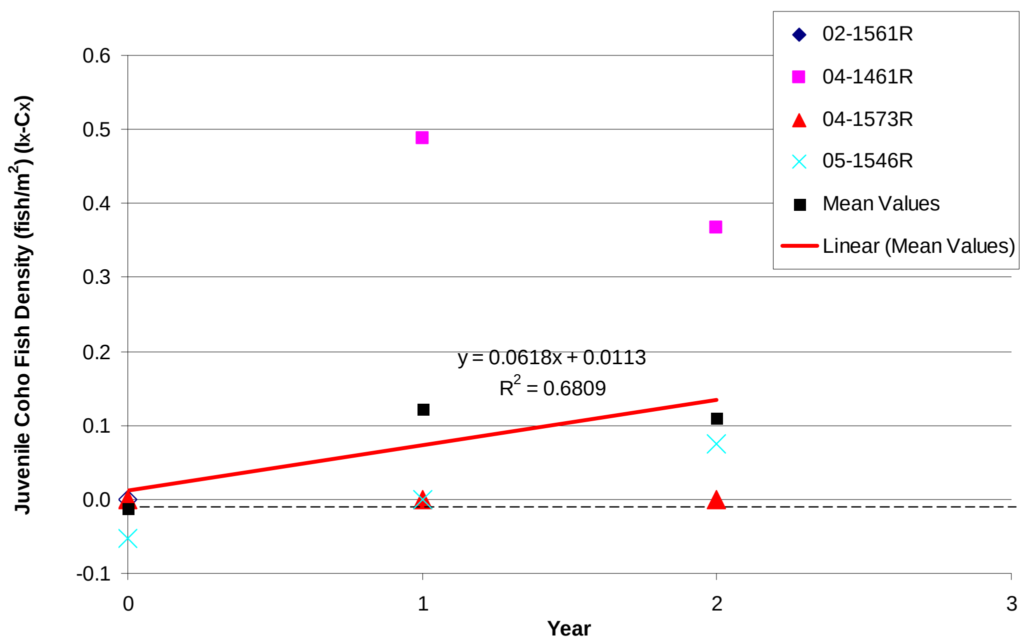


Figure 5-13. Increasing Trend in Juvenile Coho Over Each Monitoring Year

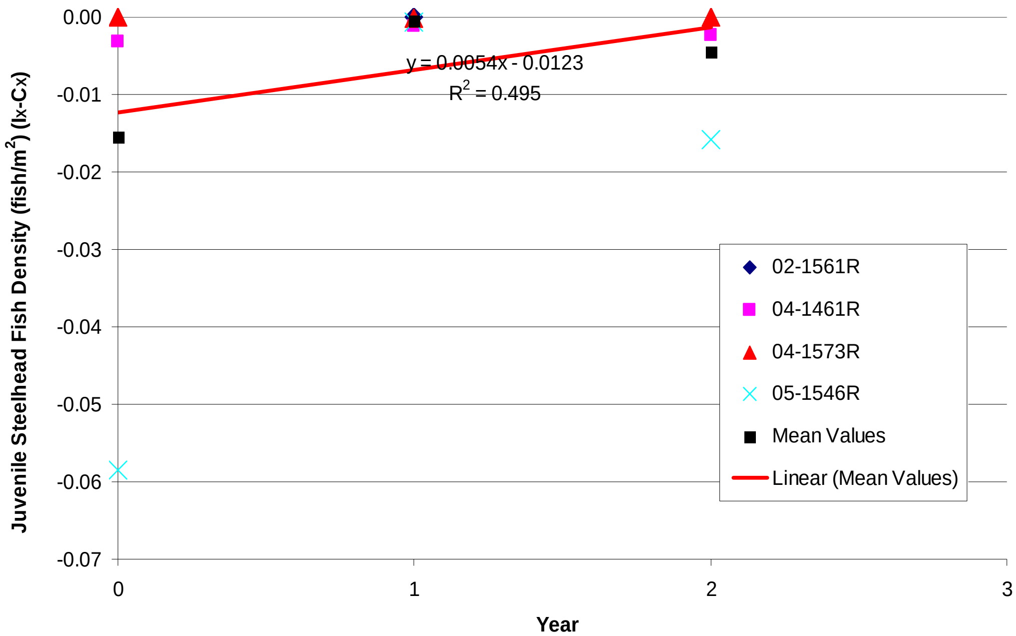


Figure 5-14. Juvenile Steelhead Decreasing Trend Towards No Fish Either in the Control or Impact Reach

Results from the statistical analyses demonstrate that Channel Connectivity Projects are effective at increasing mean vertical pool profile area and mean residual depth in the first years after project implementation. Future monitoring of these projects will assist in determining if differences in these indicators remain over time. Specifically, because these types of projects typically include the construction of side channels, if the design is not effective at maintaining the appropriate hydraulic gradient through the channel there is the potential for aggradation to occur and the channel to fill over time. Therefore, the addition of at least six more projects in this monitoring category, coupled with continued monitoring, will assist in validating the results for mean vertical pool profile area and mean residual depth.

Regarding the decision criteria for Channel Connectivity Projects, the channels remained connected to the streams at all four of the projects analyzed for channel connectivity in Year 1 and Year 2. With 100 percent of the projects remaining functional in Year 1 and Year 2, this category exceeds the decision criteria of 80 percent.

5.2.6 Diversion Screening Project Results

Seven Diversion Screening Projects were included in the evaluation for this monitoring category. The analysis for this category does not involve statistics and is based on a series of parameters that are measured and compared to standard NOAA Fisheries guidance. The decision criteria are based on the proportion of the parameters measured that are in compliance with the guidance. Using data from both monitoring years to date, Table 5-13 identifies the results for the diversion screening monitoring. In both years, the Diversion Screening Projects were in compliance with more than 80 percent of the parameters measured and were determined to be effective.

Table 5-13. Summary of Results for Diversion Screening Projects

Indicators	Year 1	Year 2
Total Number of Indicators in Compliance with NOAA Guidance	80	70
Total Number of Parameters Tested	89	79
Percent Effective	**89.89%**	**88.61%**

5.2.7 Habitat Protection Project Results

Nine Habitat Protection Projects were included in the analyses for the indicators identified in Table 5-2. However, for a number of the indicators, only seven projects were included in the analyses. This is because two of the Habitat Protection Projects are estuarine habitat and, therefore, have a different set of indicators than freshwater projects to establish effectiveness.

Each indicator included in an analysis was tested using a two-tailed *t*-test to determine if there was significant change from the baseline year to Year 3 or if the indicator was maintained. Results are shown in Table 5-14 for all indicators. Two upland vegetation indicators showed significant change between the baseline year and Year 3. Coniferous basal area increased significantly over this time frame and coniferous stems per acre decreased significantly. These two indicators are related in that if the size of the trees increase, the basal area will increase and the stems per acre will decrease due to competitive exclusion. All other indicators did not show significant change between the baseline year and Year 3.

Although coniferous stems per acre was found to significantly decrease, from Year 0 to Year 3, the result of the sample size calculations for this indicator demonstrates that a sample size of 15, respectively, are necessary to detect the current mean difference with 80 percent power. This suggests that although a significant difference was found, the test has less than 80 percent power to correctly detect the mean difference. The sample size calculation is only an estimate and in this case the estimate was off-target.

For all other indicators a much larger sample size is required to detect a difference between Year 0 and Year 3. For most of these indicators, additional years may be necessary to detect a change. In addition, these sites are spread across different geographic, geomorphic, and hydraulic regions of the state, which introduces high variability into the samples. Currently, 50 percent of the indictors have a negative mean change, however this change is not significant, and in most cases, is less than 50 percent of the baseline value. Change at these sites is expected to be slow (decades), and a longer time between sampling efforts is recommended. This suggests that in sampling in future years may provide more information than sampling these types of projects in the earlier years. Long-term trends are the best indicators of whether or not habitat protection efforts are adequate for maintaining high quality habitat.

Table 5-14. Summary of Results for Habitat Protection Projects

Indicator	Current Sample Size	Significant?	Mean Change	Percent Change	Sample Size Needed to Detect Significant Change
Mean Vertical Pool Profile Area (m^2)	7	NO	-12.81	-16%	102
Mean Residual Depth (cm)	7	NO	-2.22	-12%	146
Log10 Volume of Wood (m^3)	7	NO	-0.09	-13%	374
Riparian Vegetation Structure (%)	7	NO	4	38%	51
Mean Canopy Density (1-17)	7	NO	8.16	19%	35
Linear Proportion of Actively Eroding Banks (%)	7	NO	-0.08	-1%	2424
Percent fines (%)	7	NO	3.23	4%	82
Percent embeddedness (%)	7	NO	6	52%	43
Basal area of conifers per acre (square feet/acre)	9	YES	32.44	36%	8
Stem count of conifers per acre (number/acre)	9	YES	-21.33	-12%	15
Basal area of deciduous trees per acre (square feet/acre)	9	NO	9.26	11%	24
Stem count of deciduous trees per acre (number/acre)	9	NO	45.56	17%	249
Absolute percent cover of non-native herbaceous plants (%)	9	NO	-11.43	-37%	28
Relative percent cover of non-native herbaceous plants (%)	9	NO	-5.35	-24%	33
Absolute percent cover of non-native shrubs (%)	9	NO	-0.42	-23%	53
Relative percent cover of non-native shrubs (%)	9	NO	-0.03	-4%	1259
Fish Assemblage Index	7	NO	-1.57	-7%	5755
Macroinvertebrate Index	7	NO	1.43	-7%	356

5.3 SUMMARY

The projects in each monitoring category are assessed based on a set of response indicators that apply to each project type. Those response indicators are then evaluated at three levels; however, not all three levels apply to all project categories. Level 1 analysis evaluates the functional criteria of the project as compared to the engineered design. Level 2 analyses considers the effectiveness of the project in respect to habitat indicators. Fish response is captured in the Level 3 analyses. Table 5-15 summarizes the results of the 2008 analyses for each monitoring category.

