Oregon Watershed Enhancement Board
Washington Salmon Recovery Funding Board

Coordinated Monitoring Program for Livestock Exclusions

2009 Annual Progress Report

February 2010

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TerraStat Consulting Group

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ACRONYMS AND ABBREVIATIONS

BACI	Before-After-Control-Impact
EMAP	Environmental Monitoring and Assessment Program
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
OWEB	Oregon Watershed Enhancement Board
SRFB	Salmon Recovery Funding Board
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Livestock Exclusion Monitoring in Washington and Oregon

Jennifer O'Neal[1], Jennifer Hawkins[1], Alice Shelly[2]

Abstract

The Oregon Watershed Enhancement Board (OWEB) and the Washington Salmon Recovery Funding Board (SRFB) are currently working cooperatively to monitor 12 livestock exclusion projects in both states as part of a project-scale effectiveness monitoring program for watershed and salmon habitat rehabilitation projects. The goal is to evaluate the success of these projects on a regional scale through time. Data and results are shared between the two state programs to build a network of effectiveness monitoring efforts throughout the Northwest. The goal of this program is to collect comparable and compatible data across jurisdictional boundaries that support regional evaluation of rehabilitation project effectiveness. Coordination of data between the two programs increases the power of statistical analysis at a reduced cost. The monitoring addressed livestock presence, bank erosion, and vegetation measurements at each project site. Data from three years of monitoring for 11 of the 12 livestock exclusion projects were evaluated for overall trends in changes for three variables: bank erosion, canopy density, and vegetation structure. Within the first three years, a significant decrease in bank erosion was detected as compared to the baseline year. No significant changes were observed with canopy density and vegetation structure. However, monitoring of additional projects over the long term is necessary to adequately evaluate project effectiveness.

[1]Tetra Tech EC, Inc. 19803 North Creek Parkway, Bothell, WA 98011
[2]TerraStat Consulting Group 2707 Pegram Avenue, Austin, TX 78757

Introduction

Rehabilitation of streams affected by livestock access often includes installation of fencing to construct exclosures. Investments in the construction and maintenance of exclosures have been made to improve watershed health. The Oregon Plan strives to "conserve and restore crucial elements of natural systems that support fish, wildlife and people" with an emphasis on restoring salmon and trout throughout the state (Oregon Coastal Salmon Restoration Initiative 1997). This comprehensive program works to benefit watershed health and wildlife including threatened and endangered salmonids by implementing livestock exclusion projects that improve riparian vegetation. Improved riparian conditions benefit bird species and other wildlife that utilize the riparian corridor, and benefit water quality by reducing the influx of sediment.

Grazing by livestock near salmon streams is considered detrimental to salmonid populations as shown in studies in the western US documenting reductions of salmonid abundance due to the effects of grazing and reduced riparian conditions (Platts 1991 as cited in Bayley and Li 2008). Exclosures that are properly constructed and maintained are effective at protecting banks and riparian vegetation from livestock grazing and other activities (Bayley and Li 2008). However, most of the previous studies did not include "pre-grazing" information or consider confounding factors (Bayley and Li 2008). Three advantages of increasing riparian vegetation, density, and structure within an exclosure are: 1) improved physical habitat protection from predatory birds; 2) favorable conditions for age-0 trout (Moore and Gregory 1988 as cited in Bayley and Li 2008) in association with the decrease in width: depth ratio, which is strongly associated with the quality of habitat for salmonids (Brown 1969; Crittenden 1978; and Walling and Webb 1992 as cited in Bayley and Li 2008); and 3) increased feeding opportunities due to invertebrate production (Rhodes and Hubert 1991 as cited in Bayley and Li 2008) and greater terrestrial invertebrate drift (Edwards and Huryn 1996 as cited in Bayley and Li 2008) in vegetated overhanging banks.

The assessment of livestock exclusion project success cannot be done without adequate monitoring. Most monitoring efforts are developed to meet the specific needs of one program instead of using a coordinated regional approach. The management of salmon requires coordinated data collection across the region so that rehabilitation efforts can address the needs of species whose ranges cross both state and jurisdictional boundaries. In addition to adequately addressing the biological needs, a coordinated regional approach that combines efforts and resources can be much more efficient than individual program monitoring efforts. In order to address common monitoring needs, the Oregon Watershed Enhancement Board (OWEB) and the Washington Salmon Recovery Funding Board (SRFB) developed a coordinated monitoring program for livestock exclusions as a pilot program to combine

efforts across state jurisdictions and produce comparable and compatible data from a regional perspective.

OWEB and SRFB both have the responsibility for funding watershed and salmon habitat rehabilitation projects in their respective states. Collectively between 1999 and 2007, these two boards authorized $507 million 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 to after project implementation is due to the project action itself. Additionally, data may be analyzed to determine if, on the whole, a rehabilitation project category such as livestock exclusion projects is successful in achieving the stated objectives of the projects.

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

Livestock exclusion projects were selected for the OWEB-SRFB Coordinated Monitoring Program for Livestock Exclusions 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 rehabilitation 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 recovery of vegetation can take place (Crawford 2008). 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. The monitoring goal is to determine whether livestock exclusion projects are effective at excluding livestock, restoring riparian vegetation, and restoring stream bank stability. These parameters are measured over multiple years 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 specified time period to determine if the project category is successful.

Methods

Detailed protocols are described in Crawford (2008) with descriptions of field collection techniques, summary statistics, and data analysis procedures. The protocol used in this pilot project was developed 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 (Lazorchak et al. 1998) and from Oregon Department of Fish and Wildlife's Methods for Stream Habitat Surveys (Moore et al 2008) for measuring erosion. The protocol takes the EMAP and ODFW approaches and applies them using a Before-After-Control-Impact (BACI) sample design. 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.

Projects were selected from those that had been funded but not yet implemented for the given baseline sampling year. Once livestock exclusion projects approved for funding were identified, suitable control reaches were identified for each site. Sites selected for monitoring are shown in Figure 1. Grantees and project sponsors 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.

Control and impact reaches were established and monitored prior to project implementation as described in Crawford (2008). Sample reaches were re-located in each subsequent monitoring year with the use of site directions, reach descriptions, hand-drawn maps, global positioning system (GPS) points, rebar stakes, and photographs.

