Oregon Watershed Enhancement Board
Salmon Recovery Funding Board

Coordinated Monitoring Program for Livestock Exclusions

2007 Annual Progress Report

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Oregon Watershed Enhancement Board and the

Washington Salmon Recovery Funding Board

Coordinated Program for Livestock Exclusion Projects

2007 Progress Report

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EXECUTIVE SUMMARY

The Oregon Watershed Enhancement Board (OWEB) and the Washington Salmon Recovery Funding Board are currently working cooperatively to monitor livestock exclusion projects in both states as part of a project-scale effectiveness monitoring program for watershed and salmon habitat restoration projects. Data and results will be shared between the two states in order to begin to build a robust network of effectiveness monitoring activities within the Northwest. This coordinated approach represents a successful effort to collect comparable and compatible data across jurisdictional boundaries that supports regional evaluation of restoration project effectiveness. This program has reduced costs and increased the power of statistical analysis for both states.

The sample design for each monitoring site consists of a Before-After-Control-Impact (BACI) design. The reach where the project action takes place is called the impact reach and the control reach is established nearby in an area where conditions are not expected to change over the monitoring time frame of 10 years. Monitoring the control reach allows changes in environmental variation to be subtracted from changes due to both environmental variation and restoration action, isolating the changes to the restoration action. The monitoring addresses livestock presence, bank erosion, and vegetation measurements at each project site. Data are analyzed using a paired t-test to compare changes in the impact vs. the control over time.

When data from eleven completed projects are combined, initial results indicate that a significant reduction in bank erosion was detected in the first year after implementation. Variables measuring changes in vegetation structure and canopy cover did not change significantly during the same time frame. Additional monitoring events are needed to detect trends for these variables. More detailed information summarizing data collected during the baseline year and after project implementation is contained in the Annual Progress Report. The report also includes project objectives, methods description, and data analysis.

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ACRONYMS AND ABBREVIATIONS

BACI	Before-After-Control-Impact
dbh	diameter at breast height
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
OWEB	Oregon Watershed Enhancement Board
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
SRFB	Salmon Recovery Funding Board
WRIA	Water Resource Inventory Area

1. INTRODUCTION

The Oregon Watershed Enhancement Board (OWEB) and the Washington Salmon Recovery Funding Board (SRFB) both have the responsibility for funding watershed and salmon habitat restoration projects in their respective states. Collectively between 1999 and 2007, these two boards have authorized $507 million in funding to implement 3,408 projects that benefit watersheds and salmon habitat across Oregon and Washington. Effectiveness monitoring of these projects is critical to evaluate project performance and provide information to better inform future project designs and funding allocations. Effectiveness monitoring helps to provide accountability for expenditures in the form of quantified information on the physical and biological responses to the project action. The objective of effectiveness monitoring at the project scale is to use a robust sample design and responsive parameters to determine if change observed at a site from before project implementation to after project implementation is due to the project action itself. Additionally, data may be analyzed to determine if, on the whole, a restoration project category such as Livestock Exclusion is successful in achieving the stated objectives of the projects.

Both states have developed comprehensive, long-term monitoring strategies to identify monitoring needs for restoration actions. The Monitoring Strategy for the Oregon Plan for Salmon and Watersheds (2003) and the Washington Comprehensive Monitoring Strategy (2002) both outline goals and objectives for monitoring aquatic habitat and the biological effects of restoration.

These goals include coordination of monitoring activities. Effectiveness monitoring of projects has occurred at the local level, but has not been consistently coordinated within each state or across the state boundaries. 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 both state and jurisdictional boundaries. Staff members from both OWEB and SRFB are actively involved in monitoring coordination efforts across the region and serve on the Effectiveness Monitoring Committee of the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), which was developed to coordinate aquatic monitoring efforts.

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: 1) 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, 2) there was a need in Oregon to

monitor a sub-sample of the large number of livestock exclusion projects implemented, and 3) there has been significant investment by both states in Livestock Exclusion projects.

The objectives of livestock exclusion restoration projects are to exclude livestock from riparian areas where the animals can cause significant damage to the stream (e.g., by breaking down streambanks, increasing sedimentation, and damaging shade-producing trees and shrubs), and to allow or enhance recovery where damage has occurred. By excluding livestock, adverse impacts can be avoided and natural restoration of vegetation can take place (Crawford 2004). In some instances, damage recovery can be accelerated by planting riparian vegetation rather than waiting for natural recovery. Determination of the success and cost effectiveness of these projects requires a monitoring program that provides quantitative measures of success. As part of this program, the objectives of reducing active erosion and increasing riparian vegetation structure are applied in livestock exclusion projects. These parameters are measured and compared to change in a control site to determine if project actions are improving conditions at the site (i.e., if the project is effective). Changes are compared to defined success criteria over a specific time period to determine if the project category is successful.

