Washington Conservation Corps

Ecological Restoration Evaluation

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For more information contact:

Publications Coordinator
Shorelands and Environmental Assistance Program
P.O. Box 47600
Olympia, WA 98504-7600

E-mail: tisc461@ecy.wa.gov
Phone: (360) 407-6096

Washington State Department of Ecology - www.ecy.wa.gov/

o Headquarters, Olympia	(360) 407-6000
o Northwest Regional Office, Bellevue	(425) 649-7000
o Southwest Regional Office, Olympia	(360) 407-6300
o Central Regional Office, Yakima	(509) 575-2490
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Cover photo: Riparian restoration project in Skagit County.

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Primary Author:
Troy Warnick

Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

Secondary Author:
Shawn Zaniewski

Shoreline & Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington 98504-7710

For more information contact:

Troy Warnick
Study Coordinator
Environmental Assessment Program
P.O. Box 47600
Olympia, WA 98504-7600
E-mail: twar461@ecy.wa.gov

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Table of Contents

List of Figures and Tables

Page

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Executive Summary

The Washington Conservation Corps (WCC) Ecological Restoration Evaluation assessed the effectiveness of 28 habitat improvement projects that involved the use of WCC crew labor. The evaluation was initiated in response to a July 2005 AmeriCorps rule, which requires grantees to perform an independent evaluation of primary service activities. Habitat restoration is the primary service activity for the WCC program.

The 28 projects are located throughout the state and were selected because each represents one of the following categories: riparian planting, wetland planting, vegetation control, land use control, and habitat feature creation.

Project evaluators utilized a variety of methods for assessing each site: vegetation (type, survival/vigor, and measurements), photo points, existing sponsor monitoring data, a restoration habitat survey, and site-specific activities (e.g., amphibian surveys).

Utilizing plant survival and habitat ratings, evaluators quantitatively assessed each project type. Utilizing the Riverkeeper Restoration Project rating system, overall results show that the average habitat rating for all project sites is 8.2, or good. These project sites ranked as follows: 43% rated excellent, 49% rated good, 4% rated fair, and 4% rated poor. The sites falling below the "good" threshold had several contributing factors, and methods for improvement are discussed.

Overall, 83.4% of plants are surviving at sites in which a re-vegetation component was used. This reflects 26 of the 28 project sites. Two of the sites studied did not have a re-vegetation component and were excluded from this portion of the assessment. Twenty-four out of 26 planted sites meet or exceed the 70% plant survival goal for project sites, with 20 sites above 80%. This evaluation discusses the under-performing sites and offers suggestions for future improvement.

Based on this evaluation, the WCC can determine some best practices to use for future restoration projects. These best practices include irrigation, maintenance, and monitoring. Acknowledging the limited resources available for habitat restoration, we discuss the issue of cost-effectiveness with each practice.

Recommendations include these best practices, but most importantly, evaluators suggest that WCC crew supervisors and members develop skills and procedures in the area of restoration site monitoring.

This report takes a first step in a long-term effort to determine effective practices in habitat restoration completed by the WCC. Future analysis will continue to explore methods for improvements, most specifically sponsor collaboration and post-planting site upkeep.

Acknowledgements

The staff tasked with this evaluation gratefully acknowledges the cooperation of the project sponsors and landowners that agreed to allow their restoration projects to be a part of this evaluation. Additionally, WCC Crew Supervisors involved with each project were invaluable to this effort. Specifically, evaluators would like to thank Rob Crawford, Dale Rahier, Nick Saling, and Darrel Boredom.

Prior to implementing this evaluation, an advisory team of professionals from the Washington Department of Ecology was assembled to provide guidance and feedback on the evaluation.

Ecology Wetlands staff provide ongoing technical assistance to protect habitat and other functions of natural ecosystems. This includes site visits, one-on-one consultations, training workshops, data dissemination, publications, and more. Several Wetlands staff participated in the evaluation of WCC program activities. Dana L. Mock and Patricia Johnson, both wetland specialists, participated on the advisory team.

Dr. Tom Hruby, senior ecologist, was consulted on the development of methods and analysis of data collected. Dr. Hruby specializes in aquatic and coastal ecosystems and has developed numerous models and methods to assess and analyze the functions that wetlands perform.

Troy Warnick was the project coordinator. Troy visited all sites, managed and interpreted the data, and was the primary author of the report. Troy has a bachelor's of science degree in environmental science from the Evergreen State College and currently works for Ecology's Environmental Assessment Program. Troy has served as a habitat restoration crew supervisor leading the implementation of numerous ecological restoration projects for six years. Troy has also worked within Ecology on the Southwest Washington Coastal Erosion Study.

Shawn Zaniewski was the project field lead and conducted the final field site visits. Shawn participated in data analysis, final report development and was the secondary author of the final report. Shawn has eleven years experience in the environmental field, nine of which as a habitat restoration crew supervisor. Shawn has planned, implemented, and monitored several ecological restoration projects throughout Washington State.

Funding

Funding for this evaluation was provided in part by the Washington State Department of Ecology's Wetlands Program, the Washington Conservation Corps, and a grant from the Corporation for National and Community Service.

Introduction

About the Washington Conservation Corps

The Washington Conservation Corps (WCC) was established in 1983 as a service program for young adults between the ages of 18-25. The WCC is a program offered through the Washington State Department of Ecology and continues the legacy started by the Civilian Conservation Corps in the 1930s. The WCC provides work experience and skills to members through projects that support conservation, rehabilitation, and enhancement of Washington's natural, historic, environmental and recreational resources. Today, the WCC has nearly 150 members working on various projects in every part of the state. It has been an AmeriCorps Program since 1994.

One of the primary goals of the WCC is to assist local communities with complex issues related to ecological restoration, including the state's priority for improving habitat for federally protected species, such as salmon. To achieve this goal, the WCC has established partnerships with community based environmental organizations and local and state natural resource agencies to complete ecological restoration work statewide. The selection and design of WCC projects is driven by the locally based partners (i.e., project sponsors) to ensure that the critical needs of the communities are being met.

WCC crews around the state work with project sponsors on a variety of projects, which include wetland and riparian habitat restoration, creation, and enhancement. Specific crew work can consist of: planting native trees and shrubs, removing barriers from blocked culverts, installing riparian habitat structures, eradicating invasive plant species, constructing livestock exclusion fences, and preventing erosion.

Ecological Restoration Evaluation

The goal of this evaluation was to determine the effectiveness of ecological restoration projects that involved the use of WCC crew labor. It is also expected that the knowledge gained from this evaluation will be utilized to improve ecological restoration techniques used on future WCC projects. Included in this report are materials and resources that the evaluators feel will be beneficial to the WCC program and could be utilized in the field to benefit these projects.

This evaluation also fulfills the requirements of a July 2005 AmeriCorps rule, which requires grantees to perform an independent evaluation of primary service activities. The Washington Conservation Corps' primary service activity is habitat restoration. The WCC has several performance measures around this service area, including a key goal of acres restored.

Project updates were submitted to the WCC and included in bi-annual progress reports to AmeriCorps. An annual report of monitoring activities and summaries of information collected on monitored sites was also prepared. This document serves as a final report detailing the monitoring activities and project findings.

There were 28 projects located throughout the state selected for this evaluation. These projects represent the following restoration project types:

- Riparian Planting: Planting in the immediate vicinity of the channel or in patches along a stream reach.
- Wetland Planting: Planting in the immediate vicinity of naturally occurring or created wetlands.
- Vegetation Control: Removal of exotic or other invasive vegetation out competing desirable species in or near the channel or floodplain.
- Land Use Control: Installation of livestock exclusion fencing.
- Habitat Feature Creation: Construction and placement of habitat features such as large woody debris, salmon-rearing side channels, and rodent habitat structures.

The primary objectives for these projects were:

- Improving bank and floodplain stability, usually by increasing vegetation cover and root mass.
- Reducing stream temperature by increasing interception of sunlight by riparian canopy.
- Reducing cover and biomass of exotic and invasive plant species.
- Enhancing long-term recruitment of large woody debris, especially of coniferous species.
- Providing immediate habitat features for threatened and endangered species.

In cooperation with project sponsors, data for each project were gathered, reviewed, and verified by Ecology Wetlands staff with the assistance of the project coordinator. Scientifically based monitoring methods were developed and consisted of a combination of on-site quantitative measurements and qualitative observations, which are described in detail in the Methods section of this report.

A summary of the findings can be found in the Results section of this report. Detailed information about each site can be found in Appendix B, which provides a summary of each restoration site with a description of the following:

- Project detail
- WCC involvement
- Project goals
- Evaluation results (survival, vigor, restoration habitat rating)
- Conclusions (overall success and possible factors correlated with success)
- What contributed to success (best practices)
- What challenges were encountered

Methods

Site Selection

WCC project coordinators compiled a list of WCC project sponsors who conducted past and present habitat restoration. All project sponsors were contacted to request their participation in this evaluation by providing a descriptive list of habitat enhancement projects involving WCC crew labor that they have carried out. The resulting list contained 57 project descriptions to be considered for this evaluation. From that list projects were ordered randomly and then visited to determine suitability for the study in regards to access constraints, available background data, and cooperation of project sponsor. It was estimated that 25 projects could be evaluated. Because more sponsor monitoring data became available, we were able to evaluate 28 sites rather than 25, as minimal extra effort would be required to evaluate three additional sites.

Gathering Background Information

In cooperation with project sponsors, data for each project were gathered. Existing data, when available, were requested and, in a few instances, project sponsors provided a photographic record of the project site, which enabled evaluators a useful perspective on pre-project condition, progress during implementation, and final project appearance.

Evaluators gathered information on methods used for implementation of each project through both site tours and interviews with project sponsors and WCC crew supervisors involved with each project. During initial and return site visits, additional materials were gathered and questions answered by project sponsors, property owners, and crew supervisors regarding project details.

Site Assessment Methods

Background

Riparian vegetation plays important roles in maintaining suitable habitat for anadromous fish, including threatened and endangered salmonids. It provides shade and cover, promotes bank stability, enhances physical channel features, provides large wood recruitment, filters sediment, and serves as a major source of nutrients to support in-stream fauna and flora.

Most riparian restoration re-vegetation projects are intended to improve one or more of the functions listed above. The time period over which newly installed riparian vegetation responds to restoration varies with the plant community type (herbaceous, shrub, or tree) and the functions targeted for restoration. In the initial phases of monitoring (one or two years after implementation), it is typically useful to assess only whether or not vegetation was successfully established on a site. Subsequent monitoring can focus on the development of community characteristics, such as canopy cover or species diversity. Over the long term, the focus may shift to other conditions, such as stream temperature, in-stream wood, or in-stream habitat.

As the emphasis changes from the vegetation survival to the functions of the vegetation, the methods used for monitoring also change. During the initial phases, plant counts are adequate. Later, more complex sampling designs are necessary to obtain statistically valid measurements of community characteristics. Monitoring functions such as stream temperature or wood recruitment may not require any vegetation measurements at all.

This study included monitoring the effectiveness of riparian restoration during the initial and intermediate stages of establishment and community development at project sites. The methods typically focused on tree and shrub vegetation. This report characterizes change in vegetation conditions resulting from activities that were conducted from 1995-2006 involving WCC crew labor and reports on the analysis of the collected data. The restoration monitoring activities were carried out during the period of April 2006 to November 2007 and measured at least one entire growing season.