Data were recorded using Trimble® GeoExplorer 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.

Monitoring data collected at all 12 sites included signs of livestock presence within the exclusion zone, riparian vegetation structure, shading, and bank erosion in both control and impact reaches. Livestock presence was assessed before project implementation, and presence or absence of livestock was documented after project implementation. All projects were monitored prior to fence installation (baseline Year 0), and are scheduled to be monitored for a period of 10 years following installation during Years 1, 3, 5, and 10.

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Analysis of the 12 livestock exclusion projects in Oregon and Washington was 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 for this type of rehabilitation on a regional scale. Table 1 presents the livestock exclusion projects in Oregon and Washington, and the most recent year for which data were collected.

Table 1. Livestock Exclusion Projects Included in the Data Analysis

Program	Project Number	Project Name	Latest Monitoring Year	Latest Calendar Year Monitored	Livestock Excluded or Absent
SRFB	02-1498	Abernathy Creek	Year 5	2009	Yes
SRFB	04-1655	Hoy	Year 3	2008	No
SRFB	04-1698	Vance Creek	Year 3	2009	Yes
SRFB	05-1447	Indian Creek Yates	Year 3	2009	Yes
SRFB	05-1547	Rauth Coweeman	Year 3	2009	Yes
OWEB	205-060	Bottle Creek	Year 3	2009	Yes
OWEB	205-060	North Fork Clark Creek Tributary	Year 3	2009	Yes
OWEB	206-072	Gray Creek	Year 3	2009	Yes
OWEB	206-095	Jordan Creek	Year 3	2009	Yes
OWEB	206-283	Johnson Creek	Year 3	2009	No
OWEB	206-283	Noble Creek/Maria Gulch	Year 3	2009	Yes
OWEB	206-357	Middle Fork Malheur River	Year 1	2008	Yes

Livestock presence was assessed during each survey and photographs were taken to document any evidence of or effects from livestock use, and to document the point of entry for any livestock.

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. Table 2 identifies the summary statistics for livestock exclusions.

Table 2. Decision Criteria and Summary Statistics for Livestock Exclusion Projects

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	Actively eroding banks (linear proportion of reach)	%	*t*-test	Alpha = 0.10 for one-sided test. Detect a minimum 20% decrease between Impact and control by Year 10

Table 2. Decision Criteria and Summary Statistics for Livestock Exclusion Projects (continued)

Monitoring Parameter	Variable	Unit	Test Type	Decision Criteria
Riparian Condition (continued)	Densiometer Reading Mean canopy density at the bank	1-17 score	*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)	%	*t*-test	Alpha = 0.10 for one-sided test. Detect a minimum 20% increase between impact and control by Year 10

Source: Crawford 2008

To evaluate the success of livestock exclusion projects regionally over time, the trend of the linear proportion of each variable (actively eroding banks, mean canopy density at the bank, and the proportion of the reach with three-layer riparian vegetation present) was evaluated. The simplest way to look at this type of trend, a longitudinal analysis, is to do a profile summary, summarizing the trend at each livestock exclusion project site with one number. In this case we used the regression slope as our trend summary. A parametric *t*-test for normal distribution is used to assess whether all 12 project regression slopes demonstrate a significant trend. Use of the linear regression slope was found to be most sensitive to a linear increase or decrease occurring across the monitoring years. We estimated the least-squares regression slope of the response (impact minus control for each sampled variable) and regressed the slope against time, where time is measured relative to project implementation.

For each variable within each monitoring category, linear slopes were estimated and were evaluated for approximate normality. A one-tailed 90 percent confidence limit based on a *t*-test was used. If the 90 percent upper confidence limit was less than zero, there was a significant negative trend. If the 90 percent lower confidence limit was greater than zero, then there was a significant positive trend.

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.

For each variable with a significant trend, the mean difference between the control and impact reaches in the baseline year (d_0) for all projects was compared to the mean difference between

the control and impact reaches in Year 1 (d_1) and Year 3 (d_3) for all projects. The following equation was used to determine the percent mean difference for each indicator:

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

The following were the null (H_0) and alternative (H_A) hypotheses being tested 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

This analysis is designed to be applied each year through Year 10 to determine if the projects remain effective.

Results

Data collected from the 12 livestock exclusion projects monitored between 2004 and 2009 located in Washington and Oregon were included in the evaluation. Of the 12 livestock exclusion projects, 83 percent had fencing that was effective at excluding livestock during the most recent monitoring year, which exceeds the 80 percent requirement from the decision criteria for effectiveness of this project category.

A significant reduction in the linear proportion of actively eroding banks was detected in post-implementation monitoring years at a regional level. The other two variables (canopy density and riparian vegetation structure) did not show significant trends when assessed on a regional scale. Additional monitoring events are needed to detect trends for these variables, as the time required for changes in vegetation is extensive. The results of the trend evaluation for the 12 livestock exclusion projects are included in Table 3. Although we are not able to see a significant difference with a sample size of 12 for canopy density, with a sample size of 16, there is an 80 percent probability of detecting a population trend of at least 50 percent of the starting mean. With a sample size of 12, there is an 80 percent probability of detecting a population trend of at least 20 percent of the starting mean for riparian vegetation structure.

Table 3. Statistical Results for Livestock Exclusion Projects

Variable	Number of Sites	Average Slope	Standard Error of Slope	Distribution	Evaluation Method	P-value	Significant trend?
Bank Erosion	12	-4.6	2.5	normal	*t*-test	0.052	Yes
Canopy Density	12	0.10	0.73	normal	*t*-test	0.182	No
Riparian Vegetation	12	1.75	1.86	normal	*t*-test	0.265	No

Figure 2 displays the linear regression trend for bank erosion. Most (83 percent) of the sites show a negative slope, indicating a reduction in bank erosion for each subsequent monitoring year.