In this progress report, data collected from eleven projects distributed across both states are presented. A sample size of eleven was included to meet the requirements of a power analysis conducted prior to the implementation of the monitoring program. Data presented include the pre-implementation data and data collected after project implementation at each site and at a control reach. Paired t-tests are used to analyze the differences between impact and control reaches through time to determine project effects. Initial results indicate that a significant reduction in bank erosion was detected in the first year after implementation with a mean reduction (of 24 percent) of the linear proportion of actively eroding banks across all sites. Variables measuring changes in vegetation structure and canopy cover did not change significantly. Additional monitoring events are needed to detect trends for these variables.

2. SITE SELECTION, REACH SELECTION, AND LAYOUT

The Protocol used in this pilot project was developed originally for the SRFB and was adapted from the U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP) approach for monitoring habitat in wadeable streams. The protocol takes the EMAP approach and applies it using a Before-After-Control-Impact (BACI) sample design in which control and impact reaches are established at each project site. Change in a given parameter is calculated by subtracting the control from the impact reach in Year 0, prior to project implementation, and comparing that difference to the difference between impact and control in Year 1, after project implementation. The subtraction of the control reach value allows the data to truly reflect the results of the project action instead of changes in environmental conditions.

2.1 SITE SELECTION

Once livestock exclusion projects approved for funding were identified, the monitoring contractors (Tetra Tech EC Inc. and KWA Inc.), grantees, and project sponsors worked with landowners prior to the sampling effort to gain access to the project areas and to determine locations for control reaches. Sites selected for monitoring are shown in Figure 2-1. Contractor survey teams contacted grantees to discuss the needs for the control reaches, and the final selection of the impact and control reaches was made in the field.

2.2 ACCESS

Permission to access each project site was obtained from the landowner(s) before starting seasonal fieldwork. The access issues were prioritized so that those sites that needed to be sampled first (e.g., sites with near-term implementation dates) were the initial focus.

Grantees and project sponsors also provided valuable information and assistance in determining potential control sites for the BACI design. These reaches were often on adjacent properties and permission to access the control site over time also was gained prior to or during this initial contact. Potential control sites were examined and it was determined in the field if they were suitable.

Figure 2-1. Monitoring Site Locations

2.3 DIGITAL DATA COLLECTION

Data were recorded using Husky FEX 21® hand-held computers and Trimble® GeoExplorer global positioning system (GPS) units. Electronic field forms for each monitoring task were built either in Visual CE® or Microsoft Excel® software. Field data were downloaded to field laptops and sent to a permanent centralized database located in the Tetra Tech EC Office in Seattle, WA. Digital files for each project include a project site map with topographic maps, digital data collection forms for hand-held data loggers, photographs of the transects in the control and impact reaches, and database structures to house the field data collected and calculate the appropriate summary statistics.

2.4 BACI DESIGNS

For this sample design, control and impact reaches were established and documented. These reaches were sampled before project implementation and will be re-sampled for several years after project implementation. As shown in Figure 2-2, for each project site, the "X" point was located using a GPS unit, and control and impact reaches were located in reference to the "X" point. The "X" site was the center of the sample reach. Each reach was selected in accordance with the SRFB Protocols. Within each reach, 11 equally spaced sampling transects, labeled A through K, were established and flagged. The total length of the sample reach was based on 40 times the average wetted width of the channel, but was at least 150 meters. Permanent rebar stakes were placed at Transects A, F, and K to facilitate relocating the sample reach (Figure 2-2).