The data analysis and evaluations conducted to date indicate that some monitoring categories are showing significant changes in the first one to three years after implementation. Conclusions by category include the following:

1. In-Stream Habitat Projects are significantly improving channel morphology by increasing mean vertical pool profile area and mean residual depth.
2. Livestock Exclusion Projects are effectively decreasing bank erosion.
3. Channel Connectivity Projects are significantly increasing mean vertical pool profile area, and mean residual depth. In all cases, the percentage increase in the indicator was more than 20 percent over baseline.

In addition, functional evaluations show the following conclusions:

1. Fish Passage structures remain functional.
2. Instream structure projects are retaining AIS.
3. Riparian plantings have over 50% plant survival.
4. Livestock exclusion projects remain functional.
5. In general off-channel habitats are maintaining connection with mainstream habitats.
6. Diversion Screening Projects have been determined to be effective for over 80 percent of parameters measured.

All of these indicators of effectiveness have been reached before the timeframes established in the objectives for each monitoring category. Additional years of monitoring these projects will assist in confirming project effectiveness.

For Fish Passage and Livestock Exclusion Projects, observed trends are likely to improve with the current sample size with future years of data collection. For Riparian Planting Projects and Habitat Protection Projects the current sample size monitored over the long-term is likely to show more clear trends in growth and recovery. For Channel Connectivity and Constrained Channel Projects, completion of projects within the current sample size will help to clarify trends. For Instream Structure Projects, additional projects are needed to better detect species responses to particular project approaches. This will be discussed further in section 7.3.

Table 5-15. Summary of Analysis Results

Project Category	Level 1 Functional Criteria	Level 2 Habitat Indicators	Level 3 Fish Response
Fish Passage	• 100% of the Fish Passage Projects monitored in Years 1 and 2 met the >80% design criteria and were rated as functional.	• N/A	• Adult spawners and redds were monitored at the Fish Passage Projects and no statistically significant change was observed. • Juvenile fish abundance was also monitored at the Fish Passage Projects and no statistically significant change was observed. • Although not statistically significant, there was an increase >29% in the mean for adult spawners, redds, and juvenile fish in both Years 1 and 2. • Additional years of monitoring and sites will be required to determine effectiveness.
In-Stream Habitat	• 100% of the In-Stream Habitat Projects monitored met the criteria of >50% of the AIS remaining within the impact reach.	• In-Stream Habitat Projects as a group showed a statistically significant increase over baseline in mean vertical pool profile area for both Years 1 and 3 (and >20%). • In-Stream Habitat Projects as a group showed a statistically significant increase over baseline in mean residual depth for both Years 1 and 3 (and >20%). • In-Stream Habitat Projects as a group showed a statistically significant increase over baseline in Log10 volume of LWD for both Years 1 and 3 (and >20%).	• Chinook, coho, and steelhead parr abundance was monitored at the In-Stream Habitat Projects; however, no statistically significant change was observed. • Additional years of monitoring and sites will be required to determine effectiveness.

Table 5-15. Summary of Analysis Results (continued)

Project Category	Level 1 Functional Criteria	Level 2 Habitat Indicators	Level 3 Fish Response
Riparian Planting	• 100% of the projects monitored demonstrated a percentage of plants living that exceeded the 50% survival criteria.	• Riparian Planting Projects as a group showed a statistically significant increase over baseline in riparian vegetation structure (and >20%), but only for Year 1. • Mean percent canopy density along the banks and bank erosion was also monitored at the Riparian Planting Projects; however, no statistically significant change was observed for either Years 1 or 3. • Longer-term monitoring and additional sites will be required to demonstrate significant change in these indicators.	• N/A
Livestock Exclusion	• 83.3% in Year 1 and 100% in Year 3 of the projects monitored were found to be functional, thus exceeding the >80% criteria.	• Livestock Exclusion Projects as a group showed a statistically significant reduction over baseline in bank erosion for Year 1 (and >20%). • Mean percent canopy density along the banks and riparian vegetation structure was monitored; however, no statistically significant change was observed. • Longer-term monitoring will be required to demonstrate significant change in these indicators.	• N/A
Channel Connectivity	• 100% of the projects monitored had channels that remained connected to the stream in both Years 1 and 2.	• Channel Connectivity Projects as a group showed a statistically significant increase over baseline in mean vertical pool profile area (and >20%) in Year 1, but not Year 2. • Channel Connectivity Projects as a group showed a statistically significant increase over baseline in mean residual depth (and >20%) in both Years 1 and 2. • Mean percent canopy density along the banks and riparian vegetation structure was monitored at Channel Connectivity sites; however, no statistically significant change was observed. • Longer-term monitoring and additional sites will be required to demonstrate significant change in these indicators.	• Chinook, coho, and steelhead parr abundance was monitored at the Channel Connectivity sites; however, no statistically significant change was observed. • Additional years of monitoring and sites will be required to determine effectiveness.

Table 5-15. Summary of Analysis Results (continued)

Project Category	Level 1 Functional Criteria	Level 2 Habitat Indicators	Level 3 Fish Response
Diversion Screening	• >80% of the projects monitored were found to be intact, with >80% of the parameters tested in compliance with NOAA Guidance in both Years 1 and 2.	• N/A	• N/A
Habitat Protection	• N/A	• Habitat Protection Projects as a group showed a statistically significant increase over baseline in coniferous basal area (>20%). • Habitat Protection Projects as a whole showed a statistically significant decrease over baseline in coniferous stem count (>20%). • In upland vegetation, basal area and stem count for deciduous trees were also measured, but no significant results were observed. • In freshwater projects, mean vertical pool profile area, mean residual depth, percent fines, riparian vegetation structure, mean canopy density along the banks, and Log volume of LWD were measured, but no significant results were observed. • For estuarine projects, linear extent and cover of algae, linear extent and cover of vascular plants, and slope were measured, but no significant results were observed.	• Fish and macroinvertebrate assemblage were also monitored at the Habitat Protection Projects; however, no statistically significant change was observed. • Additional years of monitoring are required to determine effectiveness.

6 PROJECT COST EFFECTIVENESS ANALYSIS

6.1 INTRODUCTION

Chapter 5 of this report includes a statistical evaluation of project categories that tests the significance of changes in physical and biological indicators as a result of the implemented projects. This type of statistical examination provides guidance regarding project category effectiveness for addressing the questions developed by the SRFB for each of the project categories. Through statistical analysis, the effectiveness of each project category is evaluated (i.e., how advantageous a project category is), but further evaluation is needed to determine if the level of change in indicators achieved was worth the financial resources expended to implement the projects.

6.2 REASON FOR ECONOMIC EVALUATION

The SRFB has funded more than 1,126 projects and spent more than $336 million in state and federal funds toward salmon recovery. Although more than 1,126 projects have been funded, the SRFB receives well over this number of project requests for funding. Due to constrained budgets, the SRFB must make choices on which projects receive funding. There are many factors that go into deciding which projects receive funding, and the amount of money available for a single round of funding is only one of the factors used in the decision-making process.

The following analysis is intended to assist the SRFB in reviewing the cost effectiveness of funds spent on project implementation and may be a useful tool for assessing where to invest future funds.

6.3 GOALS OF ECONOMIC EVALUATION

Developing goals and evaluating different approaches for conducting an economic evaluation was the starting point for this economic evaluation. Additional guidance was necessary from the SRFB to ensure that the objectives would be satisfied, and this guidance also assisted in narrowing down the types of economic evaluation that would be applicable. This guidance consisted of the following information:

1. Evaluation should be based on the objectives of the monitoring program;
2. Analysis should present an evaluation that is meaningful for the SRFB;
3. Analysis should use data collected by the monitoring program instead of estimating monetary benefits associated with different project components;
4. The evaluation should consider the costs of a project and the life expectancy of a project; and

5. Comparisons of project categories can only be made using similar data collected across the categories.[1]

6.4 METHOD

Plummer (2005) notes that using a biological metric permits comparisons of project types. However, accurate data on a biological metric consists of long-term monitoring to overcome the large interannual variation in biological data (Korman and Higgins 1997; Ham and Pearsons 2000; Roni et al. 2003; Plummer 2005). It should be noted that this is the goal of the effectiveness monitoring program, to collect long-term physical and biological metrics. Therefore, using the SRFB indicators as a measure of the effects is applicable for economic evaluation as long as the current results are viewed as preliminary findings that serve as a baseline for long-term data collection and analysis.

Cost effectiveness can be used when benefits and costs are expressed in different metrics. Here the costs are in dollars and the benefits are represented in terms of the data collected from the monitoring program. This method of comparing physical and biological indicators as benefits to the actual costs of projects is known less formally as "bang for the buck." This type of analysis is most effective when a number of projects are evaluated using the same technological and biological indicators (Plummer 2005). For a single project category this approach meets the goals outlined for the economic evaluation. When evaluating across project categories, only categories that have data for the same indicators can be evaluated.

6.4.1 Evaluation

To determine which category of projects is the most cost-effective, the change in each indicator is compared to the life cycle cost, or, the cost of a project divided by the life expectancy for that type of a project. The change in each indicator is discussed in Chapter 5. The following steps were used to determine the change in indicator:

1. (Impact Year 0 – Control Year 0) = Difference Year 0 (d_0)
2. (Impact Year X – Control Year X) = Difference Year X, where X = Year 1, Year 2, or Year 3 (d_1, d_2, or d_3)

To determine which project category is the most cost-effective, the change in a given indicator is compared to the lifecycle cost of a project. For example, juvenile fish data are collected for Fish Passage Projects, In-Stream Habitat Projects, and Constrained Channel Projects, so these categories can be compared to each other. Juvenile fish data are not collected for Riparian Planting Projects, so those projects cannot be included in that comparison.