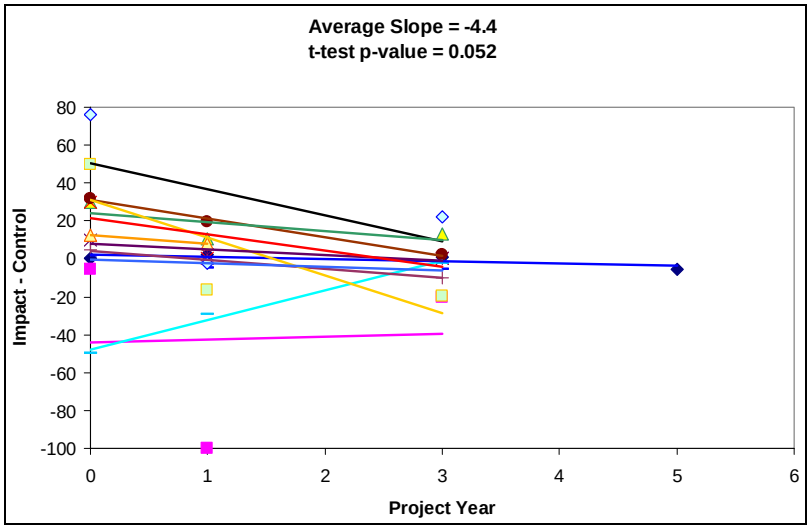

Figure 2. Linear Regressions by Project for Bank Erosion

The mean reduction in the proportion of actively eroding banks was calculated for 11 projects that included monitoring in Year 3. The mean percent difference for Year 3 monitoring compared to Year 0 was -111 percent. This decrease is greater than the 20 percent decrease decision criteria; therefore, as of Year 3 monitoring, livestock exclusion projects are determined to be successful at reducing bank erosion on a regional scale. All but one project (206-072 Gray Creek) have reduced bank erosion by at least 20 percent (see Figure 3). However, three projects (Abernathy Creek, Vance Creek, and Indian Creek Yates) had a percent difference of 100 in Year 3 because there was no difference between the impact and control reach in either Year 0 (Abernathy) or Year 3 (Vance and Indian), and 100 percent is used as the default value.

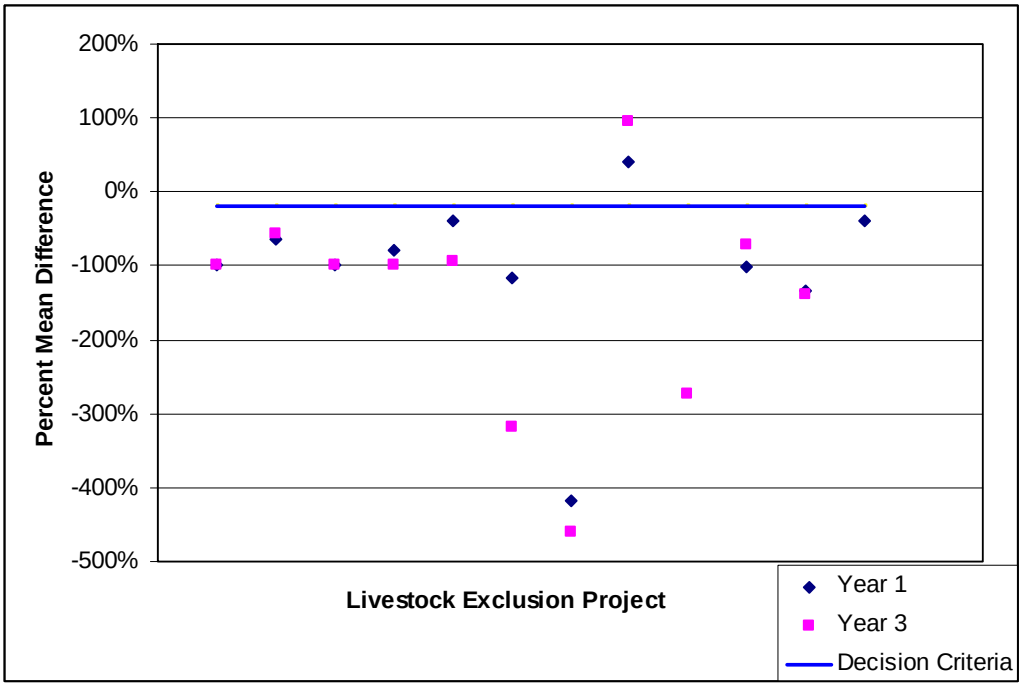

Figure 3. Mean Difference of Bank Erosion from Baseline Year 0 for Each Project

The mean percent canopy density and the proportion of the reach with three-layer riparian vegetation have not changed significantly on a regional scale. However, data for these variables are provided on an individual project basis in Table 4. Twelve projects include Year 1 monitoring data, 11 projects have Year 3 monitoring data, and 1 project has Year 5 monitoring data. Canopy density increased in 3 out of 12 projects by Year 1 and increased in 6 of 11 projects in Year 3. However, only 5 projects showed an increasing trend from Year 1 to Year 3. Details of trends are discussed on the individual report pages in Appendix A. Riparian vegetation structure increased in 3 of 12 projects in Year 1 and increased in 5 of the 11 projects in Year 3 when compared to Year 0. However, 7 of 11 projects showed an increasing trend from Year 1 to Year 3. Although an increase is not evident in Year 3

compared to Year 0 in all 7 projects, the parameter does show the trend moving in the right direction on a regional scale.

Table 4. Mean Difference of Canopy Density and Riparian Structure for Each Project

		Canopy Density % Difference			Riparian Structure % Difference		
Project Number	**Project Name**	**Year 1**	**Year 3**	**Year 5**	**Year 1**	**Year 3**	**Year 5**
02-1498	Abernathy Creek	0%	-100%	44%	0%	0%	0%
04-1655	Hoy	-26%	1%	NA	-22%	-11%	NA
04-1698	Vance Creek	-170%	164%	NA	0%	35%	NA
05-1447	Indian Creek Yates	-68%	-78%	NA	0%	100%	NA
05-1547	Rauth Coweeman	-15%	-17%	NA	-200%	-100%	NA
205-060	Bottle Creek	-22%	72%	NA	0%	60%	NA
205-060	North Fork Clark Creek Trib	233%	-27%	NA	0%	0%	NA
206-072	Gray Creek	-51%	-54%	NA	-33%	-116%	NA
206-095	Jordan Creek	-1%	91%	NA	5%	19%	NA
206-283	Johnson Creek	85%	87%	NA	100%	100%	NA
206-283	Noble Creek/Maria Gulch	167%	121%	NA	22%	100%	NA
206-357	Middle Fork Malheur River	-289%	NA	NA	0%	NA	NA
	Mean	-14%	50%	NA	-9%	17%	NA

Discussion

Benefits from this Coordinated Monitoring 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 protocol application.