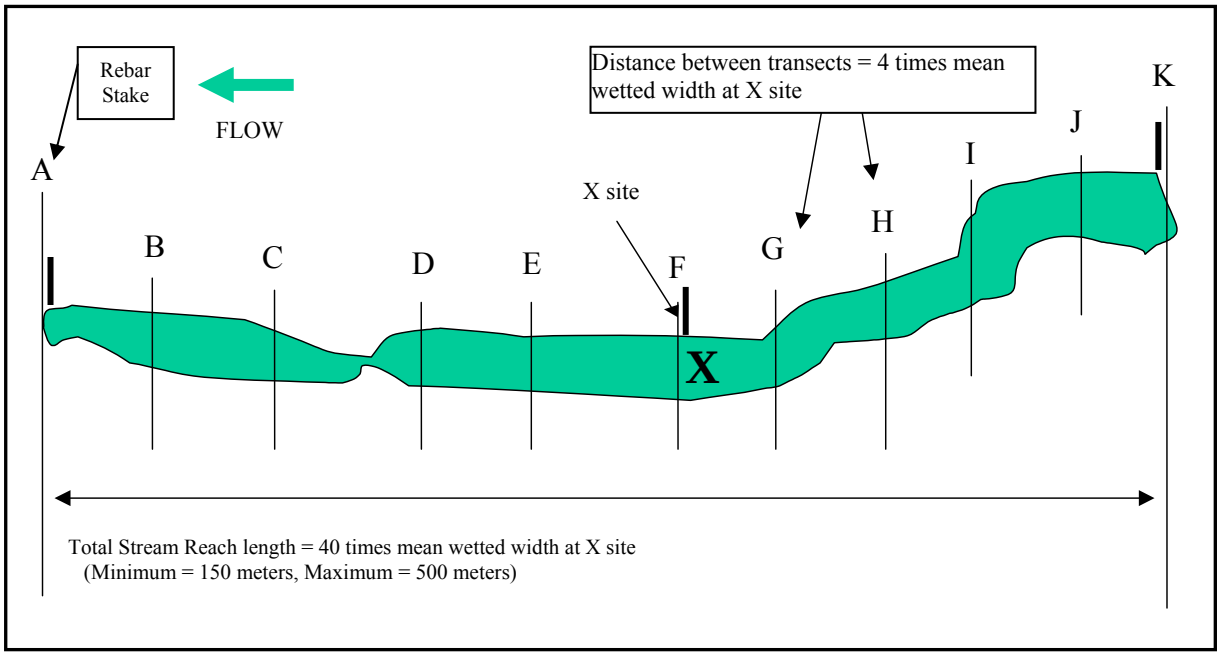

Figure 2-2. Layout of Sampled Project Reach

Transect F was located in the center of the sample reach and served as the "X" site. GPS points were recorded for each sample reach at Transects A, F, and K where the rebar stakes were placed. Photographs were taken of the view upstream and downstream at Transects A, F, and K to help relocate the transects. Additionally, a reach map was drawn for each sample reach with the location of each transect and reach-scale landmarks to help relocate the sample reach. The combination of the GPS points, rebar stakes, reach description, site directions, photographs, and a reach map was deemed sufficient documentation to relocate the sample reaches in subsequent sampling efforts.

3. MONITORING METHODS

Eleven livestock exclusion projects were identified for the 2007 field season (Figure 2-1). Monitoring data collected at these sites included livestock presence, riparian vegetation structure, shading, and bank erosion in control and impact reaches. Livestock presence was assessed before project implementation, and presence or absence of livestock was documented after project implementation. These parameters are discussed further below.

3.1 LIVESTOCK PRESENCE

Livestock presence was assessed prior to implementation using the SRFB Protocol (Crawford 2004), and this monitoring was repeated after implementation. Photographs were taken to document any evidence of or effects from livestock use and to determine the point of entry for any livestock. Livestock exclusions will be considered effective if 80 percent of the projects continue to exclude livestock after 10 years or the maximum project agreement length, which ever is greater. Any entrance of livestock into the riparian area would be an example of project failure. Data analysis methods are discussed further in Section 5.

3.2 RIPARIAN VEGETATION

The SRFB Protocol (Crawford 2004) was used to measure for riparian structure. At each lettered transect, crews visually estimated 5 meters upstream and 5 meters downstream and 10-meter horizontal distance into the bank riparian vegetation. These boundaries formed a conceptual 10 meter x 10 meter square straddling the transect along each bank. The vegetation was then mentally divided into three vertical layers:

- Canopy—vegetation greater than 5 meters (16 feet);
- Understory—vegetation between 0.5 meter to 5 meters (20 inches to 16 feet) in height; and
- Ground cover—vegetation less than 0.5 meter (20 inches) high.

Dominant vegetation type for the canopy was categorized as Deciduous, Coniferous, Broadleaf Evergreen, Mixed, or None. The canopy was considered mixed if more than 10 percent was another type. Aerial cover class of large trees (greater than 0.3 meter [1 foot] diameter at breast height [dbh]) and small trees (less than 0.3 meter [1 foot] dbh) also was determined within the canopy layer using the following categories:

- None—0
- 1—sparse, <10 percent
- 2—low, 10-40 percent

- 3—moderate, 40-75 percent
- 4—heavy, >75 percent

Dominant vegetation also was recorded for the understory layer (i.e., Deciduous, Coniferous, Broadleaf Evergreen, Mixed, or None). Aerial cover class for woody shrubs and saplings within the understory was estimated as above. Aerial cover was similarly determined for the ground layer for woody shrubs and seedlings, non-woody vegetation, and the amount of bare ground/duff. These estimates were completed for both banks at each transect along the reach. The project will be considered effective if a 20 percent increase in the proportion of the reach with all three vegetation layers is observed within 10 years.

3.3 SHADING

The SRFB Protocol (Crawford 2004) was used to measure shading for riparian plantings. Six densiometer measurements of canopy cover were taken at each cross section. By counting the number of grid intersection points within the "V" that were covered by a tree, leaf, or high branch, a score between 0 and 17 was assigned for canopy cover at each measurement point. Four measurements were taken from the center of the stream: facing downstream, upstream, toward the left bank, and toward the right bank. Two measurements were taken at the banks; one facing each bank. If the measure could not be taken, it was indicated in the data form with an explanation. Stream center scores were averaged to produce a mean canopy density at midstream. Bank measurements were averaged to produce a mean bank canopy cover along the banks. The project will be considered effective if a 20 percent increase in canopy density is observed within 10 years.

3.4 ACTIVELY ERODING STREAM BANKS

The SRFB Protocol (Crawford 2004) was used to estimate the percent of the linear distance of the channel on both sides at each transect that was actively eroding at active channel height. Active erosion is defined as active bank slumping, or clear impacts due to livestock use of the banks that are not completely revegetated. The project will be considered effective if a 20 percent reduction in percent bank length that is actively eroding is observed within 10 years.

4. RESULTS

This section summarizes the results for each project, and provides a basic description of each project site and the objectives for each project. Summary statistics are provided for both the control and impact reaches for each project site.