Vegetation

Vigor and physical plant measurements were collected using 2-meter wide belt transects. Analysts collected vegetation data, recording this on worksheets (see Appendix D) during field visits. Vegetation monitoring transects were randomly selected at each project location in order to represent an average of the overall plant population. Plants which fell within these transects were physically flagged, and GPS coordinates were recorded. Each plant was evaluated for height or diameter and overall vigor/mortality.

Projects were surveyed using GPS units to determine the extent and area of the project. Once the area had been determined for each polygon, the required number of belt transects was determined as follows. If the polygon was less than 30 acres, two percent of the area was sampled. If the area of the polygon was greater than 30 acres, one percent of the area was sampled.

In any event, a minimum of five sample plots were surveyed. If the polygon was less than 0.25 acre, all seedlings were counted. A sample of two percent of the project area was sufficient when stands were relatively uniform; more samples were required for heterogeneous stands.

Transects were randomly placed at each project using GIS and oriented perpendicular to stream and/or wetland banks. On site, transects were located using GPS and physically marked using wooden stakes indicating the beginning and the end of each transect. A field sketch was also created during transect installation. When necessary, individual plants were tagged and labeled to avoid any possibility of confusion between plants during surveys.

Survival and Vigor

Plant survival rates were acquired from each project site. Original plant numbers were determined from planting plans, sponsor and supervisor interviews, and post-implementation inspections. Current plant numbers were determined by surveys during site visits.

Plant vigor ratings used a scale of 1 to 4 with a value of 1=thriving, 2=alive, 3=stressed, 4=dead. The surveyor would assign a "thrive" rating if the plant had large lush growth, green healthy leaves, and lack of damage. Normal growth with no signs of desiccation or obvious risk of mortality was assigned an "alive" rating. A "stressed" rating was given to plants displaying obvious signs of desiccation, animal or insect damage, unseasonable browning or curling leaves, disease, or other obvious stress indications. Plants were assigned a "dead" rating when mortality had occurred or plants were not present above ground.

Growth Measurements

In order to determine rates of growth, all plants were measured for height up to 1.5 meters. If a plant was taller than 1.5 meters, a diameter measurement was taken at the 1.4-meter height. When a multi-stemmed shrub was encountered, the measurement was taken at the 1.4-meter height on the largest main stem or trunk. In order to ensure consistency in plant measurements during future surveys individual plants were physically tagged at the measurement location.

Photo Points

Permanent photo points were established at each project site. These points were marked on each site with a wooden stake, GPS coordinates recorded, and a field sketch was created. Photos were taken at least twice a year during approximately the same time each year. At least one set of photos was taken when plants were in full leaf (mid to late summer). A photographic record was completed on site during each visit. Photos for each site are included in Appendix B.

Existing Sponsor Monitoring Data

Monitoring data such as percent survival, growth rates, percent cover, and diameter collected by project sponsors was reviewed and verified for accuracy. Once verified, existing monitoring data provided by project sponsors was utilized in the evaluation of each project.

Restoration Habitat Survey

Final project habitat was evaluated using the Habitat Restoration Survey methodology developed by the Delaware Riverkeeper Network (see Appendix C). These surveys were conducted during each final site visit. The specific elements assessed during the final site visits were:

1. Restoration buffer width: This element assigns a rating according to the width of each project's buffer.
2. Trees and shrubs: This element focuses on the existence and health of planted trees and shrubs in the project area and the distribution of these trees and shrubs throughout the entire site.
3. Herbaceous vegetation: This element scores the existence and health of grasses, herbs, wildflowers, and wetland plants planted at the project site.
4. Biodiversity: This element looks at the total number of different plant species present at the project site.

5. Exotic invasive vegetation: This element addresses the percent cover of exotic and invasive species present in the project area and to what extent they are competing with the native vegetation.
6. Bioengineering techniques: This element evaluates the effectiveness of bioengineering structures installed as part of the restoration activities and is applicable only to projects that involved stabilization of extremely steep banks and habitat feature installation (LWD).

Each category listed above is scored and totaled. Final scores are interpreted with the following scale: 0-4 = Poor; 4.1-6 = Fair; 6.1- 8.9 = Good; 9-10 = Excellent.

Site-Specific Activities

In addition to project-wide assessment methods, specific monitoring activities took place on a few select sites to measure unique sponsor goals and objectives. Activities included amphibian presence surveys, gray squirrel presence using hair traps, and property owner interviews for observations of salmon presence.

Other Activities

Additionally, project sponsors were interviewed to determine the overall impact WCC crews have had on their habitat improvement projects, satisfaction with work performed, and the likelihood of project completion without access to WCC crew services.

Overall Results

A complete assessment of the effectiveness of habitat improvement projects requires an extensive amount of time (ten+ years). Ongoing monitoring by WCC crew supervisors is highly recommended to better understand and evaluate the success of WCC habitat improvement projects. It is important to point out that the information gathered during this study and discussed in this report is an analysis of a single growing season and would increase in value and reliability had it been conducted over a longer period.

Additionally, there are many factors that affect habitat improvement project success. These factors include project design, plant material health, invasive removal and other site preparation, irrigation, matting/mulching, plant stock condition and size, planting technique and care, matching plants to proper soil conditions, post- project maintenance, vandalism, drought, animal browse, and floods.

In order to determine the effectiveness of ecological improvement projects involving WCC crews, evaluators must define what it means for a project to have been effective or successful. For the purpose of this study, a successful project is defined as a restored plant community achieving progress towards being a self-sustaining improved habitat for state endangered and threatened species. A successful project should be maintenance-free and require no additional attention after a period of five to seven years from project implementation.

Ultimately, this evaluation studies the quality of WCC habitat improvement projects, but perhaps more importantly, it demonstrates that even the few moderately successful projects are better than none at all, which would quite likely be the result in the absence of the Washington Conservation Corps program. The field of habitat restoration is one that depends heavily on grant funding, which is limited. Often times the most expensive phase of a project is the construction phase, which requires heavy equipment (e.g., in-stream or land grading). The re-vegetation phase of a restoration project often comes when few funds remain. At this point, WCC crews and volunteers are vital to the completion of a project.

While the WCC has undergone program-wide evaluations in years past, this is the first that specifically addresses the efforts of habitat restoration at the program level. This evaluation is a great start to long-term monitoring. One caveat is that habitat restoration is a long-term endeavor, rather than just a one-year project with five years of maintenance following. Still, program evaluators and WCC staff agree that this is the beginning of a long-term effort to determine effective practices in habitat restoration completed by the WCC.

With that said, this evaluation can allow us to draw conclusions of the specific project sites assessed over the past two years. Utilizing the Riverkeeper Habitat Restoration rating system (see Appendix C), the average habitat rating for all project sites is 8.2, or Good (9-10 = Excellent, 6.1- 8.9 = Good, 4.1-6 = Fair, and 0-4 = Poor). See Figure 1. (For project-specific results see Appendix A.)

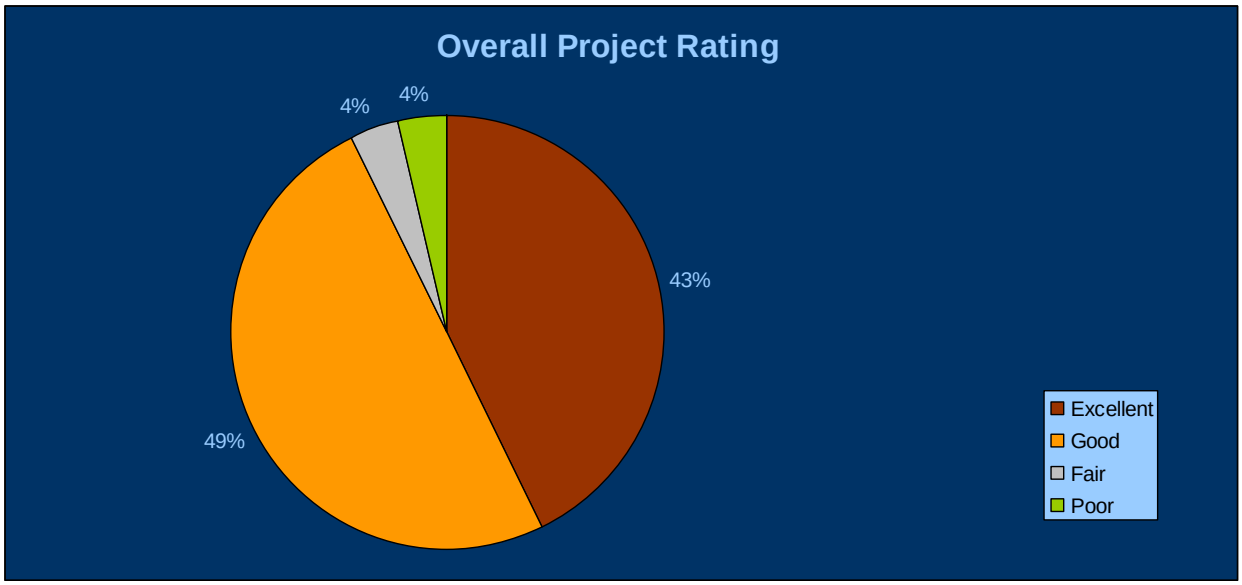

Figure 1 - Overall average project habitat rating.

Overall plant survival is a common indicator used to gauge restoration project success. Figure 2 represents the 26 project sites that included a re-vegetation component. The average plant survival rate for all 26 re-vegetation projects is 83.4%. Twenty four out of 26 planted sites meet or exceed the 70% plant survival goal for project sites, with 20 sites above 80%.

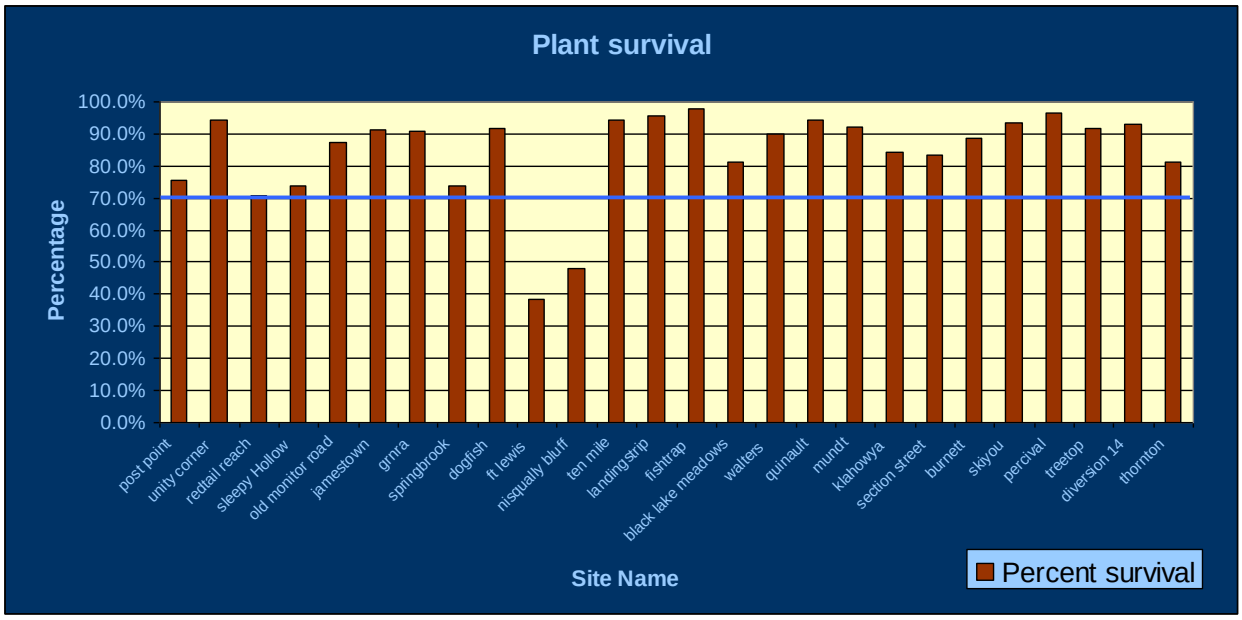

Figure 2: The overall average plant survival for all project sites.