This program could help identify which project approaches will be most effective in a given area because projects are evaluated on a regional scale and therefore, comparisons to what is effective are evaluated using a larger pool of sites and consistent evaluation tools. Data collected using these protocols are comparable across Washington and Oregon and may be adopted by other states, allowing for better allocation of monitoring efforts and funding resources to assess limiting factors for salmon recovery and watershed health improvements.

The results of monitoring livestock exclusion projects thus far reveal that they significantly reduce bank erosion. There is no significant change in canopy density or riparian vegetation structure thus far. This coordinated monitoring program is scheduled to continue to monitor each livestock exclusion project for 10 years and will determine overall effectiveness at that time. The following discusses improvements and lessons learned during the coordinated monitoring program thus far.

Riparian Vegetation and Canopy Density Improvements

Riparian vegetation and fisheries resources were adequately protected from livestock exclusion (Platts 1991 as cited in Roni et al. 2008). Briggs (1996) indicated that removal of a stressor on riparian vegetation is sometimes sufficient to allow for passive rehabilitation/natural recovery of riparian areas. Natural recovery can be effective under the right circumstances; such as if invasive species do not compete with native vegetation, but validation requires long-term monitoring (Roni et al. 2008). Invasive plant species such as reed canarygrass (*Phalaris arundinacea)* can successfully compete with native plants and rapidly take over an area, preventing native species from thriving and reducing the riparian structure. Controlling invasive species as a part of livestock exclusion projects may be a key element in maintaining adequate canopy density and riparian structure to ensure project success.

Studies of natural recovery of forests are common practice; however, most of the sites included in this monitoring program are located in grass fields lacking a three-tiered riparian vegetation structure adjacent to the site that would provide a local seed base for woody shrubs and trees. Therefore, hands-on rehabilitation, including riparian plantings, may be warranted to accelerate change in riparian vegetation structure.

Two livestock exclusion projects also included riparian plantings. As discussed in Roni et al. 2008, maintenance of riparian plantings allows for a better success rate. Riparian plantings influence all three indicators measured for a livestock exclusion project: vegetation stabilizes banks thus reducing bank erosion, it increases canopy density, and adds to the riparian structure. Therefore, it is important to maintain riparian plantings, especially in the first few years, as the young plants are susceptible to drought, being overcome by weeds, or being eaten by wildlife. Therefore, it is recommended that maintenance of riparian plantings be included annually. Without maintenance, the riparian plantings are less likely to survive, and therefore the investment in the purchase of plants and labor efforts may be wasted. Additionally, projects in grass fields would benefit from riparian plantings to add canopy density and riparian structure in an accelerated time frame. As of Year 3 monitoring, projects constructed in grass fields do not have a significant increase in riparian vegetation structure. Canopy density does increase to a certain extent with the grass getting taller, but not significantly on a regional scale. Without a significant increase in canopy density and riparian structure, the projects will not be successful in reaching all the objectives.

Cost Effectiveness

An evaluation of cost effectiveness of different project types was conducted after one year of monitoring as part of the SRFB evaluation (TtEC 2008). The evaluation compares the cost effectiveness of a project type to other project types based on similar indicators such as riparian vegetation structure, canopy density, and bank erosion. Livestock exclusion projects in Oregon and Washington were included in the SRFB cost effectiveness evaluation. Both livestock exclusion projects and riparian planting projects monitor bank erosion. Livestock exclusion projects are more cost effective than riparian planting projects when evaluated for changes in bank erosion (TtEC 2008). The cost of fencing compared to the cost of riparian plantings is likely more effective because the fencing has a direct effect of removing the source of bank erosion—livestock use— rather than the indirect effect of riparian vegetation stabilizing the stream bank. Using data from 12 livestock exclusion sites, we were able to see a significant decrease in erosion within the first year. However, the riparian planting projects did not have a significant difference in bank erosion for either Year 1 or Year 3 monitoring.

Riparian planting projects are more cost effective than livestock exclusion projects when evaluated for changes in riparian vegetation structure. Two of the 12 livestock exclusion projects included riparian plantings and show an increase in canopy density as well as riparian vegetation structure. Usually livestock exclusion projects do not include a riparian planting component, and, as a result, it may take longer to see increases in riparian vegetation structure for these project types (TtEC 2008).

Additional projects and long-term monitoring are needed to evaluate the cost effectiveness of project types as indicators change over time. The cost effectiveness of a project depends on the original investment, annual maintenance, and changes in the indicators. All three variables should be considered over the long-term to adequately assess cost effectiveness of a project type.

Effect on Biota

Most exclusion projects that have been monitored were not selected as part of a long-term experimental design with a control that could be tested efficiently. Also, cumulative effects of multiple or longer exclusions have not been investigated. Overgrazing of many areas designated for restoration is predominant, and larger areas of exclusions are necessary to evaluate water quality and habitat changes in stream reaches. There are unanswered questions about the effects of exclusions on adult populations of fish, and there is a need for large-scale monitoring and evaluation on a basin-scale (Bayley and Li 2008).

Rehabilitation techniques in general as reviewed by Roni et al. (2008) show encouraging results for improving habitat and local fish abundance. However, little or no long-term monitoring of these techniques has been conducted on livestock exclusion projects and additional time may be needed before a change in fish or other biota is detectable for this project type. There is a need for assessment of watershed processes and factors limiting biotic production, consideration of upstream or watershed-scale factors that influence the outcome of reach-scale or localized rehabilitation projects, and monitoring and evaluation at adequate temporal and spatial scales. Also, few studies have examined effects of individual or multiple projects on a sufficiently broad scale such as an entire watershed or fish population (Roni et al. 2008). Although the livestock exclusion project may positively affect local fish abundance, unfortunately this coordinated monitoring program does not currently include the funds to monitor fish and other biota presence. It is recommended that future monitoring of livestock exclusion projects include fish abundance to evaluate improvements due to the project.