4.1 DECISION CRITERIA

Decision criteria are used to determine if a project has been successful with respect to creating measurable change at the project site where the project is implemented. A value of 20 percent change was selected for most parameters as a threshold used to determine the success of a project, and can be used within a single project or in looking at the projects as a group. The decision criterion of 80 percent for the functional exclusion parameter is based on the performance of all the projects in the monitoring category (i.e., all the livestock exclusions monitored). Table 4-1 identifies the summary statistics for livestock exclusions. A determination on functional exclusions will be made after implementation.

Table 4-1. Decision Criteria for Livestock Exclusions

Monitoring Parameter	Variable	Unit	Test Type	Decision Criteria
Functional Exclusion	The number of livestock exclusions 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.
Riparian Condition	Densiometer Reading Mean canopy density at the bank	1-17 score	Paired *t*-test	Alpha = 0.10 for one-sided test. Detect a minimum 20% increase between impact and control by Year 10
	Three-layer riparian vegetation presence (proportion of reach)	%	Paired *t*-test	Alpha = 0.10 for one-sided test. Detect a minimum 20% increase between impact and control by Year 10
	Actively eroding banks (proportion of reach)	%	Paired *t*-test	Alpha = 0.10 for one-sided test. Detect a minimum 20% increase between Impact and control by Year 10
Source: Crawford 2004				

4.2 PROJECT-SPECIFIC SUMMARIES

Project results below are grouped together based on the funding source and the project sponsor that received the funding. Project sponsors included the Coquille Watershed Association, Tenmile Lakes Basin Partnership, Union Soil and Water Conservation District, Harney Soil and Water Conservation District, and Long Tom Watershed Council, Cowlitz-Wahkiakum Conservation District, Kalispel Indian Tribe, Chehalis Basin Fisheries Task Force, and Seattle City Light.

Projects were monitored prior to fence installation (Year 0), and are scheduled to be monitored for a period of ten years following installation during Years 1, 3, 5, and 10. The riparian characteristics identified in the summary statistics are intended to track the health and stability of the riparian corridor along the livestock exclusion. The stream length and reach length are determined prior to implementation of the project and are based on the size of the stream and the area affected by the project. These numbers are not expected to change over the course of project monitoring. After implementation, canopy density and riparian vegetation structure are generally expected to increase as the condition of the riparian area improves. The percentage of bank erosion is expected to decrease over time, and the exclusion design is expected to remain functional. The area excluded by fencing is measured after implementation and reported in acres.

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

Project Location

The project area is located in the Coquille Watershed, southwest of Coquille, Oregon. 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.

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 Gray Creek. The project involved fencing along both sides of the creek for approximately 1,981 meters, excluding livestock from 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 landowners 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.

Project Data

Table 4-2 summarizes the data collected during Year 0 and Year1 monitoring of the Gray Creek Livestock Exclusion Project.

Table 4-2. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	1,981	N/A	1,981
Reach Length (m)	150	150	150	150
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

[1/] See Table 4-1 for explanation of variables.
Data collected June 8, 2006 (Year 0) and June 26, 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 site over time. The following photos were taken at Gray Creek during Year 0 and Year 1. Fence installation and some vegetation growth near the stream are apparent in the Year 1 photo.

Impact reach at Transect A in 2006 (Year 0)

Impact reach at Transect A in 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 some 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 (see photo above entitled "Impact Transect A in 2007 [Year 1]"). Note the difference in the height of the vegetation between the plants closer to the creek in the center of the photo 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.

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 in the area) are contributing to a ten-fold increase in the amount of sediment delivered to Tenmile Lakes. This increase in sedimentation is affecting 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

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 the area. This project is expected to result in benefits to the watershed over the long term through increased groundwater 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 are the landowners within the project area and Mike Mader of the Tenmile Lakes Basin Partnership is the primary contact for this project.

Project Data

Table 4-3 summarizes the data collected during Year 0 and Year 1 monitoring of the Johnson Creek Livestock Exclusion Project.

Table 4-3. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	1,067	N/A	1,067
Reach Length (m)	150	150	150	150
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	N/A	N/A	No
Area of Exclusion (acres)	N/A	N/A	N/A	4

[1/] See Table 4-1 for explanation of variables.
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.

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.

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.

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 Noble Creek Road. The control reach is a currently fenced site that will remain fenced over the period of monitoring.

Project Objective

This project provided fencing and riparian planting to reduce the input of sediment from bank erosion in Maria Gulch. The project was intended to prevent livestock access to the stream, reduce sediment input and non-point source runoff, and improve riparian vegetation quality and shading. The landowners within the project area are Joe and Maria Goularte and Mike Mader of the Tenmile Lake Basin Partnership is the contact person for this project.

Project Data

Table 4-4 summarizes the data collected during Year 0 and Year 1 monitoring of the Noble Creek/Maria Gulch Livestock Exclusion Project.