Sites Below 70% Vegetation Survival

There were two sites that fell below the 70% survival goal: the Nature Conservancy's Gray Squirrel Food Islands project and the Nisqually National Wildlife Refuge's West Bluff project. There are several factors contributing to this result. Both sites were upland restoration sites and involve the revegetation of large open areas with nearly 100% exposure to direct sun. The Gray Squirrel Food Islands project was planted in late spring using bare-root plants and did not utilize irrigation at all. The Nisqually site irrigated using a water truck occasionally for only part of the planted area. The area that received periodic watering showed significantly better survival rates than that which was not irrigated (irrigated=>80% survival, non-irrigated=<20% survival). Both of these projects used small bare-root plant stock, which requires more initial watering than potted plants.

Sites Between 70% and 80% Vegetation Survival

Four sites fell between 70% and 80% survival: Post Point and Red-tail Reach in Bellingham, Springbrook Creek in Kent, and Sleepy Hollow in Chelan. None of these sites except for Sleepy Hollow used irrigation. Sleepy Hollow scored a lot higher on the habitat rating because of natural plant recruits (black cottonwood volunteers).

The City of Bellingham's Post Point project is enhancement of a degraded estuarine public park. Challenges this project is facing include significant sun exposure, difficult freshwater hydrological conditions resulting from its proximity to saltwater, a well-established invasive Himalayan blackberry population, impacts of a neighboring waste treatment construction project, and over use as a popular dog exercise area.

The City of Bellingham's Red-tail Reach project is enhancement of a stretch of Whatcom Creek located in an industrial area. Challenges this project faces include significantly established invasive weeds, full sun exposure, and compacted soil with poor water holding capability.

The City of Kent's Springbrook Creek project is a re-vegetation of the banks of a section of the creek that flows through a highly developed industrial section of Kent. Challenges this project faces include significant invasive weeds (Himalayan blackberry and reed canary grass), no irrigation, little to no site maintenance, difficult access, animal browse, and lack of adequate sun light.

The Chelan Conservation District's Sleepy Hollow project is reinforcement and re-vegetation of an eroding bank of the Wenatchee River. Challenges this project faces include poor soil, dry site with full sun exposure, having to plant in rip rap with no available soil, competition with volunteer cottonwood seedlings, and unfavorable roadside site conditions.

While these four projects currently meet the WCC goal of 70% project plant survival, greater results could have been achieved through more aggressive site maintenance and implementation monitoring. Irrigation would have greatly improved the two Bellingham projects, as well as the Kent project.

Important to note that some of these projects plant survival figures are based solely on evaluator field visits that occurred well after project implementation. Some of these projects were planted several years before monitoring occurred, which can result in a high survival rating. On these older projects, no monitoring took place during the time period when planting projects tend to sustain high plant mortality, the first two years after implementation. Every effort was made by evaluators to gather existing monitoring data collected by project sponsors during the implementation monitoring phase of these projects. However, in the cases where this data did not exist, the accuracy of the plant survival figures presented in this report could be higher than what occurred during the initial post-implementation phase.

Overall, this evaluation has shown that habitat restoration projects that utilize WCC crews are performing at an acceptable level. A high percentage of these projects currently appear to be making good progress towards meeting the goals of being self-sustaining and providing the intended habitat for threatened and endangered species of Washington state. It was apparent from project sponsor interviews that the WCC program has been instrumental in the completion and success of these projects.

Recommendations

The following recommendations and guidelines are provided in hopes that they will allow WCC crew supervisors to develop additional expertise that project sponsors will find useful to ensure that their restoration projects have the best chance for success. These recommendations were compiled from the authors' previous restoration experience, the knowledge gained through this study, and from professional restoration resources such as Sound Native Plants of Olympia, WA.

Irrigation and Project Timing

Project success rates of riparian restoration projects are influenced heavily by availability of water to recently planted vegetation. Timing of planting projects is directly related to how much irrigation is necessary. Fall plantings require much less water than spring plantings. Plants installed in early October to mid-December usually outperform those installed in the late winter or spring.

It can take several months for roots to grow sufficiently beyond the planting hole to start absorbing moisture and nutrients from the native soil. Fall soil is warm and aerated, and many plants actively grow roots during this time. Some species will continue root growth through our mild winters, and most begin their most vigorous root growth period in the late winter or early spring. Fall transplants have an extended time for root extension before spring top growth takes off. Plants installed in the spring may hardly recover from transplant shock before the heavy demands of top growth and summer drought are upon them.

The cool, cloudy days and frequent precipitation of fall and early winter provide ideal transplanting conditions. Until sufficient roots develop, newly installed plants will undergo transplant stress that can be exacerbated by warm, sunny days. Fall and winter weather allows for reduced transpiration and provides ample moisture for the roots while plants recover from transplant shock. Fall is also the time that deciduous plants are entering dormancy. Their transpiration rates are slowing down, making them less susceptible to transplant shock. Also, if a plant's top growth is damaged during an autumn installation; it is less likely to set the plant back than in the spring when the plant is gearing up for the new growing season.

Overall, fall plantings enjoy advantages that are especially important for projects that will receive minimal maintenance and irrigation. The earlier plants go into the ground in the fall, the more time they have to recover from transplant shock, adapt to the site, and expand their root systems before the growing season. This translates into lower irrigation needs and more vigorous growth than for spring plantings.

In climates where the ground is frequently frozen several inches deep in the winter, it may make sense to delay planting until spring, but western Washington weather provides perfect winters for fall plantings to become established.

This study has shown that irrigation has proven to be a significant factor in restoration project success. Typically, infrequent, deep watering helps natives and discourages weeds. Once a week in the early summer is plenty (even less for shady sites). By mid-August, cut back to every other week in order to encourage early dormancy.

Plant Stock Sizing and Type

Typically, restoration project managers choose between bare root and potted plants. According to results obtained from this study, potted plant stock has shown higher success rates than bare-root stock. The following is a comparison between potted and bare-root plant stock.

Potted plants:

- Are more expensive to purchase and transport
- Are available in fall
- Have higher survival rates
- Require more time/labor for installation
- Require less care in planting/handling
- Require less irrigation
- Have higher growth rates
- Suffer from transplant shock less

Bare root plants:

- Are less expensive to purchase and transport
- Have limited availability in fall
- Have lower survival rates
- Require less time/labor for installation
- Require more care in planting/handling
- Require more irrigation
- Have lower growth rates
- Suffer from transplant shock more

Generally, small plants transplant more successfully than larger plants. Smaller plants suffer less transplant shock than larger plants, so they are less vulnerable to insects and disease. In general, the smaller a plant at installation, the more quickly it adapts to site conditions, no longer needs irrigation, and becomes established. The plant size chosen should be governed by the project's irrigation capabilities. Smaller plants are easier to handle and cost less. They also have the capability to outgrow larger plants at the same site; within a few years, the plants that came from one-gallon containers are likely to be larger than the plants that came from five-gallon containers or ball & burlap stock.

If the project is not using mulch or plant protectors consider how big the plants need to be to survive weed competition. It is important that they be taller than the surrounding vegetation or, if maintenance will occur, that they can be located so as not to be accidentally trampled or mowed. If larger plants are selected for these reasons, remember that costs for materials and irrigation will be higher. It still may be better to buy smaller material and use the money saved to treat the plants with mulch, flagging, and/or tree protectors.

When bare-root plants are specified for projects, it is recommended to add 25-50% to the plant numbers to compensate for mortality rates, which will typically be higher than with container-grown plants. The same is true for ball-and-burlap plants if they will not be receiving frequent irrigation for the first two summers.

Plant Density

Planting density also plays an important role in restoration project success. Project planning should take into consideration site-specific features such as soil types, water table, and exposure to sun, etc., in order to determine the appropriate plant densities. Table 1 provides a general recommendation for plant densities and spacing.

Table 1: Generalized container plant spacing guidelines developed by Sound Native Plants.

Plant Type	Goal	Spacing (feet on center)	Divide square footage by:
Trees	Dense	10’	100
	Average	12-15’	144-225
	Sparse	18’	324
Shrubs	Dense	4’	16
	Average	6’	36
	Sparse	8’	64
Live Stakes	Dense	1’	1
	Average	2’	4
	Sparse	3’	9
Emergents (plant in clumps of 4)	Dense	1’	1
	Average	2’	4
	Sparse	3’	9
Herbaceous ground cover (4” pot)	Dense	1’	1
	Average	1.5’	2.25
	Sparse	2’	4
Herbaceous ground cover (1 gallon pot)	Dense	2’	4
	Average	3’	9
	Sparse	4’	16

Mulch

Mulch is an important component of restoration project success. Mulch provides nutrients to plant soil, prevents loss of water from the soil by evaporation (over 50%), limits the growth of weeds, keeps the soil cooler in the summer and warmer in the winter, helps prevent erosion, and reduces soil compaction. Project sites that used mulch showed much better success rates than those without.

Tree Protectors

Tree protectors are plastic cylinders that surround newly installed plants. In addition to some animal browse protection, they offer other benefits, especially where competing vegetation is present. Tree shelters are highly visible which is helpful during mowing or brushcutting, and the shelter allows for mowing right up to plants without damaging them. Shelters constrict lateral movement of plants, stimulating quick vertical growth. Tree shelters also act as small greenhouses, increasing heat and humidity inside; this usually speeds growth of the plant, but it may also cause overheating on very dry, sunny sites. Less-expensive tree shelters are shipped as sheets, assembled on site, and then put over the plants. When assembled, most are only about 4 inches in diameter, so combine two or more sheets for bushy plants. Plastic netting tubes ("vexar") are cheaper still, but are too small to use on anything but seedlings. Correct installation is critical: shelters must be securely attached to firmly driven stakes with no gaps between the base of the shelters and the ground.

Ground Fabric

Three basic types of ground fabric (weed cloth) treatments were encountered during this evaluation. Several sites utilized pre-cut weed cloth, a few used a continuous weed cloth barrier, and one site used weed cloth strips. Installing weed cloth suppresses invasive weeds around new plants. As opposed to black plastic, fabric blocks only light while allowing air and water penetration. Weed cloth costs more than black plastic, but it is sturdier, and large pieces can be reused, even after a few years. However, both are made from non-renewable petroleum products, and should be used only after considering more sustainable alternatives. Non-woven weed cloth is cheaper, but woven cloth is stronger and allows better air and water penetration. Weed cloth may be installed around individual plants, placed in long strips to permit mowing and other maintenance in between plants, or installed as a large blanket to smother all the weeds in a large area.

Pre-cut Weed Cloth

Weed cloth may be purchased in pre-cut squares or circles, usually 2' or 3' across, to place around individual plants. Pre-cut weed cloth typically has an X-shaped slit in the center so that the cloth can be placed over the plant, and the plant can emerge through the slit. Use the largest size available that will fit into the plant spacing scheme.

Weed Cloth Strips

Weed cloth strips come in rolls of various widths. To allow for mowing between rows, plants are installed in relatively straight rows at least 5-6' apart. The weed cloth is then rolled out between the rows of plants and installed by cutting slits in the fabric to allow sliding around each plant.