Bias Reduction

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 rehabilitation projects. These results will help to provide accountability for rehabilitation investments and promote information sharing across jurisdictions to improve design and implementation of livestock exclusion 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 were

quantified and documented for this project category, providing concrete evidence of attainment of one of the project objectives.

Roni et al. (2008) evaluated livestock exclusion rehabilitation techniques on a world-wide scale, and found that it is difficult to distinguish between failure of a particular technique and failure to consider broader processes during project implementation. Project monitoring did not consider geology, channel type, climate, exotic species, site preparation, native ungulates, effective control of grazing intensity and duration, size of the exclusion or buffer zone, and upstream processes or impacts (Roni et al. 2008). This coordinated monitoring program utilizes the BACI Design and therefore each impact reach is matched up to a control reach. Efforts are made to establish a control reach that is similar in channel type and size. The control reach is always located in close proximity; therefore variables such as geology and climate are the same between the two and cancel each other out. The same method is used to establish the reach length and transect locations for the control and impact as well as for all projects in the monitoring program. Therefore, this monitoring program considers most of the variables listed in Roni et al. (2008) that most livestock exclusion projects did not consider.

Using the same methods to evaluate control and impact reaches on many projects throughout two states is a positive step toward reducing bias in evaluating each indicator for two reasons: 1) comparing an impact to a control reach attempts to eliminate normal environmental changes over time, and 2) using consistent methods on many projects in a region instead comparing data from projects that use slightly different methods allows data to be compared across the region more accurately. However, biases can still exist when monitoring is done by different individuals, even with training, when best professional judgment is required. For example, evaluating the percent of active erosion can be a biased judgment call, as the methods do not use a precise measuring tool to evaluate active erosion between transects. The evaluation of baseline conditions can significantly affect calculations for percent difference for every monitoring year thereafter on a single project basis. For example, if there was no difference in bank erosion between the impact reach and control reach for a project, the percent difference cannot be calculated for that individual project. Each subsequent monitoring year would have no calculation for that project if there was no difference in Year 0. This effect is eliminated when projects are evaluated on a regional level and the bank erosion results are averaged prior to calculating the percent difference.

Other Improvements

Other benefits to protecting riparian vegetation include reduced influx of sediment, nutrients, and pesticides (Roni et al. 2008). Monitoring these parameters (sediment, nutrient, and

pesticide levels as well as presence of fish) could be included in future monitoring of livestock exclusion projects to expand the assessment of project success.

The purpose of livestock exclusion projects is ultimately to improve habitat conditions for fish and watershed health. It is important to adequately evaluate the long-term use of the project area to determine if the investment in the project will meet that purpose. Project sponsors should understand prior to investing in fencing whether 1) livestock is or will be present on site during the duration of monitoring events, and 2) the stream will be altered by property owners, negating efforts made to improve habitat. It was observed at one site that a fence was partially installed but not completed because livestock were not introduced after all. Monitoring the project as a livestock exclusion is therefore difficult, as no livestock were or will be present at either the impact or control reach. Other sites where fencing function is impaired or livestock are otherwise allowed access to the stream (though gates) have been observed on more than one occasion. The landowner's buy-in to the project objective is therefore a key element in maintaining the effectiveness of the fencing itself and lack of commitment could be a detriment to the success of an individual project.

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List of Contributors

Jennifer Hawkins – Tetra Tech EC, Inc.
Jennifer O'Neal – Tetra Tech EC, Inc.
Alice Shelly – TerraStat Consulting Group
Chris James – Tetra Tech EC, Inc.
Tricia Gross – Tetra Tech EC, Inc.
Kier Craigie – Tetra Tech EC, Inc.
Mark Rachuna – KWA Ecological Sciences, Inc.
Amy Bensted – Tetra Tech EC, Inc.
Karen Brimacombe – Tetra Tech EC, Inc.
Jessica Piasecki – Tetra Tech EC, Inc.

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Courtney Shaff, Oregon Watershed Enhancement Board
Greg Sieglitz, Oregon Watershed Enhancement Board
Ken Dzinbal, Washington Recreation and Conservation Office
Todd Anderson, Kalispel Indian Tribe
Martha Bray, Skagit Land Trust
Ed Conner, Seattle City Light
Coquille Valley Elks Golf Course, Landowner
Lonnie Crumley, Chehalis Basin Fisheries Task Force
Bob Davis, Landowner
Bob and Fontella Hankins, Landowners
Joe and Maria Goularte, Landowners
Sarah Hendrickson, Union Soil and Water Conservation District
Darin Houpt, Cowlitz-Wahkiakum Conservation District
Aric Johnson, U.S. Forest Service
Hertha Nesbit, Landowner
Mike Mader, Tenmile Lakes Watershed Coordinator
Gary Marshall, Landowner
Deborah Mattson, Landowner
Tom Meyer, Skagit Land Trust
Mike Miranda, Landowner
Marc O'Toole, Landowner
Pat and Joanne Rauth, Landowner
Marty Suter, Harney Soil Water Conservation District
Cindy Thieman, Long Tom Watershed Council
U.S. Forest Service, Landowner
Washington Department of Fish and Wildlife, Landowner
Dennis Wise, Coquille Watershed Association

APPENDIX A

PROJECT-SPECIFIC SUMMARIES

PROJECT-SPECIFIC SUMMARIES

Project results below are grouped together based on the grant funding used to implement the project and the project sponsor that received the funding to implement the project. 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 Conservation District, Kalispel Indian Tribe, Chehalis Basin Fisheries Task Force, and Seattle City Light and Skagit Land Trust.

The following projects require fencing riparian areas to exclude use by livestock. Monitoring occurs prior to implementation of the project (fence installation) and is identified as Year 0. Subsequent monitoring is conducted for a period of 10 years following installation at the control site and impact site 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.

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 Washington Department of Fish and Wildlife (WDFW) property located at the mouth of Abernathy Creek.