[1] Changes in the scale of projects, or incorporation of multiple types of project activities at a site, will change the associated metrics used for benefits and costs. Marginal benefits tend to decrease as a project increases in size (Plummer 2005). This point of marginal value is extremely important to consider, because the projects being evaluated here may not be of the same scale and this may produce errors in estimating the true costs and effects (in our case technological and biological indicators), thus impacting the ability to compare project categories. Overall, Plummer (2005) highlights the point that the most important factor for economic evaluation is having many sites with the same metric that will be evaluated.

The first step necessary for creating comparison graphs for categories was to determine which categories had similar data available. The next step was to graph each indicator by using the change in that indicator and the life cycle cost. The graphs for each indicator can then be used to assess which project or project category has the greatest change for the dollar investment over the life of the project.

6.5 DATA

6.5.1 Life Expectancy

For individual project evaluations, the life cycle cost is calculated to construct a ratio that is used as a unit of measure – dollars/year of project performance. As previously described in the Evaluation section, the reason for dividing the cost of a project by its life expectancy is to interpret how project categories with different life expectancies compare to each other. Consideration of project life expectancies is necessary because one type of project does not last as long as another, so a project may need to be done again in order to obtain, or continue obtaining, the same level of change in the indicator.

The life expectancy of a project can be defined as the amount of time a project should continue to work as intended. Roni et al. (2002) and Gruenwald (2006) describe the range for the life expectancy of several project categories. The average of each range was selected as the life expectancy value for economic evaluation. Both the life expectancy range from Roni et al. (2002) and the average of this range used in this economic evaluation are shown in Table 6-1. Additional life expectancy information is available in Gruenwald (2006), but the values are not outside of the ranges in Roni et al. (2002). Where no information was available for life expectancy of projects, an estimated value of 25 years was used.

6.5.2 Project Costs

Total project costs for implemented BACI design projects are show in Table 6-2. These costs are those identified by the SRFB or OWEB for each of the specific projects. By using the actual dollar values for each project and dividing by the typical life of the project, the analysis reflects the dollar expenditure per year of expected project performance.

Table 6-1. Projected Life Expectancy for Each SRFB Project by Restoration Category

SRFB Category	Life Expectancy for project (years)[1/]	Average Value Used (yrs) [2/]
Fish Passage Projects (MC-1)	10-50+	25
In-Stream Habitat Projects (MC-2)	5-20	13
Riparian Planting Projects (MC-3)	10-50+	25
Livestock Exclusion Projects (MC-4)	10-50+	25
Constrained Channels (MC-5)	10-50+	25
Channel Connectivity, Off-Channel Habitat, and Wetland Restoration Projects (MC-6)	10-50+	25
Spawning Gravel Projects (MC-7)	No Information	No Information
In-Stream Diversion Projects (MC-8)	10-50+	25
Habitat Protection Projects (MC-10)	Decades-centuries	Decades-centuries

[1/] This information, taken directly from Roni et al. (2002), estimates how long the project will last. (A plus sign (+) means it could extend beyond the indicated duration).
[2/] Average value is the average of the range given in Roni et al. (2002). This average value is the value used in the economic evaluation of this report.

Table 6-2. Total Costs for Projects

Project Number	Project Name	Category	Project Total Cost	Annual Life-Cycle Cost
02-1530	Salmon River Tributary 21-0143 Culvert Barrier	Fish Passage	$148,300	$5,932
02-1574	Malaney Creek Fish Passage Project	Fish Passage	$384,672	$15,387
04-1470	Hiawatha Fish Passage	Fish Passage	$517,764	$20,711
04-1485	Fulton Dam Barrier Removal	Fish Passage	$473,223	$18,929
04-1489	Chewuch Dam Barrier Removal	Fish Passage	$272,091	$10,884
04-1668	Beeville Rd Barrier Removal	Fish Passage	$130,000	$5,200
04-1689	Lucas Creek Barrier Correction	Fish Passage	$493,000	$19,720
04-1695	Dekay Road Fish Barrier	Fish Passage	$409,968	$16,399
05-1498	Curl Lake Intake Barrier Removal	Fish Passage	$108,000	$4,320
02-1444	Little Skookum Valley, Phase II	Instream Structures	$32,942	$2,534
02-1463	Salmon Creek Artificial Instream Structures	Instream Structures	$240,084	$18,468
02-1561[1]	Edgewater Park Off-Channel Restoration	Instream Structures	$205,333	$15,795
04-1338	Lower Newaukum Restoration	Instream Structures	$938,581	$72,199
04-1448	PUD Bar Habitat Enhancement	Instream Structures	$316,318	$24,332
04-1575	Upper Washougal River LWD Placement	Instream Structures	$338,405	$26,031
04-1589	Dungeness River Railroad Bridge Restoration	Instream Structures	$914,165	$70,320
05-1533	Doty Edwards Cedar Creek	Instream Structures	$111,730	$8,595
02-1446	Centralia Riparian Restoration Project	Riparian Plantings	$105,300	$4,212
02-1561[1]	Edgewater Park Off-Channel Restoration	Riparian Plantings	$175,333	$7,013
02-1623	Snohomish River Confluence Reach Restoration	Riparian Plantings	$690,000	$27,600
04-1649	Snow Creek Lower Watershed Site 1A	Riparian Plantings	$809,670	$32,387
04-1655[1]	Hoy Riparian Restoration	Riparian Plantings	$126,250	$5,050
04-1676	YTAHP Wilson Creek Riparian Restoration	Riparian Plantings	$36,920	$1,477
04-1698[1]	Vance Creek Riparian Planting and Fencing	Riparian Plantings	$13,031	$1,139
04-1711	Lower Klickitat Riparian Restoration	Riparian Plantings	$46,402	$2,391

Table 6-2. Total Costs for Projects (continued)

Project Number	Project Name	Category	Project Total Cost	Annual Life-Cycle Cost
02-1498	Abernathy Creek Riparian Restoration	Livestock Exclusions	$247,131	$14,823.96
04-1655[1]	Hoy Riparian Restoration	Livestock Exclusions	$127,750	$5,050.00
04-1698[1]	Vance Creek Riparian Planting and Fencing	Livestock Exclusions	$13,031	$1,139.24
05-1447	Indian Creek Yates Restoration	Livestock Exclusions	$59,715	$2,840.92
05-1547	Rauth Coweeman Tributary Restoration	Livestock Exclusions	$50,000	$2,420.00
205-060	Bottle Creek Livestock Exclusion Project	Livestock Exclusions	$6,105	$244.20
205-060	North Fork Clark Creek Tributary Exclusion Project	Livestock Exclusions	$6,105	$244.20
206-072	Gray Creek Livestock Exclusion Project	Livestock Exclusions	39,500	$1,580.00
206-095	Jordan Creek Livestock Exclusion Project	Livestock Exclusions	$20,000	$800.00
206-283	Johnson Creek Livestock Exclusion Project	Livestock Exclusions	$19,836	$793.44
206-283	Nobel Creek/Maria Gulch Livestock Exclusion Project	Livestock Exclusions	$18,431	$737.24
206-357	Middle Fork Malheur River Bank Stabilization Project	Livestock Exclusions	$4,700	$188.00
02-1625	South Fork Skagit Levee Setback Acquisition and Restoration	Constrained Channels	$902,270	$42,690.80
05-1521	Raging River Preston Reach	Constrained Channels	$320,000	$32,484.60
02-1561[1]	Edgewater Park Off-Channel Restoration	Connectivity	Subset of Total	$7,173.32
04-1461	Dryden Fish Enhancement	Connectivity	$146,000	$7,200.00
04-1573	Lower Washougal Restoration Phase 1 Site 1	Connectivity	$199,999	$10,584.00
05-1546	Gagnon CMZ Off-channel	Connectivity	$366,325	$17,253.00
04-1563	Germany Creek Conservation Restoration	Connectivity	$545,360	$32,344.40
05-1614	Beebe Creek Channel Reconfiguration	Gravel	$120,000	$15,997.92

[1/] Projects were evaluated as part of two different monitoring categories. Costs were assigned to each category to better evaluate the effectiveness of each category.

6.6 RESULTS

6.6.1 Evaluation Using Juvenile Coho Density

Three monitoring categories with Year 1 data include juvenile coho density as a measured indicator. Figure 6-1 illustrates the relative cost effectiveness of nine Fish Passage Projects, eight In-Stream Habitat Projects, and four Channel Connectivity Projects using the change in juvenile coho density between Year 1 and Year 0. The Year 1 data indicate that five Fish Passage Projects, four In-Stream Habitat Projects, and three Channel Connectivity Projects resulted in a net increase, while one Fish Passage Project and three In-Stream Habitat Projects showed a net decrease in juvenile coho density. Each category included projects that showed zero net change because no juvenile coho were observed within the survey areas during either baseline monitoring or Year 1 monitoring. Initial monitoring data suggests that Fish Passage Projects are generally more cost effective than both the In-Stream Habitat and Channel Connectivity Projects for increasing juvenile coho density.