Continuous Weed Cloth Barrier

This approach to weed control can pay off in the long run and has shown very good results on the projects in this evaluation where it was used. Large rolls, typically 12' wide, are rolled out before planting begins and secured to the ground. Plants are then installed by cutting holes in the fabric and then planted. This approach is most effective when herbicide is not an option.

Weed Cloth Maintenance and Removal

Weed cloth in any case will eventually need to be removed, typically, after plants have become well established and chances of being overtaken by invasive weeds have become very low.

Monitoring

Continued monitoring at the crew level is highly recommended. Further training for crew supervisors would be beneficial to develop marketable expertise, which could benefit project sponsors and increase chances of habitat improvement project success.

Implementation monitoring, which occurs during the critical first two years after project implementation, is extremely important to ensure complete success of planting projects. It allows project managers to be able to make decisions early, in order to correct problems such as plant mortality due to improper plant choices, poor plant stock, animal browse, drought, etc. Most project sponsors interviewed for this study utilized WCC crews in maintaining their projects after initial implementation, but only one sponsor used WCC crews for project monitoring activities.

Most of the projects included in this study were either minimally monitored or not monitored at all by project sponsors. Typically, the rationale behind this is that monitoring is thought to be expensive and time consuming. Habitat projects are mostly funded through grants, and these funds are focused on project planning and implementation, with monitoring and maintenance

often taking a lower priority or eliminated entirely. It is typically the lack of monitoring and maintenance that ultimately leads to a project's lack of long-term success.

It is suggested that, in order to improve the likelihood of project success and to determine the effectiveness of planting project implementation, crew supervisors will be given training and materials and encouraged to conduct monitoring on projects during the first two years after implementation. Monitoring will allow the WCC program to determine the status of these habitat projects with a high level of accuracy and in a timely manner. Additionally, monitoring is an important job-training tool that would enhance the WCC's ability to meet its secondary service activity of Corps Member Development. This training could be extremely beneficial to project sponsors and crews with monitoring expertise should be valuable to sponsors on future projects.

Implementation monitoring does not require a large amount of time to conduct and, depending on the project size, will often take less than a few hours per month to complete. Giving WCC crew supervisors the ability to carry out these monitoring activities will increase the success of habitat projects and should be a valuable and marketable asset to the WCC program.

WCC Habitat Meetings

It seems that there is currently a high degree of habitat improvement project knowledge among several WCC crew supervisors who participated in this evaluation. To take advantage of this existing expertise, annual meetings among WCC crew supervisors participating in habitat improvement projects to share and discuss this information is highly recommended. Meetings of this nature could be used to educate less-experienced supervisors about common methods to aid in habitat restoration projects and inform them of who the experts are in the program. Habitat restoration is still a young practice and many project sponsors are conducting projects using various methods and testing different ideas. Bringing all of the experience gained from this large variety of restoration treatments together through WCC crew supervisor meetings should be a valuable resource for the WCC program and its sponsors.

Appendices

Appendix A. Table of Project Results

Site ID	Trend	Habitat Score	Rating	Vigor 2006	Vigor 2007	Vigor Change	% Survival
Post Point	Down	7.75	Good	2.2	2.3	-0.1	75.8%
Unity Corner	Up	10	Excellent	1.9	1.9	0.0	94.3%
Redtail Reach	Down	4.5	Fair	2.1	2.2	-0.1	70.6%
Sleepy Hollow	Up	7.4	Good	1.7	2.4	-0.7	73.9%
Old Monitor Road	Up	7.1	Good	1.5	1.5	0.0	87.5%
Jamestown	Up	9	Excellent	1.9	2.0	-0.1	91.4%
GRNRA	Up	8.75	Good	1.7	1.7	0.0	90.6%
Springbrook	Up	8.25	Good	1.9	2.2	-0.3	73.8%
Dogfish	Up	7.6	Good	1.4	1.4	0.0	91.9%
Ft Lewis	Down	3.7	Poor	3.4	3.4	-0.1	38.5%
Nisqually Bluff	Up/Down	6.3	Good	2.7	3.3	-0.7	47.8%
Ten Mile	Up	9	Excellent	1.8	1.3	0.5	94.1%
Landingstrip	Up	9	Excellent	1.1	1.3	-0.2	95.7%
Fishtrap	Up	9.5	Excellent	1.6	1.2	0.4	98.0%
Black Lake Meadows	Up	7	Good	1.7	1.8	-0.1	81.3%
Walters	Up	9.5	Excellent	1.8	1.8	0.1	89.7%
Quinalt	Up	9.75	Excellent	1.8	1.8	0.0	94.3%
Mundt	Up	9	Excellent	2.0	2.2	-0.2	92.0%
Klahowya	Up	9.5	Excellent	2.0	2.3	-0.3	84.2%
Section Street	Up	8.75	Good	n/a	2.3	n/a	83.3%
Bburnett	Up	8.75	Good	n/a	2.2	n/a	88.5%
Skiyou	Up	9.5	Excellent	n/a	2.1	n/a	93.3%
Percival	Up	8.7	Good	1.8	1.7	0.1	96.7%
Treetop	Up	8.5	Good	1.1	1.4	-0.3	91.7%
Diversion 14	Up	8.2	Good	1.8	1.6	0.2	92.9%
Thornton	Up	7.4	Good	2.1	2.0	0.1	81.4%

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Appendix B. Project-Specific Summaries and Photos

1) Bellingham Post Point

Project detail

City of Bellingham Post Point estuarine and riparian enhancement project:
The Post Point estuary is located within the city of Bellingham port district and is a multi-use recreation area. Located on this property is a great blue heron rookery and important salmonid habitat. The site receives a lot of pedestrian and dog use, which has contributed to the degradation of this site. This project aims to educate the public, improve the ability of the site to sustain the existing heron population and create near-shore riparian habitat for salmon by installing fencing around areas most susceptible to the impacts of dog use. The project consisted of planting native vegetation, installing informational signs, and installing LWD habitat features for salmonids. This project was planted in winter 2005 and consisted of approximately 800 linear feet of shoreline and 30,000 square feet total restored area.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- planting
- maintenance (blackberry removal)
- site prep
- LWD placement
- fence construction
- bridge construction

Project goals

- enhance habitat for salmonids
- enhance habitat for nesting great blue herons
- public education

Evaluation results

Survival	Vigor	Restoration Rating
75.8%	2.3	7.75 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The use of organic mulch and weed matting seems to be the primary factor contributing to the success of the project. Following the protocol on plant species arrangement and plant spacing may also have played a role in the overall success of this site. This site is a popular destination for outdoor recreation by locals. Due to the high-profile nature of this park and interpretive trail, it is imperative that it maintains its aesthetic and environmental functions. This site will need to have continual maintenance for many years to ensure the progression of the plants and the site itself. If left unchecked, there is a high possibility that invasive species (primarily Himalayan blackberry and reed canary grass) could regain a stronghold on much of the project area. There is a lot of construction being done on and near this park. Plans to replace and/or replant in areas that are/were disturbed should be made in order to enhance as much of this sensitive inshore habitat as possible.

What contributed to success?

- organic mulch
- weed matting
- plant spacing
- appropriate plant species

What challenges were encountered?

- no irrigation
- invasive species

Bellingham Post Point Photos

2005

2006

2) Bellingham Unity Corner

Project detail

City of Bellingham Unity Corner slope stabilization and riparian restoration project:
This site is located in a highly urbanized section of the salmon-bearing Whatcom Creek in downtown Bellingham. The project took place in 2002 on an extremely steep slope where it is impossible to get heavy equipment. Crews removed a massive blackberry patch; placed log terracing, soil and mulch to stabilize the slope; and planted native vegetation. This site restores approximately 300 linear feet of stream bank and encompasses 7,500 square feet.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- planting
- mulching
- log terrace placement
- maintenance
- site prep

Project goals

- slope stabilization
- riparian restoration

Evaluation results

Survival	Vigor	Restoration Rating
94.3%	1.9	10 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making great progress toward full habitat restoration and is currently ranked successful by this evaluation. The buffer extends more than 75feet from the channel and the plantings are providing adequate shade to the stream. The high-density planting and the use of multiple tree and shrub species has immensely helped in stabilizing this steep slope. This site was maintained on a regular basis but now seems to be self-sufficient. The LWD is still in place and in use (several cutthroat were observed utilizing the placed woody debris). Although this site is about as "back to natural" as it could possibly be, it is in an urban setting, and there will always be a need for trimming for power lines/signs and litter patrol.

What contributed to success?

- high-density plantings
- appropriate plant species
- close proximity to stream water

What challenges were encountered?

- no irrigation
- extremely steep slope (which presents maintenance problems)

Bellingham Unity Corner Photos

2005

2007

3) Bellingham Redtail Reach

Project detail

City of Bellingham Red Tail Reach riparian restoration project:
Redtail Reach is part of Whatcom Creek in a highly developed industrial park. This reach provides the best spawning habitat in Whatcom Creek for Chinook, Coho, pinks and steelhead salmon, despite existing degraded channel conditions (straightened with no complexity) and lack of significant native vegetation or canopy cover. Activities for this site took place in 2006-2007 and included invasive vegetation removal, native plantings, creating stream meander bends and side channels, and woody debris installations throughout the reach. Woody debris structures have been placed to redirect flow, improve habitat conditions, provide bank protection, and regulate channel migration activity. WCC crews removed the huge amount of invasive plant species existing on site, then mulched, and planted native vegetation on over 5 acres.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- planting
- mulching
- maintenance
- site prep

Project goals

- riparian restoration

Evaluation results

Survival	Vigor	Restoration Rating
50%	3.3	4.5 (fair)

Conclusions (overall success and factors correlated with success)

The site is making slight progress toward full habitat restoration and is currently ranked unsuccessful by this evaluation. The major negative factor for this site is invasive species. The upland or upper bank is completely overridden by a number of different invasive shrub and/or herbaceous species. The channel itself is being choked out by reed canary grass. Major brush cutting and/or herbicide application needs to be done in order to start to control this problem. Weed matting and consistent maintenance would need to be required for future planting plans for this site. The meandering of the river and the LWD seem to be doing very well. Natural sediment and cobble deposits were beginning to accumulate on both sides of the stream bank.

What contributed to success?

- stream meanders
- LWD habitat feature installations

What challenges were encountered?

- invasive species
- no irrigation
- no weed control (matting or mulch)
- non-native seed bank

Bellingham-Redtail Reach Photos

2007

2007

4) Chelan CD Sleepy Hollow

Project detail

Chelan Conservation District Wenatchee River Sleepy Hollow bank stabilization riparian habitat enhancement project:
The site was implemented in 2004 and consisted of planting an area approximately 200' long x 40' wide along the Wenatchee River. Major flood events in 1995-96 nearly washed out a large portion of Sleepy Hollow Road. Large rocks were placed along the river bank, and rock barbs were placed in the river to provide protection for the road. Federal and state permitting agencies required the addition of habitat features as a condition for construction of the project. Logs were cabled to large rocks in the river bed, and plantings were installed along the bank to help stabilize the banks and provide riparian habitat for local fauna species.

WCC involvement

- planting
- irrigation
- site prep

Project goals

- bank stabilization
- enhance riparian habitat
- meet federal and state permitting requirements for habitat features

Evaluation results

Survival	Vigor	Restoration Rating
73.9%	2.1	7.74 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Most of the plantings success was due to the specific plant species used and the use of irrigation. Most of the plantings were installed on top of the stream bank with a few plants placed along the rock bank itself. The plantings in the rock area have done fairly well, but more plants could be utilized in this region of the project. Many natural cottonwood volunteers have become established in the planting area. The plantings will soon help to provide much needed shade to a relatively barren area of stream bank. The rock barbs and LWD are intact and functioning. A few of the barbs and LWD have accumulated some natural debris that will also help with creating habitat features.