Impact reach Transect K right bank in 2004 (Year 0)

Impact reach Transect K right bank in 2009 (Year 5)

Project Location

The project area is located along Abernathy Creek (Water Resource Inventory Area [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 U.S. Fish and Wildlife Service (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.

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 1 summarizes the data collected during Year 0, Year 1, Year 3, and Year 5 monitoring of the Abernathy Creek Riparian Restoration (Livestock Exclusion) Project.

Table 1. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/11-6/12/2004)		Year 1 (6/7-6/8/2005)		Year 3 (6/4-6/5/2007)		Year 5 (6/5/2009)	
	Control	Impact	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics								
Canopy Density (1-17)	16.68	15.55	16.55	15.41	16.46	14.18	16.50	15.86
Riparian Vegetation Structure (%)	100	100	100	100	100	100	100	100
Bank Erosion (%)	2	2	0.25	2.5	2.8	3.8	12.8	7.3
Riparian Livestock Exclusions								
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes	N/A	No
Area of Exclusion (acres)	N/A	N/A	N/A	84	N/A	84	N/A	84

Summary

Data collected at the Abernathy project site indicate that the high quality habitat present at the site is being maintained. Bank erosion decreased in the impact relative to the control reach in Year 5. Erosion observed in the impact and control reaches is not likely due to any livestock activity as the property owner does not own livestock at this time, and there was no evidence of livestock access to the stream banks. The exclusion fencing is no longer complete, and would not exclude livestock if present. The erosion observed in 2009 was likely a result of high stream flow due to storm events. Canopy density changes are within the range of natural variability at this site. Absence of livestock induced erosion along the stream banks should

allow the riparian plantings to mature and increase canopy density and diversity. We recommend that project sponsors verify the long-term use of the project area before investing in fencing.

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

Table 2 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Hoy Project.

Table 2. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (5/6/2005)		Year 1 (7/19/2006)		Year 3 (5/5/2008)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Cover (1-17)	16.7	6.0	16.64	3.09	15.9	5.3
Riparian Vegetation Structure (%)	59.1	18.2	50.0	0	50.0	4.5
Bank Erosion (%)	70.0	100	89.5	100	82.5	95.5
Riparian Livestock Exclusions						
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

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 – overgrown with reed canarygrass (2009)

Impact reach with livestock fencing and riparian planting area (2009)

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 (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 Vance Creek County 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. 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 3 summarizes the data collected during monitoring of the Vance Creek Project. The project was not completed in 2006, so Year 1 data were collected in 2007.

Table 3. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0* (10/14/2006)		Year 1 (9/11/2007)		Year 3 (6/15/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	16.65	15.91	15.68	13.68	16.5	17
Riparian Vegetation Structure (%)	95.5	18.2	86.4	9.1	95.5	45.5
Bank Erosion (%)	40	70	0	0	0	0
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	5.0	N/A	5.0

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. In Year 3 there was no evidence of livestock in the riparian area. Data collected at the site indicate no change in bank erosion (none present at the site) and increases in vegetation structure and canopy density in both the control reach and impact reach. The increase in vegetation structure is mainly due to growth of existing trees and shrubs from Year 1 to Year 3. As the riparian plantings mature at this site a further increase in riparian vegetation structure is expected.

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 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 3 (2009)

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

Table 4 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring.

Table 4. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (5/30-5/31/2006)		Year 1 (8/20-8/21/2007)		Year 3 (5/28-5/29/2009)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics						
Canopy Density (1-17)	12.0	16.1	15.5	16.8	16.1	17
Riparian Vegetation Structure (%)	100	90.9	100	90.9	100	100
Bank Erosion (%)	0	10.0	0.3	2.3	0	0
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	4.5	N/A	4.5

Summary

Data collected at the Indian Creek Yates Restoration site indicate improvement or maintenance in all three measured variables. Bank erosion in the impact reach decreased substantially between Year 0 and Year 3 and the rating for vegetation structure reached 100 percent by Year 3. 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 groundcover at these same locations had already shown obvious signs of recovery. Even further evidence of groundcover recovery was observed in Year 3 monitoring. Additionally, recent riparian plantings along a portion of the impact reach will further improve canopy density and riparian conditions in the future.

05-1547: Rauth Coweeman Tributary Restoration – SRFB

The Coweeman subbasin was 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 was 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.

Fenced impact area with no erosion issues (Year 3)

Stormwater erosion in impact area (Year 3)

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 8N, Range 1W, 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.

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 Conservation District sponsored this project and Darin Houpt is the contact person.

Project Data

Table 5 summarizes the data collected during monitoring of the Rauth Coweeman Project.

Table 5. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (5/19/2006)		Year 1 (10/12/2007)		Year 3 (5/5/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	16.96	14.55	16.64	13.86	16.64	13.82
Riparian Vegetation Structure (%)	100	90.9	100	72.7	100	81.8
Bank Erosion (%)	0.5	32.5	1.8	21.3	5.1	7.2
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	2.3	2.3	2.3

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, however, flooding in Year 3 caused some limited bank erosion that was not tied to livestock use. The fence was found to still be in place and functional. There is good vegetative cover along both banks in the impact reach and, other than flooding

effects, the banks are stable. Small decreases were noted in canopy density for both the control and impact reaches in Year 1, but these levels remained very stable from Year 1 to Year 3. Riparian vegetation structure was maintained in the control reach, but decreased in the impact reach in Year 1due to removal of invasive vegetation to allow native species to grow. From Year 1 to Year 3, the riparian vegetation structure has increased as expected.

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 U.S. Forest Service (USFS) land and Aric Johnson is the contact person for the Bottle Creek project.

Project Data

Table 6 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the Bottle Creek Livestock Exclusion Project.

Table 6. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/19-6/20/2006)		Year 1 (6/14/2007)		Year 3 (6/9/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	14.68	11.23	15.09	10.86	15.5	14.5
Riparian Vegetation Structure (%)	100	77.30	100	77.30	95.5	86.4
Bank Erosion (%)	6.5	11.0	2.0	1.3	12.4	2.5
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	N/A	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	12.5	N/A	12.5

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 3. The Year 3 photo shows the fence installed and intact in the impact reach.