Table 4-4. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	1,524	N/A	1,524
Reach Length (m)	150	150	150	150
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	49.55	27.75	11.25
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	3.5

[1/] See Table 4-1 for explanation of variables.
Data collected June 6, 2006 (Year 0) and June 27, 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 Noble Creek/Maria Gulch during Year 0 and Year 1. The 2007 photo shows the fence in place and increased vegetation growth as compared to 2006.

Impact Transect F (Maria Gulch) in 2006 (Year 0)

Impact Transect F (Maria Gulch) in 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.

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.

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 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. The "let down" fence 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 so that deciduous riparian vegetation can be protected and enhanced, providing additional shading to the stream. In addition, this project was designed to improve streambank stability, resulting in decreased sedimentation into the stream. The project area is located on US Forest Service (USFS) land and Aric Johnson is the contact person for the Bottle Creek project.

Project Data

Table 4-5 summarizes the data collected during Year 0 and Year 1 monitoring of the Bottle Creek Livestock Exclusion Project.

Table 4-5. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	610	N/A	610
Reach Length (m)	150	150	150	150
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	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	12.5

[1/] See Table 4-1 for explanation of variables.
Data collected June 19 and 20, 2006 (Year 0) and June 14, 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 site over time. The following photos were taken at Bottle Creek during Year 0 and Year 1. The Year 1 photo shows the fence installed along the creek.

Impact reach in 2006 (Year 0)

Impact reach in 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, reassessment 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.

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 to 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.

Project Location

The project area is located on North Fork Clark Creek, within the Upper Grande Ronde Watershed, in Union County. The impact and control reaches 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 so that deciduous riparian vegetation could be protected and enhanced, providing additional shading to the stream. In addition, this project was designed to improve streambank stability, resulting in decreased sedimentation into the creek. The project area is located on US Forest Service (USFS) land and Aric Johnson is the contact person for the Clark Creek Tributary project.

Project Data

Table 4-6 summarizes the data collected during Year 0 and Year 1 monitoring of the North Fork Clark Creek Livestock Exclusion Project.

Table 4-6. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	732	N/A	732
Reach Length (m)	150	150	150	150
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

[1/] See Table 4-1 for explanation of variables.
Data collected June 20, 2006 (Year 0) and June 15, 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 North Fork Clark Creek Tributary during Year 0 and Year 1. The Year 1 photo shows increased undergrowth after project implementation.

Impact reach at Transect K in 2006 (Year 0)

Impact reach at Transect K in 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 in 2006 and this was maintained through 2007.

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.

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.

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, Oregon, within the Long Tom Watershed. Neither the control nor the impact reach is fenced and both are actively used by horses.

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 landowner within the project area is Deborah Mattson, and Cindy Thieman of the Long Tom Watershed Council serves as the contact person for this project.

Project Data

Table 4-7 summarizes the data collected during Year 0 and Year 1 monitoring of the Jordan Creek Livestock Exclusion Project.

Table 4-7. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	1,609	N/A	1,609
Reach Length (m)	150	150	150	150
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	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	7.8

[1/] See Table 4-1 for explanation of variables.
Data collected August 14, 2006 (Year 0) and September 13, 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 Jordan Creek during Year 0 and Year 1. New growth of vegetation along the stream can be seen in the photo from 2007.

Impact reach in 2006 (Year 0)

Impact reach in 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.

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.

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 Washington Department of Fish and Wildlife (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, 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 U.S. Fish and Wildlife Service (USFWS) Abernathy Technical Center. The impact reach is located within one of the conservation easement areas

on private property and the control reach is located 1.3 miles upstream from the impact reach on USFWS property, adjacent to the Abernathy Fish Technology Center.

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

Table 4-8 summarizes the data collected during Year 0 and Year 3 monitoring of the Abernathy Creek Riparian Restoration (Livestock Exclusion) Project.

Table 4-8. Summary Statistics for Pre- and Post-Implementation (Year 0 and Year 3) Monitoring

Variable[1/]	Year 0 (2004)		Year 3 (2007)	
	Control	Impact	Control	Impact
Stream Physical Characteristics				
Stream Length (m)	N/A	4,023	N/A	4,023
Reach Length (m)	240	240	240	240
Riparian Characteristics				
Canopy Density (1-17)	16.68	15.55	16.46	14.18
Riparian Vegetation Structure (%)	100	100	100	100
Bank Erosion (%)	2.0	2.0	2.8	3.8
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	84

[1/] See Table 4-1 for an explanation of variables.
Data collected June 11-12, 2004 (Year 0) and June 4-5, 2007 (Year 3)

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 during the Year 1 and Year 3 surveys at Abernathy Creek. The Year 3 survey photos provide evidence that the exclusion is still in place and is being maintained.

Livestock exclusion fencing after installation in 2005 (Year 1)

Livestock exclusion fencing in 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.

04-1655: Hoy Riparian Restoration – SRFB

The Hoy Riparian Restoration project occurred along a two-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 reaches of the 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. The photographs below show the erosion along the riverbank in 2005. The Hoy Riparian Restoration Project was designed to restore the riparian area along this property and protect the river banks, sustaining the morphology of the river channel.

Eroding river bank in 2005 (Year 1)

Livestock exclusion fence in the impact reach; plantings behind fence are beginning to grow above grass (Year 1)

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.