What contributed to success?

- irrigation
- appropriate species
- native plant volunteers

What challenges were encountered?

- preparing a suitable planting bed in thick rip-rap material
- invasive species
- dry soil conditions

Chelan CD-Sleepy Hollow Photos

2005

2007

5) Chelan CD Old Monitor Road

Project detail

Chelan Conservation District Wenatchee River Old Monitor Road riparian restoration and bank stabilization project:
This site was implemented in 2001 and consisted of planting approximately 1200 feet x 30 feet of stream bank. This project aims to stabilize a steep eroding bank along the salmon-bearing Wenatchee River. In addition to the planting activities, rock barbs were placed to redirect stream flow away from the bank, as well as large rock placement along the bank for armament.

WCC involvement

- planting
- site prep
- maintenance

Project goals

- bank stabilization
- riparian habitat enhancement

Evaluation results

Survival	Vigor	Restoration Rating
87.5%	1.5	7.1 (good)

Conclusions (overall success and factors correlated with success)

The site is making good progress toward full habitat restoration and is currently ranked successful by this evaluation. The plant species used seem to be the right ones for this region and area. The use of a wider variety of plant species at a higher density would definitely speed up the progression of the plants and help stabilize the stream bank more quickly. The weekly irrigation by the land owner was the most beneficial factor on the site. The rock barbs and LWD are in place and functioning. These elements, along with volunteers, have also contributed to the establishment of the plantings.

What contributed to success?

- irrigation
- volunteers
- rock barbs redirecting water flow
- property-owner maintenance

What challenges were encountered?

- steep, eroding, sloped bank
- invasive plant species
- dry soil

Chelan CD-Old Monitor Road Photos

2005

2007

6) Jamestown S'Klallum 7 Cedars

Project detail

Jamestown S'Klallum Tribe 7 Cedars Casino wetland mitigation project:
This project took place in 1994 and consisted of creating/ enhancing a 3.89-acre wetland to mitigate environmental impacts of the nearby construction of the 7 Cedars Casino. The nearby Jimmy-come-lately Creek is salmon bearing. This project site is located near the town of Sequim and is surrounded mostly by pastoral farmland and Highway 101.

WCC involvement

- planting of ~2000 plants

Project goals

- mitigate impacts of construction of nearby Casino

Evaluation results

Survival	Vigor	Restoration Rating
91.4%	2.0	9.0 (excellent)

Conclusions (overall success and factors correlated with success)
The site is making great progress toward full habitat restoration and is currently ranked successful by this evaluation. This high rate of success is attributed to the temporary use of irrigation at the beginning of the project. Another contributing factor to the success of this site was the particular species and planting density chosen for the site. It is fulfilling its purpose of absorbing runoff from the large parking lot and casino. It is also filtering this water before it enters Jimmy-come-lately Creek and eventually into the Puget Sound.

What contributed to success?

- irrigation
- high plant density
- appropriate plant species
- enhancing an already-existing wetland

What challenges were encountered?

- highway runoff

Jamestown S'Klallum-7 Cedars Photos

2006

2006

7) Kent Green River Natural Resource Area

Project detail

City of Kent Green River Natural Resources Area wetland creation project:
Two wetlands were created in an area that had not been wetland in the past. These two amphibian ponds were constructed as off-site mitigation for development projects in downtown Kent. The smaller pond, completed in 2002, is 5,770 square feet and was planted with 232 riparian shrubs and just under 1,000 wetland emergent species. The larger pond, completed in 2003, is 35,967 square feet and was planted with 9,884 wetland emergent species and 1,476 riparian shrubs and trees. In addition, the WCC planted a 5.79-acre buffer around these two ponds with upland shrubs and trees and constructed a corridor consisting of plantings, emergent species, and large wood habitat features, with the goal of amphibian recruitment into these newly created wetland habitats.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- site preparation (mowing)
- heavy equipment operation for the excavation of the pond areas
- preparation of the pond bed
- planting
- mulching
- placement of large wood habitat features
- installation of irrigation system
- post planting site maintenance

Project goals

- amphibian recruitment
- meet goals of mitigation requirement
- flood control
- water quality improvement
- wildlife habitat creation
- public recreation and education

Evaluation results

Survival	**Vigor**	**Restoration Rating**
90.6%	1.7	8.75 (good)

Conclusions (overall success and factors correlated with success)

The site is making great progress towards full habitat restoration and is currently ranked successful by this evaluation. Appropriate site location and good planning on part of the project sponsor led to this success. The use of irrigation and aggressive maintenance methods were also contributing factors. All tree, shrub, and emergent species seem to be thriving in this newly created wetland ecosystem. The site seems to be achieving the goals of providing new adequate wildlife habitat as well as fulfilling public recreation and education needs.

What contributed to success?

- thorough restoration plan and expertise from project sponsor
- appropriate site location/choice of plant materials
- irrigation
- aggressive ongoing maintenance

What challenges were encountered?

- presence of invasive species

2005

2007

8) Kent Springbrook Creek

Project detail

City of Kent Springbrook Creek riparian restoration project:
Springbrook Creek is a salmon-bearing urbanized creek that runs through the industrial area of Kent. Consequently, riparian habitat is severely degraded or nonexistent and overrun with invasive and non-native plants including Himalayan blackberry and reed canary grass. This project was completed in December of 2004. It included invasive species clearing, LWD placement (done by outside consultant), and planting of 9,419 trees and shrubs along the banks of the creek. A total of 6,200 linear feet of stream bank was enhanced, and the entire area was mulched using experimental techniques and materials consisting of cardboard and burlap or with a special mulch mat material.

WCC involvement

- site preparation (clearing of blackberries/ reed canary grass)
- installation of special mulching materials (cardboard/burlap)
- planting
- post-implementation site maintenance

Project goals

- remove invasive plant species
- LWD placement
- enhance stream bank and riparian area

Evaluation results

Survival	Vigor	Restoration Rating
73.8%	2.2	8.25 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful but at risk by this evaluation. The use of cardboard and burlap matting has given this project a good chance at success. There are a lot of invasive plants, primarily reed canary grass and Himalayan blackberry, still present and thriving in some areas. Though the plants are continuing to grow and will, likely, eventually shade out the non-natives, some basic site maintenance would greatly improve plant growth and overall site development. The amount of invasive plant material on this project is huge. The experimental matting/mulching materials appears to work fairly well. It seems, at this point, that they will last long enough for the planted materials to out-compete the invasives. Compared to projects, such as Percival Creek, that used a more permanent ground cloth (which will need to be removed at some point), there are definitely more invasives growing here. The cardboard/burlap method seems to have been the least effective invasive control technique used here as there is a much more prevalent invasive plant population in these areas. The tree species planted are already tall enough to help shade much of the creek and moderate water temperatures.

What contributed to success?

- proximity to water
- plant density
- effective matting

What challenges were encountered?

- invasive species
- no irrigation

Kent-Springbrook Creek Photos

2004

2006

9) Kitsap CD Dogfish Creek

Project detail

Kitsap Conservation District Dogfish Creek riparian and in-stream habitat enhancement project: This project is located on Dogfish Creek in a slightly developed rural and pastoral part of Kitsap County near Poulsbo. Dogfish Creek is a salmon-bearing stream suffering from degradation because of past poor farming practices, vegetation and wood removal and development. This project took place in 2000 and consisted of the implementation of LWD and root wads, construction of off-channel salmon-rearing habitat, a wet livestock crossing, fence construction and riparian plantings as part of a USDA Wildlife Habitat Incentive Program contract. The project spans over 550 feet and created/enhanced 35-50 feet of riparian buffer on each side of the creek.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- site prep
- planting
- LWD placement
- salmon rearing habitat construction
- fence construction
- stream livestock crossing construction

Project goals

- improve rearing habitat for chum, Coho, and Chinook salmon
- exclude livestock from accessing the stream
- enhance/create riparian habitat

Evaluation results

Survival	Vigor	Restoration Rating
91.9%	1.4	7.60 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The use of tree protectors seemed to be a primary factor to the success of this project. A high-density planting strategy was used in order to suppress invasive plants and seems to have worked. All LWD is in place and functional. A lot of the woody debris has accumulated more natural material. The fence is serving as great buffer between the riparian and pastoral areas. The livestock crossing is being utilized as a corridor between pastures. Brush cutting and tree protector removal could help the site become more successful.

What contributed to success?

- tree protectors
- existing tree canopy provided adequate shade for newly planted vegetation
- proximity to water
- plant density
- LWD placement

What challenges were encountered?

- no irrigation
- livestock land use

Kitsap CD-Dogfish Creek Photos

2005

2007

10) Kitsap CD Little Bear

Project detail

Kitsap Conservation District Little Bear Creek culvert replacement project:
Little Bear Creek is a small salmon-bearing stream in rural Kitsap County near Port Orchard. The old culvert at this site was undersized at 36" and created a barrier to fish passage up stream. The culvert was replaced with a 95" x 67" arch culvert, and LWD was placed in the culvert and nearby streambed to enhance habitat. The larger culvert now allows for easier fish passage.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- site prep

Project goals

- replace undersized culvert
- LWD placement

Evaluation results

Survival	Vigor	Restoration Rating
n/a	n/a	9.0 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The site is functional and is operating at its full potential. The culvert has over doubled the width of the stream and provided salmon with a much more natural habitat. The construction was done with minimal disturbance, and the site has rebounded rather quickly. Planting both sides of the stream bank would further enhance this small stream.

What contributed to success?

- proper reconstruction of stream bank slope
- installation of LWD

What challenges were encountered?

- lack of vegetation

Kitsap CD-Little Bear Photos

2007

11) The Nature Conservancy Gray Squirrel Food Islands

Project detail

The Nature Conservancy Fort Lewis Gray Squirrel food islands project:
Fort Lewis is a US army post that encompasses 87,000 acres of forest, prairie and oak savanna land. Much of the historical prairie lands of Washington state have been converted to farms and pastures, severely limiting the available habitat of the endangered western gray squirrel. The Nature Conservancy has targeted the western gray squirrel on Fort Lewis and is attempting to improve the habitat of this species through restoration activities. This project took place in 2005 through 2006 and consisted of planting 20 groups of 10m x 10m plots with 28 plants each.

WCC involvement

- WCC crews were the only labor force for the implementation of this project.

Project goals

- increase foraging opportunities for the western gray squirrel on Fort Lewis
- increase the connectivity of known populations
- increase food bearing vegetation within a corridor between populations

Evaluation results

Survival	Vigor	Restoration Rating
38.5%	3.4	3.7 (poor)

Conclusions (overall success and factors correlated with success)

The site is not making progress toward full habitat restoration and is currently ranked unsuccessful. The lack of irrigation, replanting, and site maintenance are leading to the demise of this site. These are all results of a lack of funds. These sites may not be salvageable, and prospects of doing this kind of restoration in the future should take long-term funding and maintenance under serious consideration.

What contributed to success?

n/a

What challenges were encountered?