Impact reach in 2006 (Year 0)


Impact reach in 2009 (Year 3)

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 decrease in bank erosion was noted in the impact reach when compared to a control reach. In Year 3, the erosion in the impact reach remained low, while increases were noted in the control reach. An increase in riparian structure in the impact reach was documented in Year 3, while the control reached showed very little change. Canopy density decreased slightly when compared to a control reach between Year 0 and Year 1, but increased in Year 3. 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 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 evidence of elk or livestock activity was observed in the impact reach during the Year 1 (2007) survey. In 2009 (Year 3), evidence of recent elk activity was documented within the impact reach; however no evidence of livestock use was noted. Evidence of wildlife presence was also observed along the bank of the control reach in Year 3.

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 USFS land and Aric Johnson is the contact person for the Clark Creek Tributary project.

Project Data

Table 7 summarizes the data collected during Year 0, Year 1, and Year 3 monitoring of the North Fork Clark Creek Livestock Exclusion Project.

Table 7. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/20/2006)		Year 1 (6/15/2007)		Year 3 (6/10/2009)	
	Control	Impact	Control	Impact	Control	Impact
Stream Physical Characteristics						
Stream Length (m)	N/A	732	N/A	732	N/A	610
Reach Length (m)	150	150	150	150	150	150
Riparian Characteristics						
Canopy Density (1-17)	14.1	14.8	13.1	15.4	14.3	14.8
Riparian Vegetation Structure (%)	100	100	100	100	100	100
Bank Erosion (%)	37.0	38.5	4.8	0	7.7	2.3

Table 7. Summary Statistics for Pre- and Post-Implementation Monitoring (continued)

Variable	Year 0 (6/20/2006)		Year 1 (6/15/2007)		Year 3 (6/10/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	No	N/A	Yes	N/A	No[1/]
Area of Exclusion (acres)	N/A	N/A	N/A	6.5	N/A	6.5

Note:

[1/] Fencing was in the "let-down" position at the time of monitoring.

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 3. The Year 3 photo shows increased undergrowth after project implementation.

Impact reach facing upstream at Transect K in 2006 (Year 0)

Impact reach facing upstream at Transect K in 2009 (Year 3)

Summary

Data collected at the North Fork Clark Creek Project in 2009 indicate slight changes in two of the parameters measured. Canopy density in the impact reach decreased slightly from Year 1 and was measured to be the same as in Year 0. Bank erosion increased in Year 3, but continued to be significantly lower than in Year 0. Both the impact reach and the control reach have been at the maximum level for vegetation structure since monitoring began in 2006 and this was maintained through 2009.

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, as no evidence of livestock use was documented within either reach. However, at the time of the survey in 2009 (Year 3), the fencing was still in its "let down" condition. As a result, it was not functioning as exclusionary fencing at the time of the survey.

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 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 to prevent livestock access to the creek and therefore 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 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. Maintenance of the waterway includes trenching (dredging) the stream of the vegetation and sediment approximately every 7 years to allow the adjacent fields to adequately drain. 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. Dennis Wise, Director of the Coquille Watershed Association is the contact for this project.

Project Data

Table 8 summarizes the data collected during monitoring of the Gray Creek Livestock Exclusion Project.

Table 8. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/8/2006)		Year 1 (6/26/2007)		Year 3 (6/15/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	11.64	16.36	13.46	15.77	14.82	17.0
Riparian Vegetation Structure (%)	27.3	0	36.4	0	59.1	0
Bank Erosion (%)	63.2	13.4	64.0	34.8	7.3	5 [1/]
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	No	N/A	No	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	2.8	N/A	2.8

Note:

[1/]Erosion is estimated for Year 3 due to vegetation cover and lack of visibility of bank.

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 Gray Creek during Year 0 and Year 3. Fence installation and dense vegetation growth in the stream are apparent in the Year 3 photo.

Impact reach at Transect A in 2006 (Year 0)

Impact reach at Transect A in 2009 (Year 3)

Summary

After the first year, improvements in measured variables were observed at the Gray Creek project site for canopy density and riparian vegetation structure. During Year 3 monitoring (2009), 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. However, vegetation was impacted within the exclusion area. Note the short grass adjacent to the fence line in the 2009 photo above.

This creek provides drainage for the adjacent fields. Maintenance on the drainage ditch is performed approximately every 7 years. Removal of excessive vegetation and sediment deposits are necessary to allow the creek to drain the fields. Due to the trenching of the creek

since the last monitoring event, the banks were steeply cut and the creek bed was deep. Direct access into the creek was not possible, so the creek was assessed from the banks. Due to the dense growth of reed canarygrass in the riparian zone and skunk cabbage in the creek, erosion was estimated from the banks.

The primary reason for excluding livestock from a waterway is to promote riparian vegetation growth and prevention of excessive erosion. However, maintenance of the creek strips the banks, exposing unconsolidated material that is prone to erosion, which is carried into the waterway, raising the streambed elevation, and thus promoting the need for further maintenance. The creek primarily functions as a drain for the adjacent farms. The potential benefits of the fencing installation are negated by maintenance on the creek.

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 the 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 within the Long Tom Watershed and Coyote Creek sub-watershed. Historically, neither the control nor the impact reach were fenced and both were 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 land owner within the project area is Deborah Mattson, and Cindy Thieman serves as the contact person for this project.

Project Data

Table 9 summarizes the data collected during monitoring of the Jordan Creek Livestock Exclusion Project.

Table 9. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (8/14/2006)		Year 1 (9/13/2007)		Year 3 (6/18/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	16.82	2.05	16.64	1.77	16.96	15.59
Riparian Vegetation Structure (%)	100	4.5	100	9.1	100	22.7
Bank Erosion (%)	100	94.5	100	0	26.5	6
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	N/A	N/A	Yes	N/A	Yes
Area of Exclusion (acres)	N/A	N/A	N/A	7.8	N/A	7.8

The riparian characteristics identified above are intended to track the health and stability of the riparian corridor along the project area. After implementation, mean canopy density and riparian vegetation structure are expected to increase. Length of actively eroding banks is expected to decrease, and the exclusion is expected to remain functional.