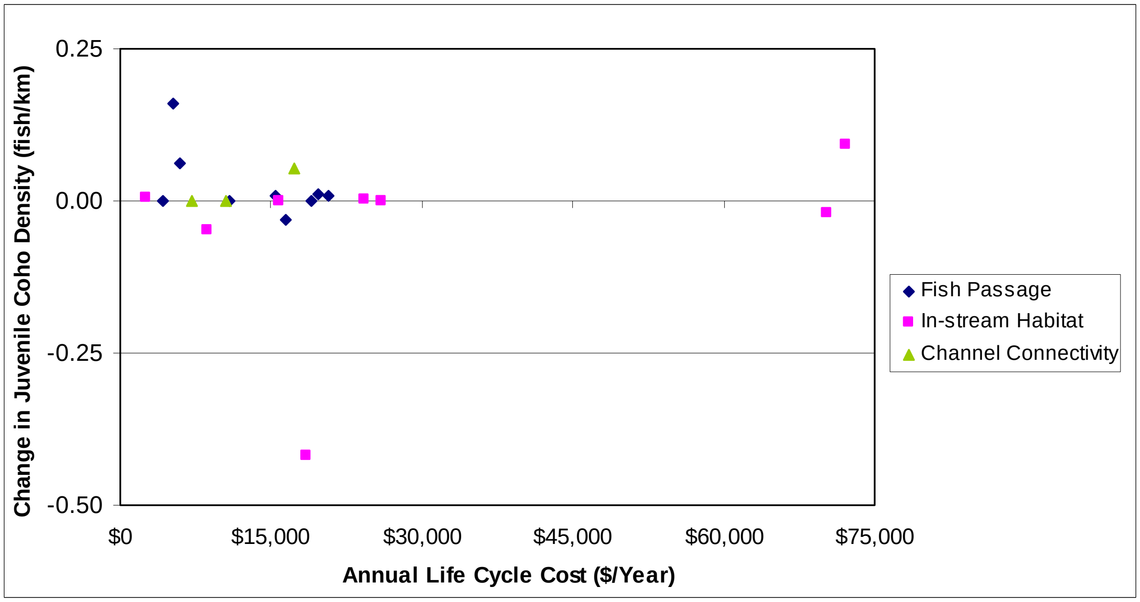


Figure 6-1. Change in Juvenile Coho Density versus Annual Life Cycle Cost

6.6.2 Evaluation of Cost Effectiveness Using Steelhead Parr Density

Steelhead parr density is measured as an indicator in nine Fish Passage Projects, eight In-Stream Habitat Projects, and four Channel Connectivity Projects that have Year 1 data. A comparison of Year 1 data to Year 0 data indicates that five of the Fish Passage Projects resulted in a net increase in steelhead parr density, while four showed a net decrease. Three of the In-Stream Habitat projects showed an increase, two showed a decrease, and three showed no steelhead parr in Year 0 or Year 1. Of the Channel Connectivity Projects, two showed a positive change, one showed a negative change, and one showed zero net change because no steelhead parr were observed within the survey areas during either baseline monitoring or Year 1 monitoring. Year 1 data suggest that Fish Passage Projects are slightly more cost effective than both In-Stream Habitat and Channel Connectivity Projects for increasing steelhead parr density (see Figure 6-2).

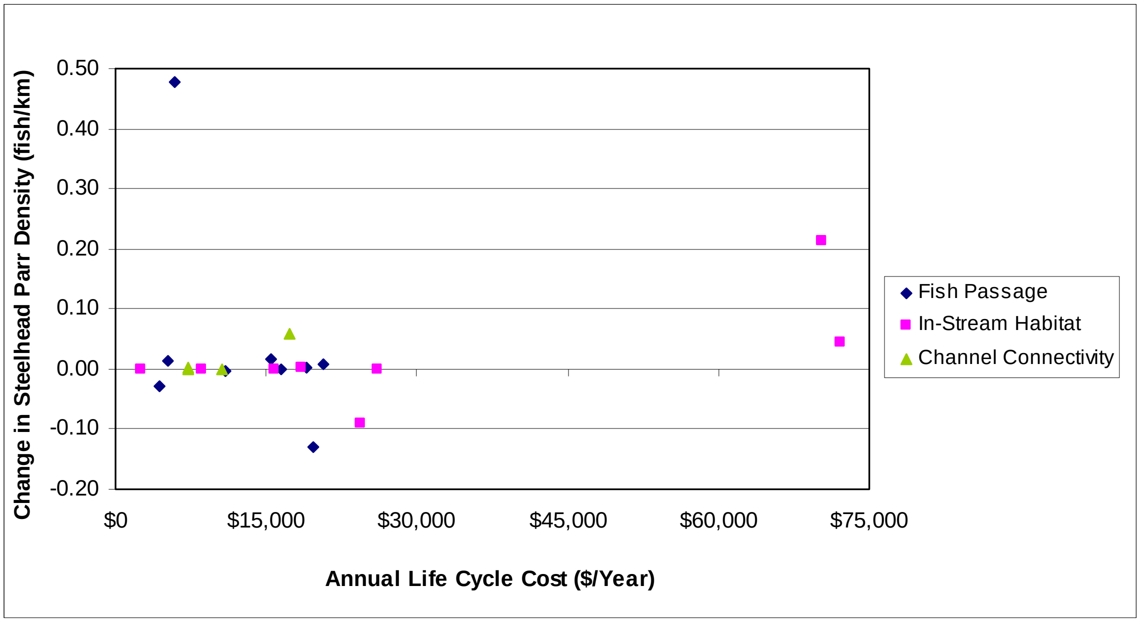


Figure 6-2. Change in Steelhead Parr Density versus Annual Life Cycle Cost

6.6.3 Evaluation of Cost Effectiveness Using Juvenile Chinook Density

As with juvenile coho and steelhead parr, juvenile Chinook is a measured indicator in the Fish Passage, In-Stream Habitat, and Channel Connectivity Projects with Year 1 data. Three Fish Passage Projects, one In-Stream Habitat Project, and two Channel Connectivity Projects showed a net increase. One Fish Passage Project, four In-Stream Habitat Projects, and two Channel Connectivity Projects showed a net decrease. Five of the Fish Passage Projects and three of the In-Stream Habitat Projects show zero net change. This is due to the fact that no juvenile Chinook were observed in either the control or impact reaches of these projects during pre and post-implementation monitoring. As with juvenile coho and steelhead parr, juvenile Chinook densities suggest that Fish Passage Projects are slightly more cost effective than In-Stream Habitat and Channel Connectivity Projects for increasing Chinook juvenile density, although the differences are much smaller for this species (see Figure 6-3).

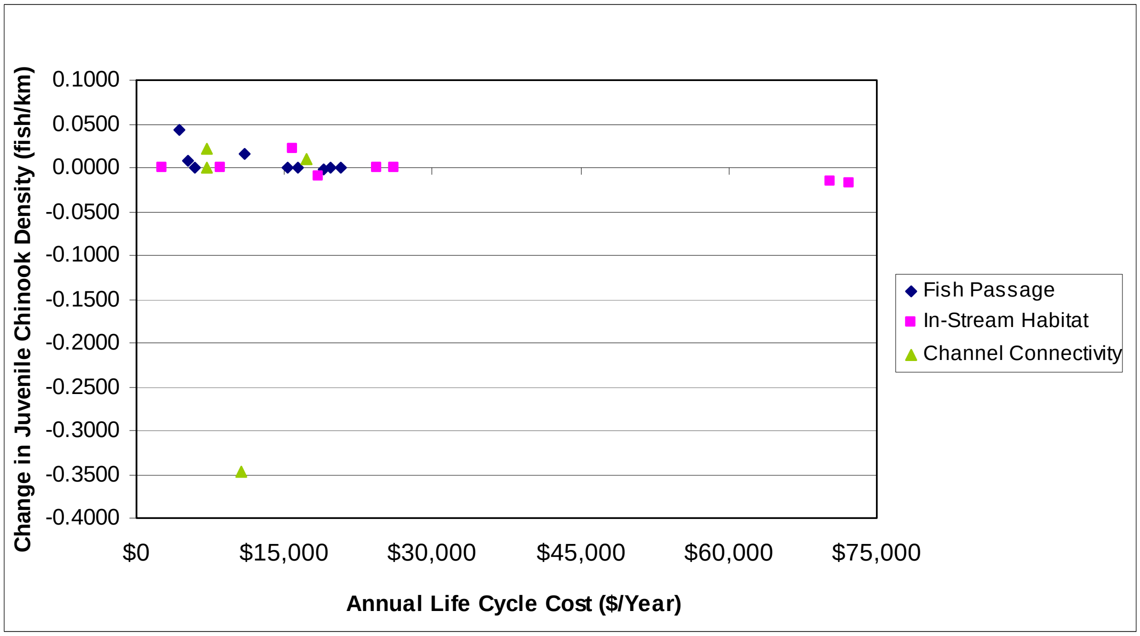


Figure 6-3. Change in Juvenile Chinook Density versus Annual Life Cycle Cost

6.6.4 Evaluation of Cost Effectiveness based on Mean Residual Vertical Pool Profile Area

Three monitoring categories with Year 1 data include the Mean Residual Vertical Pool Profile Area as a measured indicator. Figure 6-4 shows the relative cost effectiveness of eight In-Stream Habitat Projects, four Channel Connectivity Projects, and two Constrained Channel Projects using this indicator. The range of effect levels for In-Stream Habitat Projects includes two projects with a net decrease and six projects with net increases. All four of the Channel Connectivity Projects showed a net increase in Mean Residual Vertical Pool Profile Area, while one of the Constrained Channel Projects showed an increase and one showed a decrease. Using one year of post-project monitoring, data suggest that Channel Connectivity Projects are generally more cost effective than the In-Stream Habitat Projects, which, in turn, appear most cost effective than Constrained Channel Projects for increasing pool refuge as measured by the Mean Residual Vertical Pool Profile Area.