- no irrigation
- small/sickly plant stock
- exposure to direct sunlight
- invasive species
- Military training

The Nature Conservancy-Gray Squirrel Food Islands Photos

2006

2007

12) Nisqually National Wildlife Refuge West Bluff

Project detail

Nisqually Wildlife Refuge West Bluff forest upland restoration project:
The Nisqually Wildlife Refuge is located near Olympia on the Nisqually river delta and consists of 12.6 square kilometers. The project site is approximately 100 acres in size and is located on the top of the west bluff of McAllister Creek, within the refuge. The invasive Scotch broom has become well established throughout the parcel and has been mowed two or three times annually since the beginning of the project. Since 1999, 35000 plants have been installed, with varying success rates. For the purpose of this study we have looked at the most recent planting project conducted by WCC/Komachin Middle School students in 2005. This phase of the project included 5,000 plants, utilizing two different planting methods to help determine a future approach for this site.

WCC involvement

- site prep (mowing, organization)
- supervise the KMS students during their planting and weeding activities
- finish planting, weeding, and quality control/repair after KMS event
- carry out ongoing maintenance of the plants by weeding and watering

Project goals

- restore forested uplands
- provide students and teachers from Komachin Middle School the opportunity to take part in environmental stewardship within their community
- increase the wildlife habitat value of the project site by:
- improving stability to the bluff
- improving water quality in McAllister Creek and the Nisqually River estuary
- reducing runoff and erosion
- providing a wide corridor for wildlife movement
- providing a larger forested buffer for nesting bald eagles and great blue herons

Evaluation results

Survival	Vigor	Restoration Rating
47.8%	3.0	6.3 (good)

Conclusions (overall success and factors correlated with success)

Overall the site is not making progress toward full habitat restoration and is currently ranked unsuccessful. However, due to the fact that two treatment methods were used at this site (one was mulched heavily and watered regularly; the other was not mulched or watered), and we are seeing a huge difference between the two. The small portion of the project that received water and mulch can be rated as successful. Unfortunately, the successful portion is only 1/20 of the overall project area. Lack of water and uncontrolled invasive plant problems seem to be the highest contributing factor to the lack of success for the remainder of the site. The use of an irrigation system and tree protectors have greatly improve survivability of the newly planted vegetation. The use of weed matting and/or cardboard may be an effective strategy to use against the presence of invasive species, primarily Scotch broom. Another alternative is to establish smaller areas within the entire project site. This may be more time consuming, but easier to manage. The use of mulch, such as fir bark and straw, appears to have a positive effect on some of the areas. Conifers seem to have the best survivability, although many of these plants still died. Perhaps more aggressive preparations, such as burning combined with mowing and herbicide spraying, would give better success.

What contributed to success?

- irrigation and mulch where it was used

What challenges were encountered?

- invasive species
- dry soils
- direct sun exposure
- inconsistent/no irrigation
- insufficient site prep
- insufficient maintenance plan

Nisqually National Wildlife Refuge-West Bluff Photos

2006

2007

13) Nooksack Salmon Enhancement Association Ten Mile Creek

Project detail

Nooksack Salmon Enhancement Association Ten Mile Creek riparian restoration project:
Ten Mile Creek is a salmon-bearing stream located in rural, pastoral Whatcom County. The creek has been degraded by deforestation, development, and channel straightening. This project restored 1700 linear feet of stream channel by planting native vegetation in 20-30-foot- wide buffers on each side. The project took place in 2004 and 2005.

WCC involvement

- site prep
- planting
- maintenance
- monitoring

Project goals

- enhance stream bank and riparian area

Evaluation results

Survival	Vigor	Restoration Rating
94.1%	1.3	9.0 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The species used, planting density, and the site's close proximity to a water source are the main contributing factors in the overall success of this site. (The use of tree protectors had a positive impact on the site's progression.)A plan to remove the tree protectors is warranted, as some of the larger plants are starting to grow into the protectors. The vegetation is now providing adequate habitat and shade for this section of Ten Mile Creek.

What contributed to success?

- proximity to a water source
- plant density
- plant diversity
- tree protectors

What challenges were encountered?

- plan for removal of tree protectors

Nooksack Salmon Enhancement Association-Ten Mile Creek Photos

2004

2007

14) Nooksack Salmon Enhancement Association Landingstrip Creek

Project detail

Nooksack Salmon Enhancement Association Landingstrip Creek riparian restoration project: Landingstrip Creek is a salmon-bearing stream running through rural pasture land in Skagit County. Work began on this project in 2003 and consisted of LWD placement, minor channel reconfiguration, and riparian planting.

WCC involvement

- monitoring
- LWD habitat feature placement
- stream reconfiguration
- herbicide application
- site prep
- invasive removal
- post implementation maintenance

Project goals

Reduce some of the surrounding impacts of residential and agricultural land use by installing LWD habitat structures and reestablishing riparian cover which will benefit Chinook, Coho and chum salmon, and cutthroat trout by:

- reducing water temperature
- creating a source for LWD recruitment
- filtering pollutants
- creating wildlife habitat
- stabilizing eroding banks

Evaluation results

Survival	Vigor	Restoration Rating
95.7%	1.2	9.0 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The availability of water, choice of appropriate plant species, and the use of tree protectors seem to be the key factors in the success of this site. The LWD are intact and functioning. Some of the woody debris has caused the accumulation of more debris. Weed matting and some light maintenance could help suppress an invasive grass problem.

What contributed to success?

- proximity to water
- plant diversity
- tree protractor

What challenges were encountered?

- need for weed matting
- more maintenance

Nooksack Salmon Enhancement Association-Landingstrip Creek Photos

2004

2006

2004

2006

15) Nooksack Salmon Enhancement Association Fishtrap Creek

Project detail

Nooksack Salmon Enhancement Association Fishtrap Creek riparian restoration project:
This project began in 2002 and restored a 25-foot buffer along both sides of 1,400 linear feet of Fishtrap Creek through the Homestead subdivision downstream of Badger Rd. The majority of land adjacent to the creek is used for residential housing, grazing, and feed crop production. The creek running through this seven acre property has good year-round flow and spawning gravels, but showed some bank erosion.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- maintenance
- monitoring
- herbicide application
- mulching
- matting
- fencing

Project goals

Reduce some of the surrounding impacts of residential and agricultural land use by reestablishing riparian cover which will benefit chinook, coho and chum salmon, and cutthroat trout by:

- reducing water temperature
- creating a source for LWD recruitment
- filtering pollutants
- creating wildlife habitat
- stabilizing eroding banks

Evaluation results

Survival	Vigor	Restoration Rating
98.0%	1.4	9.5 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Multiple tactics were used to encourage plantings to out compete invasive species. Aggressive maintenance, tree protectors, beaver fence, weed matting, and the sparse use of herbicide all seem to be major contributing factors in the progression of this site. The plantings appear to be satisfying the projects goals of providing shade, creating wildlife habitat, and stabilizing eroding banks. This project is self-sufficient and almost back to a natural state.

What contributed to success?

- site preparation
- tree protectors
- weed matting
- maintenance

What challenges were encountered?

- rodent herbivory

Nooksack Salmon Enhancement Association-Fishtrap Creek Photos

2005

2005

16) Olympia Black Lake Meadows

Project detail

City of Olympia Black Lake Meadows riparian restoration project:
Work began on this project in the fall of 2002 and consisted of intensive plantings on both side of the Black River ditch. A mix of conifers, deciduous trees and shrubs were used for stream bank stability as well as shade for lowering of stream temperatures. With time, the larger trees will become standing habitat structures and eventually L.W.D. in the stream.

WCC involvement

- WCC crews were the only labor force for the implementation of this project.

Project goals

- reduce stormwater impacts and non-point pollution
- provide/enhance wildlife habitat
- provide protective cover for stream life
- reduce stream temperature
- provide long-term woody debris
- provide spawning habitat
- provide rearing habitat
- educate public

Evaluation results

Survival	Vigor	Restoration Rating
81.3%	1.8	7.0 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Reed canary grass and Himalayan blackberry were pervasive before planting began. Only one mowing took place before planting. The use of alder in study areas did well but requires a longer-term restoration commitment. This might be a good method for difficult sites. Use of black matting to cover the entire project worked well. More weeding should have taken place to maintain plants. Beaver exclusion fence worked very well until they figured out how to get in. Completely enclosed planting areas would have been more successful. Irrigation through the summer would also have been beneficial.

What contributed to success?

- matting
- fencing
- maintenance
- proximity to a water source

What challenges were encountered?

- beaver damage
- more extensive fencing
- irrigation

Olympia-Black Lake Meadows Photos

2005

2007

17) Olympic National Forest Walters Creek

Project detail

Olympic Nation Forest Walters Creek slope stabilization project:
This project was started in 1999. The project area consisted of a slope failure along a 1,000 ft. of stream bank. These bioengineering structures consisted of the construction of willow crib walls and fascines that extended an estimated 900 as well as log terraces intended to catch loose debris sloughing from the hillside. Bare root plantings were focused above log terraces and also stretched throughout the slope failure. A final application of seed and mulch was spread over the treatment area.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- planning and design to implementation
- installed crib wall
- installed log terraces
- willow fascines
- seeding
- mulching

Project goals

- stabilize slope erosion into creek and onto road
- rehabilitate slope to naturalized condition

Evaluation results

Survival	Vigor	Restoration Rating
89.7%	1.8	9.5 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. This project was completed on a nearly impossible slope grade. Crib walls and fascines seemed to have had the most important impact on this site. The plantings have now established root systems that are helping to stabilize the slopes. Volunteers are starting to appear on the stabilized slope. This successful planting and stabilizing project is an example of what determination and hard work can accomplish on an "impossible" project. Since the project site was on a south facing slope with no irrigation, a high density of plants, western white pine, was the ideal species.

What contributed to success?

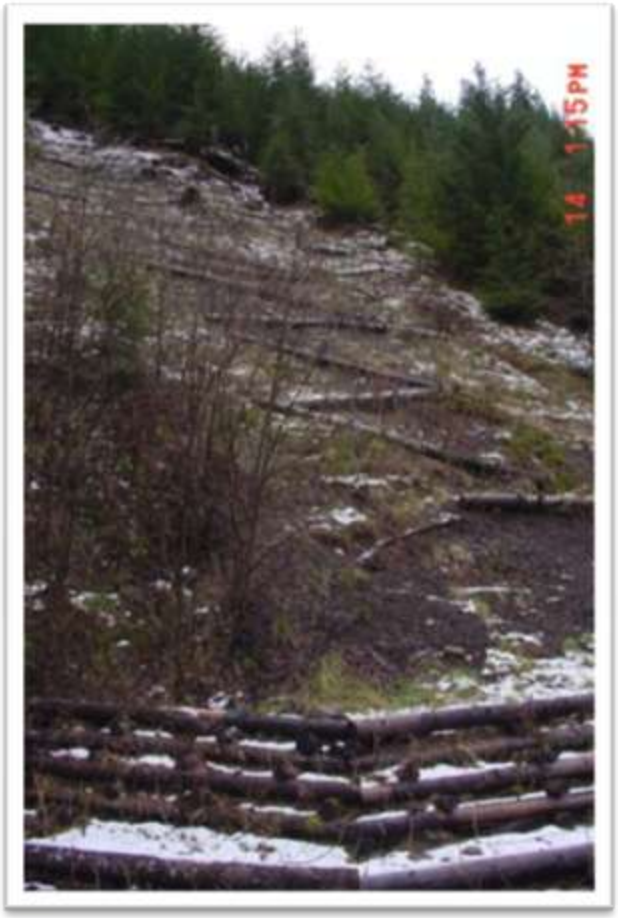
- crib walls and fascines
- plant density
- natural volunteers

Challenges encountered?