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 from Jordan Creek show new growth of vegetation along the stream in the photo from 2009.

Impact reach Tr K facing downstream in 2006 (Year 0)

Impact reach Tr K facing downstream in 2009 (Year 3)

Summary

Data from the Jordan Creek Livestock Exclusion project indicate an increase in canopy density and riparian vegetation structure in the impact reach. Active bank erosion has decreased substantially in the impact reach from Year 0 and remains low in Year 3. Canopy density in the impact reach (as shown in the photos above) increased substantially between Year 1 and Year 3. Riparian vegetation also increased from Year 0 through Year 3 while the control remained constant. The indicators measured at this site show a trend for success of this project.

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 A in 2006 (Year 0)

Impact reach at Transect A in 2009 (Year 3)

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 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, are the landowners within the project area and Mike Mader serves as the primary contact for this project.

Project Data

Table 10 summarizes the data collected during monitoring of the Johnson Creek Livestock Exclusion Project.

Table 10. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/7/2006)		Year 1 (6/28/2007)		Year 3 (6/16/2009)	
	Control	**Impact**	**Control**	**Impact**	**Control**	**Impact**
Riparian Characteristics						
Canopy Density (1-17)	16.05	6.77	15.32	13.96	16.77	15.52
Riparian Vegetation Structure (%)	0	0	4.5	4.5	13.6	4.5
Bank Erosion (%)	4.3	80.2	76.5	74.5	4.3	26.3
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	N/A	N/A	No	N/A	No
Area of Exclusion (acres)	N/A	N/A	N/A	4	N/A	4

Summary

Data collected at the Johnson Creek site indicate improvement in canopy density and bank erosion relative to the control reach. As vegetation matures through time, further improvement in measured parameters is expected.

The photos show an exposed right bank at Transect A in the impact reach during Year 1 and the sloughing that occurred before the Year 3 monitoring in the same area where the rebar was placed in Year 1. The erosion was not caused by livestock, but likely due to high water flows. This bank will likely continue to erode due to high water flows.

Impact reach at Transect A in 2007 (Year 1)

Impact reach at Transect A in 2009 (Year 3)

The fencing appeared to be impaired in both the impact and control reaches during the 2009 monitoring. Although at the time of the survey no livestock were observed within the exclusion area, there was evidence of livestock access to the creek at the control reach. Livestock have accessed the control reach as shown by evidence of trampled vegetation and

bank erosion along the left bank at Transect E-F. The landowner explained that a calf was birthed in the creek at that location and the livestock accessed the site on more than one occasion.

Control reach at transect E-F in 2009 (Year 3)

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

The Noble Creek/Maria Gulch Project is 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.

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 on Noble Creek that will remain fenced over the period of monitoring. The impact site is Maria Gulch, a tributary to Noble Creek.

Maria Gulch Impact Transect A in 2006 (Year 0)

Maria Gulch Impact Transect A in 2009 (Year 3)

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 were intended to prevent livestock access to the stream, reduce sediment input and non-point source runoff, and to improve riparian vegetation quality and shading. Fencing was installed on both the control reach (Noble Creek) and on the impact reach (Maria Gulch). Planting on Maria Gulch was located approximately 100 yards upstream of the impact reach. Native seedlings were planted on Noble Creek within the control reach. The land owners within the project area are Joe and Maria Goularte and Mike Mader serves as the contact person for this project.

Project Data

Table 11 summarizes the data collected during monitoring of the Noble Creek/Maria Gulch Livestock Exclusion Project.

Table 11. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (6/6/2006)		Year 1 (6/27/2007)		Year 3 (6/17/2009)	
	Control	Impact	Control	Impact	Control	Impact
Riparian Characteristics						
Canopy Density (1-17)	11.86	10.36	14.5	15.5	14.96	15.27
Riparian Vegetation Structure (%)	4.5	45.5	0	50	9.1	90.9
Bank Erosion (%)	0	49.55	27.8	11.3	21.0	1.3
Riparian Livestock Exclusions						
Exclusion Design (y/n)	N/A	N/A	N/A	Yes	N/A	Yes[1\]
Area of Exclusion (acres)	N/A	N/A	N/A	3.5	N/A	3.5

Notes:
[1\] The fence on the impact reach was intact but there were game trails leading to the creek. The fence on control reach was not intact and there was evidence of livestock in stream.

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 2009 photo from Year 3 shows the fence in place and increased vegetation growth as compared to 2006 (Year 0). Wildlife have access to the impact reach from the hillside on the left bank. Notice the game trail adjacent to the fence in the 2009 photo.

Impact Transect F facing downstream in 2006 (Year 0)

Impact Transect F facing downstream in 2009 (Year 3)

Summary

The Noble Creek/Maria Gulch project has demonstrated improvement in all three measured variables. Increases are noted after implementation for canopy density and vegetation structure and a decrease is noted for bank erosion.

The fencing was inspected along the impact reach and found to be fully intact along the right bank as shown in the photo above. There is no fence along the left bank of the impact reach

which is adjacent to a forested hillside. The forest is inhabited by elk and other wildlife which potentially can impact the stream habitat at the project site. There was evidence of game trails to the stream from the hillside as well as along the fence line as shown in the 2009 photo above.

The fence along the control reach on Noble Creek was not intact in the vicinity of Transect F (see photo below), and the gate was left open for livestock to pass through. Evidence of livestock access to Noble Creek is shown in the photo below.

Impaired fence on control reach (Noble Creek 2009)

Evidence of livestock in control reach (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.

Project Data

Table 12 summarizes the data collected during Year 0 and Year 1 monitoring of the Middle Fork Malheur River Livestock Exclusion Project.

Table 12. Summary Statistics for Pre- and Post-Implementation Monitoring

Variable	Year 0 (8/16/2006)		Year 1 (8/21/2008)	
	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 (%)	58.5	71.3	33.8	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

Summary

Monitoring was conducted at the Malheur site prior to implementation in 2006 and during the first year following implementation. Canopy density changed very little in the impact reach but increased slightly in the control 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. Future monitoring events are expected to clarify trends in measured indicators.