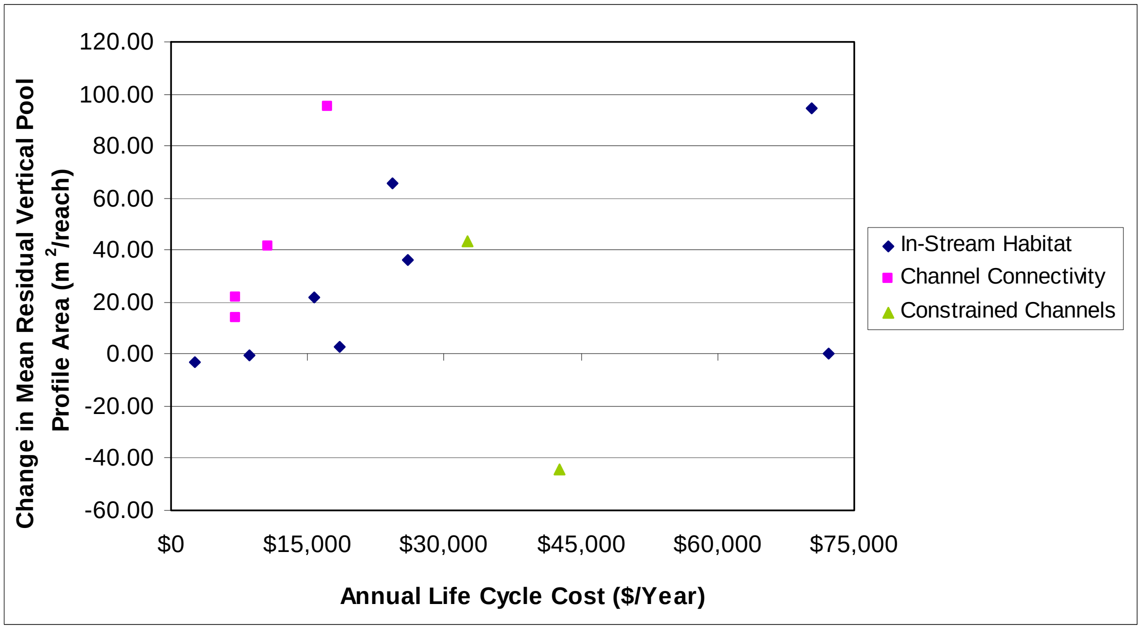


Figure 6-4. Change in Mean Residual Vertical Pool Profile Area versus Annual Life Cycle Cost

6.6.5 Evaluation of Cost Effectiveness based on Mean Residual Pool Area

The pattern of data points in Figure 6-5 for cost effectiveness of monitoring categories for Mean Residual Pool Area mimics the pattern seen for Mean Thalweg Vertical Pool Profile Area as these indicators are mathematically related. All projects sampled showed a net increase following one year of post-project monitoring, except for two In-Stream Habitat Projects and one Constrained Channel Project, and Channel Connectivity Projects are most cost effective for increasing Mean Residual Pool Area, followed by In-Stream Habitat Projects and Constrained Channel Projects.

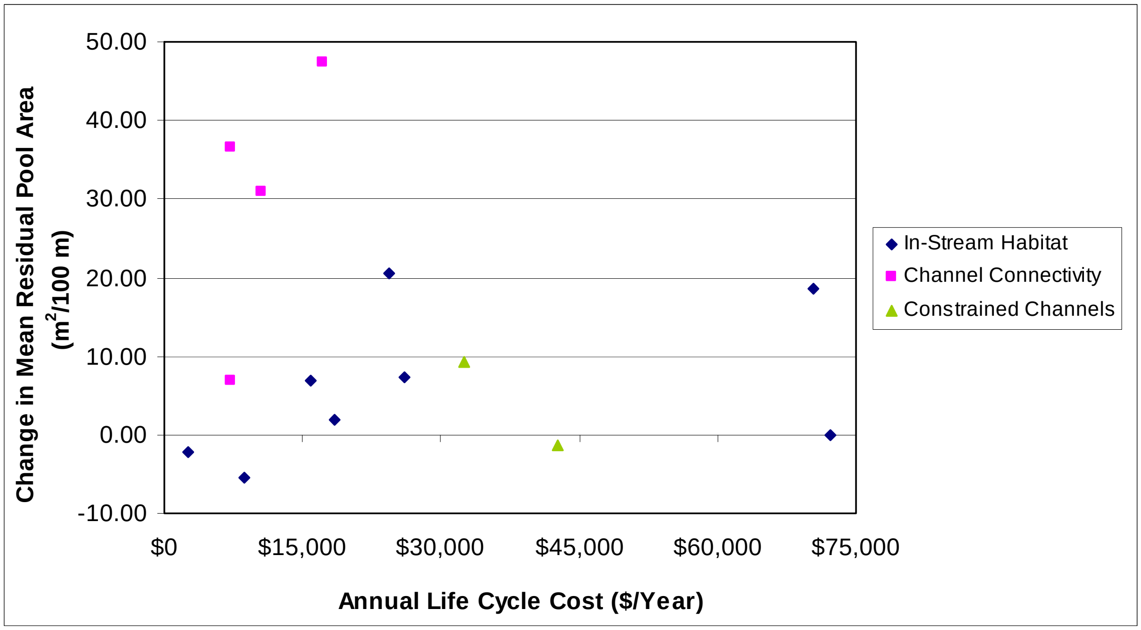


Figure 6-5. Change in Mean Residual Pool Area versus Annual Life Cycle Cost

6.6.6 Evaluation of Cost Effectiveness based on Riparian Vegetation Structure

Eight Riparian Planting Projects, twelve Livestock Exclusion Projects, and four Channel Connectivity Projects were compared for cost effectiveness in Figure 6-6. Increases and decreases are observed in all of these categories in the first year after implementation. In the Riparian Planting Projects, the decreases are often due to the need to remove invasive vegetation present at the site in order to increase the likelihood of survival for the new plants. For the Livestock Exclusion and Channel Connectivity Projects, there is rarely a riparian planting component associated with these projects. As a result, it may take longer to see increases in riparian vegetation structure than in those projects where plantings are being installed. Generally, Livestock Exclusion Projects are the least costly, followed by Riparian Planting and Channel Connectivity projects. Cost effectiveness is greatest for Riparian Planting Projects with greater increases at moderate cost. Livestock Exclusion Projects show lower levels of increase in vegetation structure, but at a lower cost per project. Channel Connectivity Projects show mixed results for a higher average cost than Riparian Planting Projects.

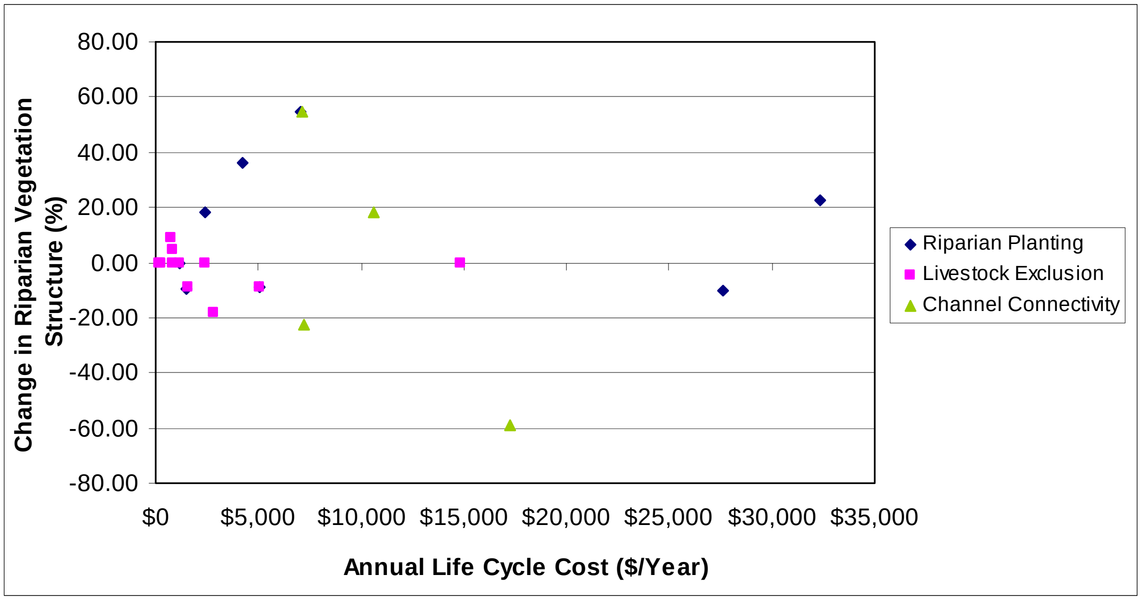


Figure 6-6. Change in Riparian Vegetation Structure versus Annual Life Cycle Cost

6.6.7 Evaluation of Cost Effectiveness based on Mean Canopy Density Along the Banks

Eight Riparian Planting Projects, twelve Livestock Exclusion Projects, and four Channel Connectivity Projects were compared for cost effectiveness in Figure 6-7. Only two of the Riparian Planting Projects showed an increase in mean canopy density along the banks in Year 1, while six showed a decrease. The Livestock Exclusion Projects also showed a mixed response after one year of monitoring, with four showing a net positive change and eight showing a negative change. Of the four Channel Connectivity Projects, only one returned positive results, while the other three showed a negative response in mean canopy density along the banks. For those projects that included a planting component, the installed plantings are often set back from the edge of the bank, resulting in a longer period of time needed for the plants to grow large enough to provide shading to the stream. It is expected that as the projects develop and mature, changes in mean canopy density along the banks would become more pronounced. From the first year of data collection, Livestock Exclusion Projects show the greatest increase in Canopy Density at the lowest cost.