- degree of unstable slope
- no irrigation

Olympic National Forest-Walters Creek Photos

2005



2007

18) Olympic National Forest Mouse Houses

Project detail

Olympic National Forest rodent habitat creation project:
This project, located in the Olympic National Forest, tests an experimental method of providing previously unavailable terrestrial habitat for rodents. The design uses three logs stacked in a pyramid shape at least 30 feet long by 20 inches high and 3 feet wide to simulate habitat provided by downed old-growth logs in area where old-growth trees are nonexistent. Rodents are the main food source for the endangered Oregon spotted owl and many other raptors.

WCC involvement

WCC crews were the only labor force for the implementation of this project. Activities included:

- harvest of material
- installation of structures

Project goals

- Provide rodent habitat to increase available food source for endangered owls and other raptors.

Evaluation results

Survival	Vigor	Restoration Rating
n/a	n/a	10 (excellent)

Conclusions (overall success and factors correlated with success)

The site seems to be meeting project goals. Small mammal presence has been confirmed through the identification of tunnels and nesting materials. The structures made of larger logs seemed to promote more activity than groups of smaller logs. The site appears to have a carrying capacity large enough to accommodate more habitat structures.

What contributed to success?

- use of large logs
- complete ground contact

What challenges were encountered?

- n/a

Olympic National Forest-Mouse Houses Photo

2007

19)Olympic National Park Quinault North Shore

Project detail

Olympic National Park, Quinault, North Shore road riparian restoration and bank stabilization project: This project repaired a river bank erosion and road washout due to flooding conditions in the salmon-bearing Quinault River. The Quinault North Shore road connects many residential, commercial, and National park roads. The riparian plantings consisted of native plant materials from local genetic stocks. These plants were obtained by salvage and propagation using seed, cuttings, and stock plants.

WCC involvement

- plant salvage
- planting

Project goals

- protect as much existing riparian vegetation as possible
- create favorable conditions for natural regeneration from the native seed bank
- restore stream bank and shade fish habitat along the bank

Evaluation results

Survival	Vigor	Restoration Rating
94.3%	1.8	9.75 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The biggest concerns were to prevent invasive plant species from out-competing the newly planted vegetation and also to secure the stream bank in order to prevent sediment from entering the stream. The use of rip rap and existing large vegetation appears to have secured the stream bank and allow the plantings and seed applications to root. Another major contributor to the success of this site was the use of local soils. This allows native seeds in the soil to germinate, while helping prevent invasive species from establishing. Other reasons for the success of the site were the use of curlex bales as an incubator and ground cover, as well as the monitoring and maintenance of the plantings

What contributed to success?

The use of:

- large rip rap rock
- existing large vegetation
- local soils
- curlex bales

What challenges were encountered?

- existing and continued stream bank erosion
- threat of introducing invasive vegetation

Olympic National Park-Quinault North Shore Photos

2005

2007

20) Skagit CD Mundt

Project detail

The Skagit Conservation District private property wetland mitigation and creation project: This project is mitigating the impacts of a nearby rock quarry. Work began on this project in the spring of 2001 and continued through fall of 2004. The site was prepared by brush cutting invasive species and planting bare root plants and live stakes throughout the wetland. Maintenance, replanting, and the removal of bull frogs were all done in the duration of the three years.

WCC involvement

- site preparations
- planting
- replanting
- bull frog removal
- maintenance

Project goals

- removal of invasive plant species
- enhance stream bank and riparian area

Evaluation results

Survival	Vigor	Restoration Rating
92%	1.4	9.0 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. This well-maintained site is successful mainly due to the planting scheme used. The plant spacing, dense in the lower emergent area and less dense in the upper tree/shrub area, and the use of the proper species seemed to be the major contributing factors. Invasive species, primarily reed canary grass, are prevalent throughout the site. Most of the plantings appear to be out-competing the invasives, but weed matting, brush cutting, and/or herbicide application may help the site become more successful.

What contributed to success?

- maintenance
- site/project planning
- tree protectors
- plastic shade cloth
- direct seeding

What challenges were encountered?

- year round water allowed non-native bullfrog invasion
- invasive plant species

Skagit CD-Mundt Photo

2006

21) Skagit CD Klahowya

Project detail

The Skagit Conservation District Klahowya Creek riparian restoration project:
Work began on this riparian project in 2000 and continued through 2004. Klahowya creek is a salmon bearing stream that runs through a Boy Scout Camp named Fire Mountain. Site preparations and plantings were done to enhance stream/ riparian area, provide habitat for avian and aquatic species and lower stream temperatures.

WCC involvement

- site preparations
- planting
- installation of tree protectors
- maintenance

Project goals

- removal of invasive plant species
- enhance stream/ riparian area
- provide habitat for avian and aquatic species and lower stream temperatures

Evaluation results

Survival	Vigor	Restoration Rating
84.2%	1.6	9.5 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Major contributors to the success of this project are the use of tree protectors, specific species used, and continual maintenance. There are invasive grasses on the site, and the use of mulch around each planting seemed to help them become more established. Replanting in areas with mortality and denser plant spacing may be alternative strategies to help plants out-compete invasives and may also help this site become more successful.

What contributed to success?

- tree protectors
- maintenance
- mulching
- stock fencing

What challenges were encountered?

- invasive plant species
- plant spacing
- need for replants in places

Skagit CD-Klahowya

2005

2007

22) Skagit CD Section Street

Project detail

The Skagit Conservation Districts Gauges Slough/ Section Street riparian restoration project: The section Street restoration project was started in 2000 and finished by 2001. The site was prepared by brush cutting and removing invasive species. The one acre project area was planted with 1800 bare root plants and incorporated a foot nature trail. Hand pulling and brush cutting of invasive species were the strategies used in maintaining the site.

WCC involvement

- site preparations
- planting
- maintenance

Project goals

- removal of invasive plant species
- re-establish native plants
- provide recreational natural area

Evaluation results

Survival	Vigor	Restoration Rating
83.3%	1.9	8.5 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Site preparations and plant species used seem to be the major contributing factors to the success of this site. Its close proximity to a major water source also had a major impact on the planting efforts by allowing their roots to stay in the water column for longer periods of time. Himalayan blackberry patches are starting to take over in certain areas. More maintenance, weed matting, and herbicide application may be options for battling this problem.

What contributed to success (best practices)

- site preparations
- project planning
- close proximity to a water source

Challenges encountered

- invasive plant species
- lack of maintenance and/or weed matting

Skagit CD-Section Street Photos

2006

2006

23) Skagit CD Burnett

Project detail

The Skagit Conservation Districts Burnett wetland and riparian restoration project:
This restoration project was started in fall of 2000 and finished by winter of 2005. The project details include site preparations, planting of potted plants, installation of tree protectors, herbicide application, and maintenance.

WCC involvement

- site preparations
- planting
- installation of tree protectors
- herbicide application
- maintenance

Project goals

- enhance wetland area
- enhance riparian area

Evaluation results

Survival	Vigor	Restoration Rating
88.5%	1.6	8.75 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The use of weed matting and tree protectors appear to be the leading contributing factors to the success of this site. The species used and spacing/density have also helped this site progress. More maintenance and/or the continued use of herbicide may help to combat the invasive weed problems.

What contributed to success?

- weed matting
- tree protectors
- mulch (wood chips)

What challenges were encountered?

- invasive plant species
- lack of continued maintenance/ herbicide application

Skagit CD-Burnett Photos

2006

2006

24) Skagit CD Skiyou

Project detail

The Skagit Conservation Districts Skiyou Slough riparian restoration project:
This riparian project encompasses both the Skiyou Slough and the Skagit River. This once agricultural field was planted with 7000 different tree and shrub species to enhance riparian habitat and help to prevent stream bank erosion. Other project tasks included the installation of tree protectors, plant inventories, and overall maintenance.

WCC involvement

- site preparations
- planting
- installation of tree protectors
- maintenance

Project goals

- removal of invasive plant species
- enhance stream bank and riparian area
- prevention of stream bank erosion

Evaluation results

Survival	Vigor	Restoration Rating
93.3%	1.3	9.5 (excellent)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The use of an array of species, as well as the density and spacing, seemed to be the biggest contributing factors to the success of this site. The planted vegetation seems to be healthy and is now competing with the non-native grasses and Himalayan blackberry. Cattle are allowed into the project site and there are signs of plant damage due to the cattle. Also, the river bank is eroding in some spots, which removes plantings. Large woody debris and/or rip rap may help to slow this erosion.

What contributed to success?

- project planning
- plant density
- maintenance

What challenges were encountered?

- continued erosion
- presence of livestock
- invasive plant species

Skagit CD-Skiyou Photos

2005

2007

2005

2007

25) Tumwater Percival Creek

Project detail

City of Tumwater Percival Creek riparian restoration project:
This project began in 2001 and finished in 2003. A diverse array of shrub and tree species was utilized. Project details included the control of nonnative plant species, the hand application of water, and the use of weed matting.

WCC involvement

- WCC crews were the only labor force for the implementation of this project.

Project goals

- enhance stream bank and riparian area

Evaluation results

Survival	Vigor	Restoration Rating
96.7%	1.8	8.7 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. In this site, the planting area was completely covered with black matting, was weeded regularly, and was watered by hand through the dry season. It looks to be self-sufficient, but another year or two of maintenance could help the plantings in the flood plain areas. It will probably be a few years until the site will be back to its natural state. The shrubs are getting close to maturity but most of the trees under 20 feet tall. The use of more black matting would help suppress weeds. Where the matting is, the natives are filling in, especially on the creek side of the road. The other side of the road is doing well but is growing slower. Browsing is another issue but one that cannot be fixed by using regular tree protectors because the plants are too large. Hand watering appears to play a major role in the success of this site.

What contributed to success?

- hand watering
- plant density
- weed matting
- maintenance

What challenges were encountered?

- invasive plant species
- animal browsing

Tumwater-Percival Creek Photos

2005

2007

26) Yakima CD Tree Top

Project detail

Yakima Conservation District Yakima River Tree Top riparian restoration bank stabilization project:
This project was funded by the Salmon Recovery Funding Board and is located on the salmon-bearing Yakima River (right bank) starting at the downstream edge of Harrison Road Bridge in East Selah. The project was done to stabilize about 1,800 feet of riverbank (first section going downstream). Items implemented in this area were three J-hook vanes, three root wad structures, bank sloping, and riparian planting (including watering and weeding). In the next 5,000 feet, a 75-foot wide buffer was established (including the first 1,800 feet), as well as other riparian restoration activities. There is a large great blue heron rookery located within the project site restoration area.

WCC involvement

WCC crews were the only labor force for the implementation of this project.

Project goals

- stabilize stream bank
- enhance riparian area

Evaluation results

Survival	Vigor	Restoration Rating
91.7%	1.3	8.5 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. It will take a few more years before it reaches self-sufficiency, due to the presence of weeds. Once the trees are large enough to out-compete the weeds, they won't need maintenance. A few of the trees were being overwhelmed by weeds. Matting at their bases and routine maintenance would be effective in controlling weeds.

What contributed to success?

- plant species used
- proximity to a major water source
- L.W.D. placement

What challenges were encountered?

- erosion
- invasive plant species

Yakima CD-Tree Top Photos

2005

2007

27) Yakima CD Diversion 14

Project detail
Yakima Conservation District Diversion #14 irrigation diversion and riparian restoration project: This project was funded by the Salmon Recovery Funding Board and is located on the main stem of salmon-bearing Ahtanum Creek (left bank at approximately RM 10.5) in rural farmland. The project was constructed in 2005 and included construction of nine rock weirs to remedy an in-stream passage barrier and to provide grade control for an irrigation diversion. The project also implemented a 10-cfs fish screen, dike/berm setback (75 feet) to establish a three acre riparian area (also provides for floodplain connection) for restoration, two root-wads, and other restoration activities.