Project Objective

The objective of the project was to protect and restore natural streamside vegetation, improve stream temperature, reduce erosion, improve filtration, and recruit large woody debris (LWD).

The target species for this project was Chinook salmon. Seattle City Light and Skagit Land Trust sponsored this project, and Ed Conner, Tom Meyer, and Martha Bray are the contacts.

Project Data

Table 4-9 summarizes the data collected during Year 0 and Year 1 monitoring of the Hoy Livestock Exclusion project.

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

Variable[1/]	Year 0 (2005)		Year 1 (2006)	
	Control	Impact	Control	Impact
Stream Physical Characteristics				
Stream Length (m)	N/A	3,218	N/A	3,218
Reach Length (m)	210	210	210	210
Riparian Characteristics				
Canopy Density (1-17)	16.73	6.0	16.64	3.09
Riparian Vegetation Structure (%)	59.1	18.2	50.0	0
Bank Erosion (%)	37.5	47.5	55.3	50.0
Riparian Livestock Exclusions				
Exclusion Design (y/n)	N/A	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	38.0

[1/] See Table 4-1 for explanation of variables
Data collected May 6, 2005 (Year 0) and July 19, 2006 (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 during the Year 0 and Year 1 surveys at the Hoy Livestock Exclusion project. The Year 1 photo shows some stabilization of eroding banks due to vegetation growth.

Eroding bank in impact area in 2005 (Year 0)

Stream bank in impact area in 2006 (Year 1)

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. Data collected at the site indicate that there has not been improvement in either riparian vegetation structure or canopy density, but that slight improvements in bank erosion occurred in the first year after implementation.

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 sea-run 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 aims 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 landowner and Toutle High School students provided the labor to remove the existing fence, conduct site preparation activities necessary to establish woody riparian vegetation, and plant the riparian vegetation, and are willing to help 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. The impact reach is located on the Rauth property within Township 8N, Range 1W, and Section 26. The control reach 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.

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

Table 4-10 summarizes the data collected during Year 0 and Year 1 monitoring of the Rauth Coweeman Project.

Table 4-10. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	1,207	N/A	1,207
Reach Length (m)	146	146	146	146
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	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	2.25

[1/] See Table 4-1 for explanation of variables.
Data collected May 19, 2006 (Year 0) and October 12, 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 site over time. The following photos were taken during the Year 0 and Year 1 surveys at the Rauth Coweeman site. The Year 1 photo shows the fence that is now functional and excluding livestock.

Access to stream by livestock (Year 0)

Livestock exclusion fencing (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 increases 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.

The Year 1 survey for this project was completed shortly after the fencing was installed. Fresh horse manure was found within the exclusion area during this survey, but likely resulted from livestock activity just prior to the completion of the fence. The new fence was inspected and found to be fully intact at the time of the survey.

05-1447: Indian Creek Yates Restoration Project – 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 streambanks 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 quality and connectivity within the creek.

Exclusion fencing installed in impact reach (Year 1)

Impact reach in 2007 (Year 1)

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 located on the Walker property within Township 32N, Range 45E, and Section 20.

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

Table 4-11 summarizes the data collected during Year 0 and Year 1 monitoring of the Indian Creek Project.

Table 4-11. 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
Stream Physical Characteristics				
Stream Length (m)	N/A	965	N/A	965
Reach Length (m)	160	160	160	160
Riparian Characteristics				
Canopy Density (1-17)	12.0	16.09	15.5	16.82
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	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	4.5

[1/] See Table 4-1 for explanation of variables.
Data collected May 30 - 31, 2006 (Year 0) and August 20 - 21, 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 during the Year 0 and Year 1 surveys at Indian Creek. The Year 1 photo shows the fence in place and vegetation growth along the fence.

Evidence of livestock crossing in the impact reach (Year 0)

Livestock exclusion fencing in impact reach (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 cannot 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.

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.

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 northwest of Elma, flows through residential lands and 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.

Project Data

Table 4-12 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.

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

Variable[1/]	Year 0 (2005)		Year 1 (2007)	
	Control	Impact	Control	Impact
Stream Physical Characteristics				
Stream Length (m)	N/A	7,644	N/A	7,644
Reach Length (m)	150	150	150	150
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	N/A	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	5.0

[1/] See Table 4-1 for explanation of variables
Data collected August 2, 2005 (Year 0) and September 11, 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 during the Year 0 and Year 1 surveys at Vance Creek. The Year 1 photo shows the recent plantings installed along the creek as well as the fencing.

Livestock access to creek pre-implementation (Year 0)

Livestock exclusion fencing in 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.

5. DATA ANALYSIS

This chapter includes the analyses from the combined monitoring of livestock projects in Oregon (as part of the OWEB Livestock Exclusion Monitoring Program) and Washington (as part of the SRFB Livestock Exclusion Monitoring Program). The results in this chapter are based on the eleven livestock exclusion projects completed through funding from the OWEB and SRFB programs. Each of the eleven projects included one year of pre-project implementation data and one year of post-project implementation data. The first section in this chapter describes the methods used to analyze the projects, and the second section presents the results from data analysis and an evaluation of the findings.