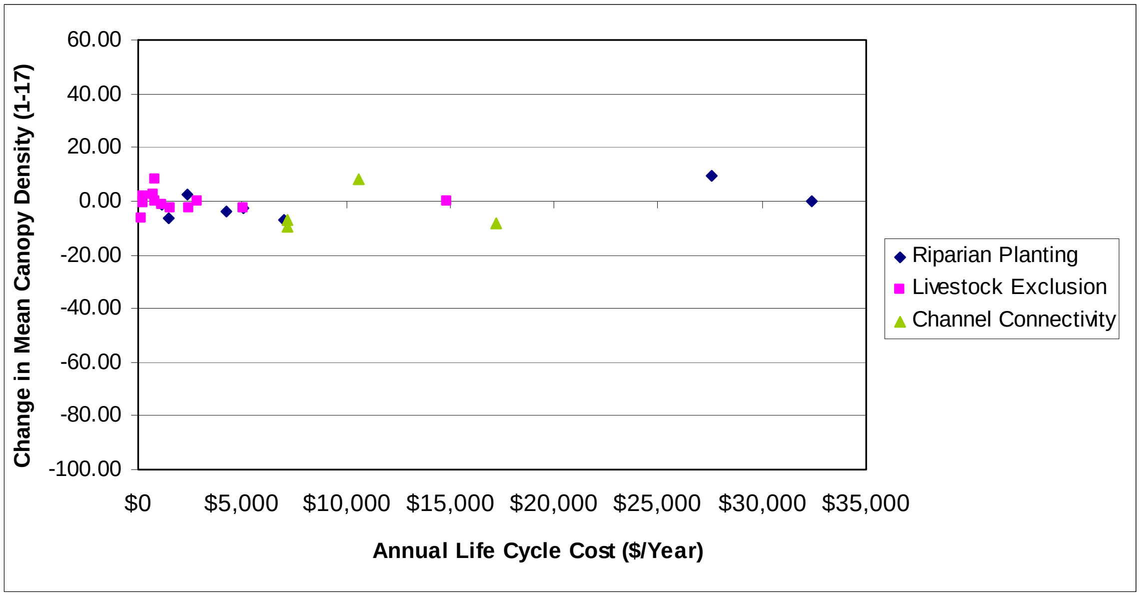


Figure 6-7. Change in Mean Canopy Density along the Banks versus Annual Life Cycle Cost

6.6.8 Evaluation of Cost Effectiveness based on Bank Erosion

Two monitoring categories with Year 1 data include bank erosion as a measured indicator. Figure 6-8 illustrates the relative cost effectiveness of eight Riparian Planting Projects and twelve Livestock Exclusion Projects using this indicator. Unlike the other monitoring categories, a negative percent change in bank erosion indicates a positive response to project implementation. Three Riparian Planting Projects and nine Livestock Exclusion Projects showed a net decrease in bank erosion, while two Riparian Planting Projects and two Livestock Exclusion Projects showed a net increase in bank erosion. Three of the Riparian Planting Projects and one Livestock Exclusion Project showed no net difference between the control and impact reaches during pre- and post-implementation monitoring. Following one year of monitoring, the cost effectiveness of Livestock Exclusion Projects appears to be fairly high with significant decreases in erosion at low cost. This is likely due to the direct exclusion of livestock from the streams, which removes the source of the physical disturbance. Riparian Planting Projects often require substantial disturbance (clearing of invasive vegetation) around the project area, which may initially result in a slight increase in bank erosion. During subsequent years of monitoring, a reduction in bank erosion is expected for both Riparian Planting and Livestock Exclusion Projects.

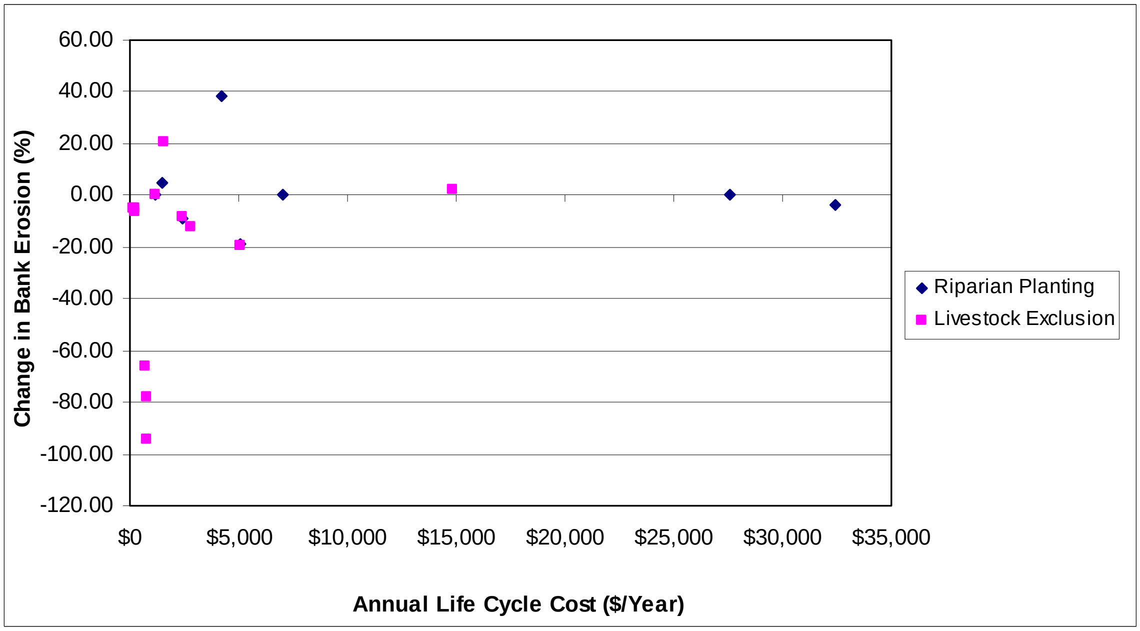


Figure 6-8. Change in Bank Erosion versus Annual Life Cycle Cost

6.7 DISCUSSION

The initial cost effectiveness analysis shows a range of responses to the actions implemented using SRFB funding. All of these projects are still in their initial stages and, while some of the projects have more than one year of post-project data, only Year 1 data were used for this analysis so that a greater number of projects could be compared using a consistent response time frame. For some project types, such as Fish Passage and Channel Connectivity projects, where access to new habitat is opened or created, responses are expected in the near term. Other habitat enhancement projects such as In-Stream Habitat, Constrained Channel, Riparian Planting, and Livestock Exclusion projects are expected to take longer to see significant change develop for some of the geomorphic and vegetation indicators. Consistent tracking of these projects through time will increase the understanding of the variability in response for all the project types and the time frame needed for both physical and biological indicators to change.

6.8 ISSUES/CONCERNS

These results should not be viewed as reliable until more years of data are available as they represent preliminary findings from only one year of data. Initial responses may change over the next 5 to 10 years of the monitoring program as the projects develop and more years of data are collected in each monitoring category. Additional information is also needed to assess the life expectancy of project categories more accurately. As monitoring programs such as this one continue, this information will become more representative of projects that have been implemented and monitored for life expectancy and effectiveness.

Additional concerns about cost effectiveness analysis include that the analysis does not take into account the individual limiting factors for each watershed. Projects are evaluated based on changes in monitored indicators as compared to project cost. This comparison does not identify whether or not the limiting factors in a given watershed are addressed by a given project category. The information included in this section is included for comparison purposes only and should be combined with watershed specific information when used to make project selection decisions.

6.9 FUTURE ANALYSIS

Future cost effectiveness analysis will include tracking these projects through time to re-evaluate changes in indicator status and compare these changes to the baseline difference. As more projects are implemented, trends in cost effectiveness may emerge that can be used to compare project type performance. Further development is needed for methods to compare changes in indicators through time to a single project implementation investment. This would include discounting the original investment in project costs for future years of trends in measured physical and biological indicators. In addition, project cost analyses should include maintenance costs for each project on an annual basis. In addition, further economic analysis with respect to costs versus economic benefits would add information on the economic and social benefits of these projects that are not captured in the current analysis.

7 SUMMARY AND RECOMMENDATIONS

Results to date from the SRFB Reach-Scale Effectiveness Monitoring Program indicate that some project categories are showing significant changes in the first one to three years following implementation. Many of the variables monitored in the Fish Passage, In-Stream Habitat, Livestock Exclusion, and Channel Connectivity Project categories have shown an increase greater than 20 percent over baseline. In addition, functional evaluations for many indicators show that effectiveness has been reached before the timeframes established in the objectives for each monitoring category. The remaining variables are likely to require additional time and more projects to identify significant change. As more years of data are collected, it will be possible to determine the presence of trends through time for variables in each monitoring category.

7.1 CUMULATIVE MONITORING SCHEDULE – CURRENT

Monitoring for the program is currently scheduled through 2018. Figure 7-1 illustrates the total number of projects scheduled throughout the monitoring program. As shown in the figure, the number of projects per year was slightly lower in 2008 than in 2007. This will likely be decreasing for the future, unless additional projects are added to complete the sample size for those monitoring categories that are not yet complete.

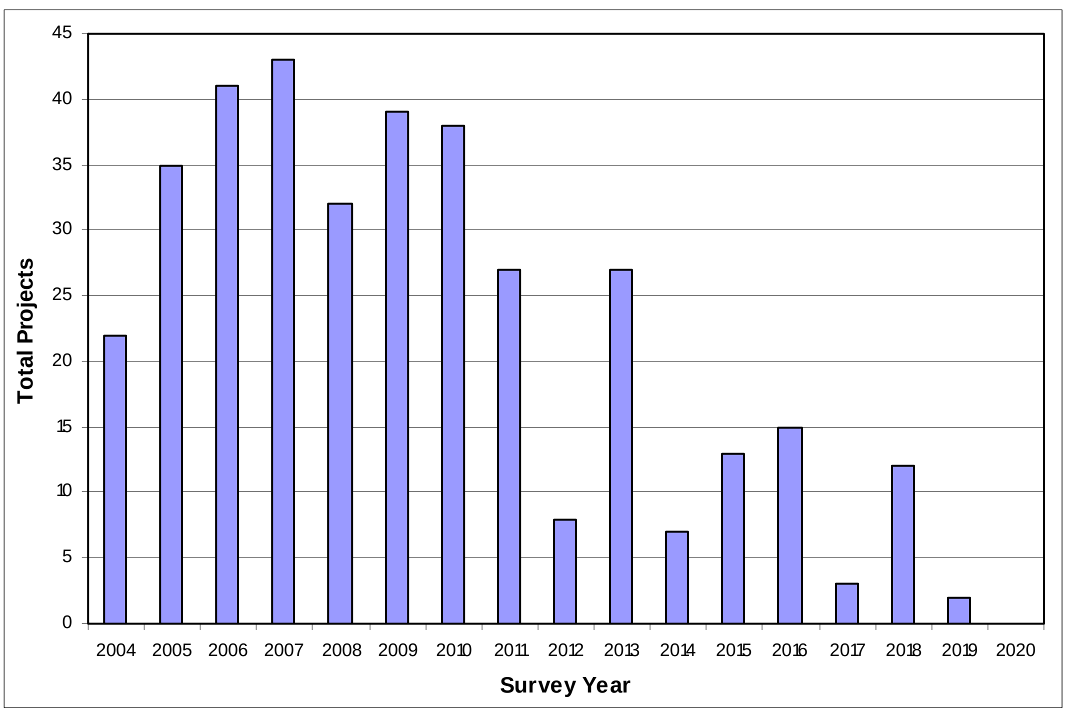


Figure 7-1. Number of Projects Monitored by Survey Year

Currently, three monitoring categories have not met the original sample size objective of 10 projects: Channel Connectivity, Gravel Placement, and Constrained Channel Projects. In addition, two Fish Passage Projects are currently unknown, in terms of implementation status, as is one Riparian Planting Project and one Spawning Gravel Project. If additional projects are added in 2008, the project schedule would be modified and the total duration of the program would change to include the new projects.

In terms of the cost to implement the Reach-Scale Effectiveness Monitoring Program, as the number of projects decreases, the cost to monitor those projects decreases, but the value of additional monitoring data greatly increases the ability to detect trends over the long-term. For those monitoring categories that are scheduled for 10- and 12-year durations, the later monitoring events are critical to tracking change in terms of project effectiveness due to the slow rate of change in some of the monitoring variables measured.

7.2 CUMULATIVE MONITORING SCHEDULE – RECOMMENDED

Recommendations for alterations to the monitoring schedule are based on observations from post-implementation monitoring on the rate of change observed for variables measured. Some of the variables in two of the monitoring categories, Riparian Planting Projects and Habitat Protection Projects, are very slow to show change. In order to adapt the monitoring program to these results, we recommend that the return interval for these monitoring categories be extended after the Year 3 survey.

For Riparian Plantings, the current schedule is to monitor in Years 1, 3, 5, and 10 following project implementation. We recommend the schedule be changed to Years 1, 3, 8, and 12 for this category to allow more time for plants to develop between monitoring events. Under this new schedule, the monitoring effort for this category of projects would extend into 2019.

For Habitat Protection, the current schedule is to monitor projects in Years 3, 6, 9, and 12. We recommend that the monitoring interval be extended such that projects are monitored in Years 3, 8, and 12 following initial reach establishment. Under this new schedule the monitoring effort would extend into 2020 for this monitoring category. For Habitat Protection Projects, this would reduce the number of monitoring events from five to four, reducing the monitoring costs for this category.

Interim contacts with project sponsors from both monitoring categories are highly recommended to ensure continuity with project sponsors and to document any large environmental changes that may affect the condition of the project site in between monitoring events. Funding requirements for these project sponsor contacts would be included in the annual budget for the program.

7.3 RECOMMENDATIONS FOR DATA COLLECTION

<u>Fish Passage Projects:</u>

- Current trends show positive biological response to projects. Monitoring can be concluded after Year 5 (2009).

- Because monitoring for this category is intended to detect access for juveniles and adults the success criteria should be redefined to focus on the following:
  - Were juvenile salmonids and adults observed upstream from the barrier in each year monitored after the project was implemented?
  - Are the fish passage design criteria being met?

<u>In-Stream Habitat Projects:</u>

- Results documented in this report and in the literature have adequately addressed the questions regarding pool formation due to In-Stream Habitat. However, questions remain regarding fish response to various types of In-Stream Habitat Projects. As such, and due to the numerous confounding factors incorporated into this categorical analysis, the following recommendations should be carried out for this monitoring category:
  - Segregate the projects based on geography, geology, hydrology, project type, and target fish species (projects that target Chinook should be the first priority).
  - Increase the sample size by integrating with project effectiveness data collected in intensively monitored watersheds.
  - Evaluate how juvenile fish species respond at each site to the specific action (e.g. is fish density higher at the specific location of the placed structures than in other areas of the reach?)
  - Tie monitoring to specific habitat or biological objectives identified by project sponsors.

<u>Riparian Planting Projects:</u>

- Continue to monitor for canopy cover and vegetation structure, but because many of the plantings are not installed next to the streams, measure these indicators in future years at the edge of the plantings, instead of at the waters edge.
- Change survival measurements to percent cover after Year 3 to address volunteer plants
- Delay the third sampling event to Year 8 to allow more time for plant growth, however maintain contact with project sponsors.

<u>Livestock Exclusion Projects:</u>

- Continue to monitor the 12 projects over time for effectiveness and for implementation.

<u>Constrained Channel Projects:</u>

- Modify protocol to better address projects in larger river systems.
- Continue to monitor existing 10 projects though implantation.

<u>Channel Connectivity Projects:</u>

- Continue to monitor the 10 projects in this category until all 10 projects are implemented.

- Integrate with Intensively Monitored Watershed Program to identify additional project level monitoring to increase sample size.

Spawning Gravel Projects:

- Current sample size is not adequate for statistical analysis. Discontinue monitoring for this category until additional projects are available.

Diversion Screening Projects:

- Current projects show that other than maintenance needs, current screen designs are functional. Implementation monitoring for maintenance can be conducted by project sponsors. Discontinue monitoring this category after Year 5 (2009).

Habitat Protection Projects:

- Change monitoring interval to Years 3, 8, and 10.

7.4 DATA MANAGEMENT RECOMMENDATIONS

Data storage and data management needs for the Reach-Scale Effectiveness Monitoring Program have increased as the program continues. Current work includes clarification of protocols to describe analysis procedures and database improvements to document calculations in the database. These Improvements are typical as programs increase in scale and data capacity. Future recommendations include integrating the project database more closely with PRISM and/or the Habitat Work Schedule so that project monitoring data is more directly accessible to project sponsors.

7.5 COST-EFFECTIVENESS RECOMMENDATIONS

Future analysis of the project cost-effectiveness should include discounting of original investment for implementation so that effect trends through time can be compared to project costs. Once all projects have more than one year of data collected, this discounting approach will be applied.

7.6 REGIONAL COORDINATION FOR REACH-SCALE EFFECTIVENESS MONITORING PROGRAM

Starting in 2006, the SRFB coordinated with OWEB to monitor Livestock Exclusion Projects using the same protocols and the same contractor. In 2008, these efforts were continued and the data were pooled in data analysis across both programs. The results of this coordination are included in this report, and in an additional document created for the OWEB SRFB Coordinated Monitoring Program for Livestock Exclusions (Tetra Tech EC, Inc. 2008). This program represents a successful example of regional cooperation and coordination of monitoring efforts to produce comparable and compatible data for improved data analysis. The addition of the OWEB projects increased the Livestock Exclusion Project sample size from 5 to 12 projects, improved the power of the data analysis, and met the sample size goal for the program, at no additional cost to the SRFB.

Efforts like the Coordinated Monitoring Program for Livestock Exclusions result in improved data sharing and a reduction in monitoring costs. Additional efforts to coordinate monitoring programs are underway between OWEB and SRFB and through the efforts of SRFB staff members involved in regional coordination with other agencies. Improvements in data compatibility across the region will lead to better management decisions in terms of both project design and project funding allocation.

Coordination with the Intensively Monitored Watershed Program will also result in potential opportunities to increase the sample size for project categories where that has been recommended. This increase would potentially allow for segregation of projects by species and concentrate project monitoring in specific geographic areas. Additional partnerships with existing programs can help improve the results of the Reach-Scale Effectiveness Monitoring Program while still controlling the costs expended for monitoring programs.