5.1 DATA ANALYSIS METHODS

Analysis of the eleven projects in Oregon and Washington is founded on the BACI sample design and incorporates both spatial and temporal replication. Employing the BACI design and monitoring multiple livestock exclusion projects over multiple years increases the ability to detect actual treatment effects. Table 5-1 presents the livestock exclusion projects in Oregon and Washington, and the years for which pre- and post-implementation data have been collected. For project number 02-1498, a second year of post-project (Year 3) implementation data has been collected. Analyses that were performed 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 to determine project effectiveness for the group of projects. The decision criteria used in this evaluation are based on the objectives established for livestock exclusion projects, and comprise two components: 1) decision criteria for evaluating the function of livestock fencing; and 2) a benchmark evaluation of the percent change in the mean difference between the control and impact reach from before to after project implementation.

The following equation was used to determine the percent mean difference for each indicator:

$$\left(\frac{\text{Mean Difference Current Year} - \text{Mean Difference Baseline Year}}{\text{Mean Difference Baseline Year}}\right)\times 100$$

Table 5-1. Projects Included in the Data Analysis

Project Number	Project Name	Years of Data Collected
02-1498R	Abernathy Creek Riparian Restoration	Years 0, 1, and 3
04-1655C	Hoy Riparian Restoration	Years 0 and 1
04-1698R	Vance Creek Riparian Planting and Fencing	Years 0 and 1
05-1447R	Indian Creek Yates Restoration	Years 0 and 1
05-1547R	Rauth: Coweeman Tributary Restoration	Years 0 and 1
206-095	OWEB: Jordan Creek	Years 0 and 1
206-072	OWEB: Grays Creek	Years 0 and 1
206-283	OWEB: Noble Creek	Years 0 and 1
206-283	OWEB: Johnson Creek	Years 0 and 1
205-060	OWEB: Bottle Creek	Years 0 and 1
205-060	OWEB: North Fork Clark	Years 0 and 1

Decision Criteria for Livestock Exclusion Projects (MC-4):

- The treatment will be determined effective if the livestock are excluded from 80 percent of the projects after Year 10.
- The linear proportion of actively eroding stream banks will be assessed and the treatment will be determined effective if a decrease of 20 percent or more is determined from the calculated percent difference between the mean difference in Year 0, or pre-project data, and the mean difference in the post-project data by Year 10.
- The mean percent canopy density at the bank and proportion of the reach with three-layer riparian vegetation present will be assessed and the treatment will be determined effective if an increase of 20 percent or more is determined from the calculated percent difference between the mean difference in Year 0, or pre-project data, and the mean difference in the post-project data by Year 10.

5.1.2 Statistical Analysis

For the eleven projects analyzed, the linear proportion of actively eroding banks, mean canopy density at the bank, and the proportion of the reach with three-layer riparian vegetation present were compared using the one-tailed paired *t*-test to determine if the project was effective (alpha = 0.10). In other words, the difference in the project mean between the control and impact reaches in the baseline year (d_0) was compared to the difference between the control and impact reaches in the current year (d_1). The mean difference between (d_0) and (d_1) across all eleven projects was tested to see if it was significantly less than (for eroding banks) or greater than (for canopy and riparian vegetation) zero. This analysis is designed to be applied each year through Year 10 to determine if the projects remain effective.

Prior to performing the one-tailed paired *t*-test, the distribution of the differences between (d_0) and (d_1) were evaluated to determine if the assumption of normality was met as required by the paired *t*-test. The differences from these projects departed substantially from a normal distribution, so the nonparametric analogue to the paired *t*-test, the Wilcoxon paired-sample test, was employed.

5.2 ANALYSIS AND EVALUATION

The data used in the effectiveness evaluation of the monitoring category consist of the Wilcoxon paired-sample test results, and decision criteria related to both the effectiveness of the livestock fencing and whether a change greater than 20 percent in the mean difference between d_0 and d_1 is observed. The following were the null (H_0) and alternative (H_A) hypotheses being tested in the Wilcoxon paired sample test for each variable:

For the linear proportion of actively eroding banks:

H_0: The mean difference between the baseline year (d_0) and the current year (d_1) ≥ 0
H_A: The mean difference between the baseline year (d_0) and the current year (d_1) < 0

For the mean percent canopy density at the bank and the proportion of the reach with three-layer riparian vegetation present:

H_0: The mean difference between the baseline year (d_0) and the current year (d_1) ≤ 0
H_A: The mean difference between the baseline year (d_0) and the current year (d_1) > 0

5.2.1 Livestock Exclusion Project Results

The results of the Wilcoxon paired-sample test indicate that the linear proportion of actively eroding banks was reduced significantly as a result of the projects implemented (Table 5-2). The calculated test statistic for this variable (T_+-statistic) was 8, which is less than the one-tailed T-critical value of 14, indicating a statistically significant reduction. The mean reduction after project implementation in the proportion of actively eroding banks in the impact reach vs. the control reach was 24, which results in a percentage change of 206 percent when compared to the baseline difference. This decrease is greater than the 20 percent decrease used as decision criteria. Using the evaluation methods for this variable, this category of projects was successful at reducing bank erosion. Although bank erosion significantly decreased, the mean percent canopy density and the proportion of the reach with three-layer riparian vegetation have not changed significantly as a result of the projects.