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APPENDIX A

PROJECT LIST

Effectiveness Monitoring - Projects Schedule

Washington Salmon Recovery Funding Board

Project Number	ProjectName	Listings	Stream	Category	Target Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
02-1530	Salmon River Trib 21-0143 Culvert Barrier	Coast No Listing	Salmon river	MC-1 Passage	Coho	Year 0	Year 1	Year 2	none	none	Year 5	Completed										
02-1574	Malaney Creek Fish Passage Project	PS Threatened	Malaney Creek	MC-1 Passage	Chum	Year 0	2nd year 0	Year 1	Year 2	none	none	Year 5	Completed									
04-1470	Hiawatha Fish Passage	PS Threatened	Hiawatha Cr	MC-1 Passage	Chum		Year 0	2nd year 0	Deferred	Year 1	Year 2	none	none	Year 5	Completed							
04-1485	Fulton Dam Barrier removal	U Col Endangered	Chewuch River	MC-1 Passage	Chinook		Year 0	2nd year 0	Year 1	Year 2	none	none	Year 5	Completed								
04-1489	Chewuch Dam Barrier removal	U Col Endangered	Chewuch River	MC-1 Passage	Chinook		Year 0	Year 1	Year 2	Year 3	none	Year 5	Completed									
04-1668	Beeville Rd MP 2.09	Coast No Listing	Peterson Creek	MC-1 Passage	Coho		Year 0	Year 1	Year 2	none	none	Year 5	Completed									
04-1689	Lucas Creek Barrier correction	Coast No Listing	Lucas Creek	MC-1 Passage	Chinook		Year 0	Year 1	Year 2	none	none	Year 5	Completed									
05-1498	Curl Lake Intake Barrier removal	Snake Threatened	Tucannon River	MC-1 Passage	Chinook			Year 0	Year 1	Year 2	none	none	Year 5	Completed								
04-1695	Dekay Road fish barrier	Coast No Listing	Polson Creek	MC-1 Passage	Coho		Year 0	Year 1	Year 2	none	none	Year 5	Completed									
02-1444	Little Skookum Valley, Phase II:Riparian	PS Threatened	Little Skookum Creek	MC-2 Instream	Coho	Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
02-1463	Salmon Creek	Coast No Listing	Salmon Creek	MC-2 Instream	Coho	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
02-1515	Upper Trout Creek Restoration	Threatened	Trout Creek	MC-2 Instream	Steelhead	Year 0	Deferred	2nd year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
02-1561	Edgewater Park Off-Channel Restoration	PS Threatened	Skagit River	MC-2 Instream	Chinook	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
04-1209	Chico Creek Instream Habitat Restoration	PS Threatened	Chico Creek	MC-2 Instream	Chum		Year 0	2nd year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
04-1338	Lower Newaukum restoration	PS Threatened	Newaukum Creek	MC-2 Instream	Chinook		Year 0	2nd year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed		
04-1448	PUD Bar habitat enhancement	Threatened	Grays River	MC-2 Instream	Chum		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1575	Upper Washougal River LWD Placement	Threatened	Washougal River	MC-2 Instream	Steelhead		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1589	Dungeness river Railroad Bridge Restoration	PS Threatened	Dungeness River	MC-2 Instream	Chinook		Year 0	2nd year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed		
05-1533	Doty Edwards Cedar Creek	Threatened	Cedar Creek	MC-2 Instream	Chinook			Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed		
04-1660	Cedar Rapids flood plain	PS Threatened	Cedar River	MC-2 Instream	Chinook		Year 0	2nd year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
07-1803	Skookum Reach Restoration	PS Threatened	SF Nooksack River	MC-2 Instream	Chinook					Year 0	none	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed
02-1446	Centralia Riparian Restoration project	Coast No Listing	Chehalis River	MC-3 Riparian	Coho	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
02-1561	Edgewater Park Off-Channel Restoration	PS Threatened	Skagit River	MC-3 Riparian	Chinook	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
02-1623	Snohomish R Confluence Reach Restoration	PS Threatened	Snohomish River	MC-3 Riparian	Chinook	Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1649	Snow Creek lower watershed Site 1A	PS Threatened	Snow Creek	MC-3 Riparian	Chum		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1655	Hoy riparian restoration	Threatened	Skagit River	MC-3 Riparian	Chinook		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1660	Cedar Rapids flood plain	PS Threatened	Cedar River	MC-3 Riparian	Chinook		Year 0	2nd year 0	none	none	Year 1	Year 5	none	none	none	none	Year 10	Completed				
04-1676	YTAHP Wilson Creek Riparian restoration	Mid Col Threatened	Wilson Creek	MC-3 Riparian	Steelhead		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1698	Vance creek Riparian planting & fencing	Coast No Listing	Vance Creek	MC-3 Riparian	Coho		Year 0	2nd year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed			
04-1711	Lower Klickitat riparian restoration	Mid Col Threatened	Klickitat River	MC-3 Riparian	Steelhead		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
02-1498	Abernathy Creek Riparian Restoration	Threatened	Abernathy Creek	MC-4 Livestock	Chinook	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
04-1655	Hoy riparian restoration	Threatened	Skagit River	MC-4 Livestock	Chinook		Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed				
04-1698	Vance creek Riparian planting & fencing	Coast No Listing	Vance Creek	MC-4 Livestock	Coho		Year 0	2nd year 0	Year 1	none	Year 3	Year 5	none	none	none	none	Year 10	Completed				
05-1547	Rauth Coweeman Trib restoration	Threatened	Coweeman River	MC-4 Livestock	Coho			Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed			
05-1447	Indian Creek Yates Restoration	Northeast	Indian Creek	MC-4 Livestock	Bull Trout			Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed			
02-1625	SF Skagit Levee Setback Acq & Rest.	PS Threatened	Skagit River	MC-5 Channel	Chinook	Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed					
04-1596	Lower Tolt River Floodplain reconnection	PS Threatened	Tolt River	MC-5 Channel	Chinook		Year 0	2nd year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
05-1398	Fenster levee setback	PS Threatened	Green River	MC-5 Channel	Chinook			Year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
05-1521	Raging River preston reach	PS Threatened	Raging River	MC-5 Channel	Chinook			Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed			
05-1466	Lower Boise Creek construction	PS Threatened	Boise Creek	MC-5 Channel	Chinook			Year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
06-2223	Greenwater R ELJ & Road Decommissioning	PS Threatened	Greenwater River	MC-5 Channel	Chinook				Year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed
06-2239	Fender Mill Floodplain Restoration - Phase I	U Col Endangered	Methow River	MC-5 Channel	Chinook				Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
07-1519	Reecer Creek Floodplain Restoration	Mid Col Threatened	Reecer Creek	MC-5-Channel	Steelhead					Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed
06-2250	Chinook Bend Levee Removal	PS Threatened	Snoqualmie River	MC-5 Channel	Chinook				Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
02-1561	Edgewater Park Off-Channel Restoration	PS Threatened	Skagit River	MC-6 Connectivity	Chinook	Year 0	Year 1	Year 2	none	none	Year 5	Completed										
04-1461	Dryden Fish Enhancement	U Col Endangered	Wenatchee River	MC-6 Connectivity	Chinook		Year 0	Deferred	Year 1	Year 2	none	none	Year 5	Completed								
04-1573	Lower Washougal Restoration Phase 1 Site 1	Threatened	Washougal River	MC-6 Connectivity	Chinook		Year 0	Deferred	Year 1	Year 2	none	none	Year 5	Completed								
05-1546	Gagnon CMZ Off channel	U Col Endangered	Wenatchee river	MC-6 Connectivity	Chinook			Year 0	Year 1	Year 2	none	none	Year 5	Completed								
06-2277	Upper Klickitat R. Enhancement - Phase II	Mid Col Threatened	Klickitat River	MC-6 Connectivity	Steelhead				Year 0	Deferred	Year 1	Year 2	none	none	Year 5	Completed						
06-2190	Riverview Park Restoration	PS Threatened	Green/Duamish	MC-6 Connectivity	Chinook					Year 0	Year 1	Year 2	none	none	Year 5	Completed						
04-1563	Germany Creek Conservation Restoration	Lower Col Threatene	Germany Creek	MC-6 Connectivity	Chum					Year 0	Year 1	Year 2	none	none	Year 5	Completed						
06-2239	Fender Mill Floodplain Restoration - Phase I	U Col Endangered	Methow River	MC-6 Connectivity	Chinook				Year 0	none	Year 1	Year 2	none	none	Year 5	Completed						
07-1691	Lockwood Creek Phase 3		Lockwood and Riley C	MC-6 Connectivity	Coho					Year 0	Year 1	Year 2	none	none	Year 5	Completed						
04-1209	Chico Creek Instream habitat	PS Threatened	Chico Creek	MC-7 Gravel	Chum		Year 0	2nd year 0	Deferred	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed	
05-1614	Beebe Creek channel reconfiguration	U Col Endangered	Beebe Creek	MC-7 Gravel	Steelhead			Year 0	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed			
07-1678	Trout Creek/Hemlock Dam	Threatened	Trout Creek	MC-7 Gravel	Steelhead					Year 0	Deferred	Year 1	none	Year 3	none	Year 5	none	none	none	none	Year 10	Completed
02-1540	Touchet River screens Phase 2	Snake Threatened	Touchet River	MC-8 Screening	Steelhead	Deferred	Deferred	Deferred	Deferred	Year 1	Year 2	none	none	Year 5	Completed							
02-1543	Walla Walla Urban Fish Screens & Meters	Snake Threatened	Garrison Creek	MC-8 Screening	Steelhead	Deferred	Year 1	Year 2	none	none	Year 5	Completed										
02-1544	Tucannon River Watershed	Snake Threatened	Tucannon River	MC-8 Screening	Steelhead	Deferred	Deferred	Deferred	Year 1	Year 2	none	none	Year 5	Completed								
02-1656	Dry/Cabin Crk Fish Passage & Screening	Mid Col Threatened	Dry Creek	MC-8 Screening	Steelhead	Deferred	Year 1	Year 2	none	none	Year 5	Completed										

Project Number	ProjectName	Listings	Stream	Category	Target Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
04-1373	Indian Creek Diversion Screening #1	Northeast	Indian Creek	MC-8 Screening	Bull Trout	Deferred	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***								
04-1373	Indian Creek Diversion Screening #2	Northeast	Indian Creek	MC-8 Screening	Bull Trout	Deferred	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***								
04-1373	Indian Creek Diversion Screening #3	Northeast	Indian Creek	MC-8 Screening	Bull Trout	Deferred	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***								
04-1508	Jones Shotwell Screen and Diversion	U Col Endangered	Unnamed Creek	MC-8 Screening	Steelhead	Deferred	Deferred	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***							
04-1568	Garfield County Irrigation screening project	Snake Threatened	Alpowa Creek	MC-8 Screening	Steelhead	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***									
04-1675	YTAHP Lower Reecer Creek	Mid Col Threatened	Reecer Creek	MC-8 Screening	Steelhead	Deferred	Deferred	Deferred	Deferred	Deferred	**Year 1**	**Year 2**	none	none	**Year 5**	***Completed***						
00-1669	Chelan/Douglas Land Trust	U Col Endangered	Entiat River	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
00-1788	King Co Water & Land Res	PS Threatened	Rock Creek	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
00-1841	King Co DNR & Parks	PS Threatened	Green River	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
01-1353	Logging camp canyon Phase 1	Mid Col Threatened	Logging camp Cr	MC-10 Acquisition	Steelhead	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
02-1485	Chimacum Cr Estuary Riparian Acquisition	PS Threatened	Chimacum Creek	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
02-1535	Weyco Mashel Shoreline Acquisition	PS Threatened	Mashel River	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
02-1592	Curley Creek Estuary	PS Threatened	Curley Creek	MC-10 Acquisition	Chum	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
02-1622	Issaquah Cr Log Cabin Reach Acquisition	PS Threatened	Issaquah Creek	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
02-1650	Methow critical riparian habitat acquisition	U Col Endangered	Methow River	MC-10 Acquisition	Chinook	**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***			
04-1335	Piner Point on Maury Island	PS Threatened	Puget Sound	MC-10 Acquisition	Chinook			**Year 0**	none	none	**Year 3**	none	none	**Year 6**	none	none	**Year 9**	none	none	**Year 12**	***Completed***	

SALMON RECOVERY FUNDING BOARD

Reach-Scale Effectiveness Monitoring Program

2008 Annual Progress Report