Of the eleven projects, 82 percent had fencing that was effective at excluding livestock, which exceeds the 80 percent requirement from the decision criteria for effectiveness.

Table 5-2. Summary of Significant Results from Livestock Exclusion Projects

Variable	T_+-statistic	T-critical	Significant?	Mean Change	Percent Change
Linear Proportion of Actively Eroding Banks (%)	8	14	YES	-24	-205%

Figure 5-1 shows the change in cumulative bank erosion at all projects through time and illustrates the decrease in erosion levels in the impact reaches as compared to the control reaches. Figures 5-2 and 5-3 show the cumulative changes in canopy density and riparian vegetation structure through time and indicate that the changes in the impact reaches in 2007 have not exceeded the changes in the control reaches.

Overall, for the livestock exclusion projects evaluated, the projects were effective at excluding livestock and reducing bank erosion, but significant results for changes in canopy density and riparian vegetation structure have not been observed and will likely take more time to detect.

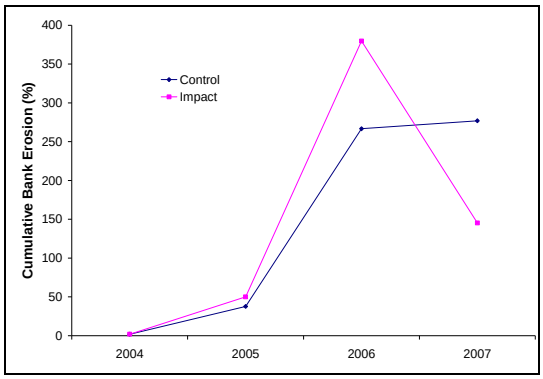

Figure 5-1. Cumulative Bank Erosion

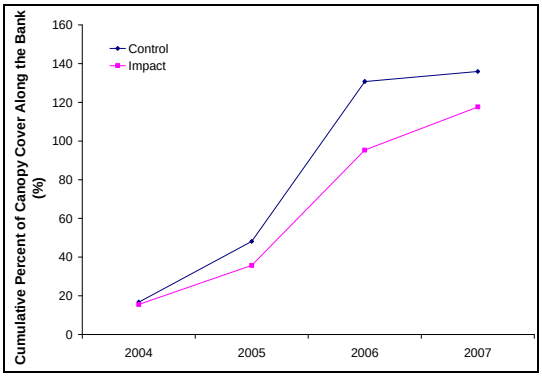

Figure 5-2. Cumulative Canopy Density

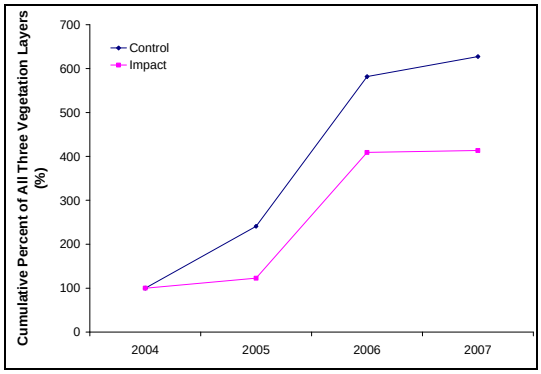

Figure 5-3. Cumulative Vegetation Structure

6. SUMMARY

In accordance with the desired outcomes of coordinated regional monitoring to provide comparable and compatible data, this Coordinated Monitoring Program for Livestock Exclusions has incorporated regional protocols to monitor the effectiveness of one category of restoration projects. These results help to provide accountability for restoration investments and promote information sharing across jurisdictions to improve design and implementation of these projects. These data can be used to track the success of projects through time and can be used to determine whether project objectives are being met. Within the first year after implementation, significant reductions in bank erosion have been quantified and documented for these Livestock Exclusion Projects, providing concrete evidence of attainment of one of the project objectives.

This report is an example of how one category of restoration projects can be monitored using regionally consistent protocols and data management systems for reach-scale effectiveness monitoring. Benefits from the program are provided to both states in terms of cost sharing and ease of data access. Using an independent third party to consistently apply monitoring techniques to all projects has assured that the results will be comparable and compatible in terms of protocol application. Other project categories are planned to be added to this program in the future. Through time, as additional project categories are added to the monitoring program, cost-effectiveness comparisons can be completed comparing project categories and project performance across the region. These programs could help to better direct efforts to fund projects that will be most effective in a given area. Data collected using these protocols are comparable across Oregon and Washington. The protocols may be adopted by other states, allowing for better allocation of restoration efforts and funding resources to address limiting factors for salmon recovery and watershed health improvements.

7. REFERENCES

Crawford, B. 2004. Protocol for Monitoring Effectiveness of Riparian Livestock Exclusion Projects. Accessed at: http://www.iac.wa.gov/Documents/SRFB/Monitoring/MC-4_Livestock_Exclusion_Projects.pdf.

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