WCC involvement
- WCC crews were the only labor force for the implementation of this project.

Project goals
- Enhance riparian and wetland areas

Evaluation results

Survival	Vigor	Restoration Rating
92.9%	1.7	8.2 (good)

Conclusions (overall success and factors correlated with success)
The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. Plant diversity, spacing, and the use of irrigation at the beginning seemed to be the greatest contributing factors to the success of this site. The site will require water and weed maintenance for quite some time. It will be several years before it is back to its natural state. Weed matting and maintenance would help reduce invasive plant species.

What contributed to success?
- plant diversity
- plant density
- irrigation
- maintenance

What challenges were encountered?
- lack of continued irrigation
- lack of continued maintenance
- invasive plant species

Yakima CD-Diversion 14 Photos

2005

2007

28) Yakima CD Cowiche Creek

Project Detail

Yakima Conservation District Cowiche Creek riparian restoration bank stabilization project: Thornton Project –The project is located on salmon-bearing Cowiche Creek, approximately two miles up-stream of Summit View Extension (right and left bank). The project included moving livestock corrals back from the stream, fencing of riparian areas, prescribed grazing plan components, LWD placement within the flood plain, and riparian restoration. The re-vegetation took place in 2006.

WCC involvement

- WCC crews were the only labor force for the implementation of this project.

Project goals

- LWD placement
- enhance riparian area

Evaluation results

Survival	Vigor	Restoration Rating
81.4%	2.1	7.4 (good)

Conclusions (overall success and factors correlated with success)

The site is making progress toward full habitat restoration and is currently ranked successful by this evaluation. The matting worked very well where used but the gaps allowed non-natives to establish, and they are now competing with natives. The irrigation is another key in overall survival of the plants. The species seem to fit the site, and most natives are thriving. More invasive weed removal and weed maintenance could be used. A wider variety of native plants could have been used. This site is far from self-sufficiency and will need consistent maintenance for quite a few years. This could change if a strategy for non-native species removal were to be implemented.

What contributed to success?

- weed matting
- proximity to a water source
- livestock fencing

What challenges were encountered?

- low plant diversity
- invasive species
- lack of irrigation

Yakima CD-Cowiche Creek Photos

2005

2007

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Appendix C – RiverKeeper Habitat Restoration Survey

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RPS Scoring

This section is designed to develop an overall score for your project site. There are six elements you will assess and each element will be ranked with a score from 1 to 10. Low scores indicate poor conditions while higher scores indicate ideal conditions. Record the score that best fits the observations you make based on the narrative descriptions that are provided on your datasheet. Do not score elements that are not applicable to your site. Be sure to refer to the baseline RPS that was done for your site shortly after the project was completed. Use the comments section to provide additional information about each indicator to help us better understand the conditions you scored.

These six categories are for evaluation of the restoration project area only. That is, areas where plantings and any bioengineering activities have been carried out. Do not include surrounding land use and conditions.

Restoration Buffer Width -Larger buffers produce greater benefits for both wildlife and water quality. Estimate the width of the planted buffer project in feet. The RPS allows you to assess each bank separately if plantings are present on both sides of the stream. **Note only the area of the buffer planted as part of your project. If additional buffer already exists beyond the planted area, note this in the Comments section but do not consider when scoring your site.**

Planted vegetation extends >75 feet from the active channel	Planted vegetation extends 50 feet from the active channel	Planted vegetation extends 35 feet from the active channel	Planted vegetation extends 15 feet from the active channel	Planted vegetation extends less than 1 foot from the active channel
10	7	5	3	1

As trees mature and canopies widen, the buffer will ultimately broaden as well. Even if there are no trees planted at the site, remember that tall meadow grasses and wildflowers also function as healthy buffers. You may notice that mowing has decreased buffer width or quality. Grasses and wildflowers should not be mowed, particularly after trees and shrubs have become established (normally within 2 to 3 years). A plant community, consisting of trees surrounded by tall native herbaceous grasses and wildflowers, generally supports good buffer function.

Note your observations on buffer width in the Comments section. Note in your Maintenance Recommendations the possibility of expanding the buffer by expanding the "no-mow" zone. Few projects will have a pre-existing buffer of native trees, shrubs, or meadow grasses, which is why a buffer was established in the first place.

Trees and Shrubs -This element focuses on the status of planted trees and shrubs in the project area and the distribution of these trees and shrubs throughout the project area. **If the project was designed to be a meadow and not a forested buffer, do not rate this indicator.**

RPS Scoring Tips

Two educated opinions are better than one. We encourage you to pair up with another trained steward to perform the assessment.

You can assign scores between categories. For example, if a buffer is 60 feet wide, you can give the buffer a score of 8.

This scoring system is semi-quantitative in nature. It requires that you distinguish significant differences. For example, do not sweat over assigning a score of8 or 9.

Careless mowing will kill trees and shrubs. If mowing is evident check the base of trees and shrubs for damage. In most cases, buffers should not be mowed.

>90% of the project area has trees and shrubs that are healthy and growing	~70% of the project area has trees and shrubs that are healthy and growing	~50% of the project area has trees and shrubs that are healthy and growing	~30% of the project area has trees and shrubs that are healthy and growing	<10% of the project area has trees and shrubs that are healthy and growing
10	7	5	3	1

Healthy trees and shrubs should have signs of growth, including green leaves, buds, flowers or fruits, depending on the time of year. Be sure to note any impacts that may be affecting plant survival such as mowing, herbivory and disease. If your project site has a site map, refer to it to note where trees and shrubs were planted originally. If you notice gaps where trees and shrubs are absent, this could indicate damage by mowing, trampling, or mortality. In most cases, if a buffer project was planted, the plantings will be somewhat contiguous. As a rule of thumb, trees and shrubs are usually spaced anywhere from 6 to 20 feet apart while herbaceous plants are typically spaced from 1 to 3 feet apart. In some cases, an access area may have been left unplanted in order to decrease trampling, but these access points should be marked on your project's site map.

When you notice specific mortality and other impacts, take spot photos to document the damage. Also, if mowing is performed at the site, be sure to take a look at the base of the trees and shrubs to see if they have suffered mower or weed whip damage. Trees can recover from this damage if girdling did not occur, but careless mowing practices will kill trees. Note impacts to trees and shrubs in the Comments section and contact the project partner or maintenance crew immediately if mower damage is evident to encourage the installation of "no mow" signs. Herbivory, trampling, flood and ice damage, disease, and dieback are all other impacts that you should consider for this category and note in the Comments section.

You may notice that volunteer native trees and shrubs have colonized the project area on their own. Count these native volunteers in your score as they help create a natural buffer for the stream. Note volunteer species in the Comments section if known.

Herbaceous Vegetation -This element scores the status of grasses, herbs, wildflowers, and wetland plants planted at the project site. Ideally, herbaceous vegetation will be greater than six inches in height and not impacted by mowing.

>90% of herbaceous vegetation is green and healthy with a height of at least six inches	~70% of herbaceous vegetation is green and healthy with a height of at least six inches	~50% of herbaceous vegetation is green and healthy with a height of at least six inches	~30% of herbaceous vegetation is green and healthy with a height of at least six inches	<10% of herbaceous vegetation is green and healthy with a height of at least six inches
10	7	5	3	1

If there are areas of bare soil, note this in the Comments section and list re-seeding as a possible maintenance option.

You may notice that volunteer native grasses, herbs, wild-flowers, and wetland plants have colonized the project area on their own. Count these native volunteers in your score as they help create a natural buffer for the stream. Note volunteer species, if known, in the Comments section. If mowing is impacting vegetation, contact the project partners immediately and encourage the installation of "no-mow" signs.

Improved biodiversity means a healthier buffer with higher wildlife values.

Biodiversity -This element looks at the number of different species present at the project site. Count the number of different native plant species found in the project area. **Be sure to include only native trees, shrubs and herbaceous plants. Do not include invasive species in this count**.

There are at least 16 different native plant species growing in the project area	There are at least 12 different native plant species growing in the project area	There are at least 8 different native plant species growing in the project area	There are at least 4 different native plant species growing in the project area	There is only one native plant species growing in the project area
10	7	5	3	1

You will likely notice that volunteer plants have established themselves in the project area. This is ideal as long as they are not invasive species. Include native volunteers in your count. If you can identify the different species, list them in the Comments section. Otherwise, simply count the different types of species you see at the project site.

Exotic Invasive Vegetation -Determine the extent of exotic invasive species present in the project area. First, look in your Project Folder to determine if any invasive plants were noted in the area in the past. If they were present in the past, they are likely still present to some extent.

No invasives present in the project area or general vicinity around project area	~25% of project area has invasive species present and competing with planted vegetation	~50% of project area has invasive species present and competing with planted vegetation	~75% of project area has invasive species present and competing with planted vegetation	Invasive species dominate the project area – few natives unaffected by invasives
10	7	5	3	1

In the Comments section, note the degree of infestation and plant distribution. Draw invasive plant locations on your diagram to help with future maintenance efforts. If you are unfamiliar with invasive plants, be sure to take *Plant Invaders of Mid-Atlantic Natural Areas* with you as well as re-sealable plastic bags to preserve a suspected invasive plant for later identification. Take pictures of the plant (preferably against a white background) to help with identification. Early detection is the key to controlling invasive plants so becoming familiar with common invasive species is a big help.

Bioengineering Techniques -This element is applicable only to projects that involved re-grading and re-vegetating of stream banks. If bioengineering techniques were employed at your project site, they will be listed in your Project Folder.

This element focuses on how well bioengineering techniques are holding up over time and how plant establishment is progressing. Bioengineering techniques are designed to degrade over time as the planted native vegetation takes root and grows to hold the banks in place.

>90% of all bioengineering materials intact and functioning; plants well-established	~70% of bioengineering materials intact; minor patches of erosion; majority of plants established	~50% of bioengineering materials intact; erosion common and compromising planted vegetation	~30% of bioengineering materials intact; high erosion areas with few surviving plants	<10% of bioengineering materials intact; bare soil, gullies and erosion dominate area
10	7	5	3	1

Look at your site to determine if bare soil and erosion are dominating the project area and causing sediment pollution during times of rain. If no vegetation is present within the bioengineering structures, it is likely that erosion will worsen as the materials degrade. Check to make sure that materials are pinned down securely. Note if coir logs are missing from the toe of the bank, leaving only the crisscrossed stakes that once pinned these structures into the toe of the bank. Record any other observations in the Comments section.

Overall Score Calculation

Total the scores for each applicable element then divide that number by the total number of categories scored. This is your Overall Score for the site. Circle the Poor, Fair, Good, or Excellent rating calculated for your project site.

Total Points	
Number of Categories Scored	
OVERALL SCORE (Divide Total Points by Number of Categories Scored)	

< 4.0 = Poor

4.1 - 6.0 = Fair

6.1 - 8.9 = Good

> 9.0 = Excellent

Congratulations! You did it.

Maintenance Recommendations

As you are completing the RPS, note any maintenance recommendations that would benefit the site. If you are willing to lead maintenance efforts at your site, let DRN know and we will provide you with support and advice. You may also refer to the Restoration Project Maintenance section of this Toolkit for help with maintenance concerns. If you perform maintenance, be sure to document what you have done on the Maintenance Log (see page 110) and send a copy to DRN for our records.

Restoration Project Survey Scores (1-10):
Consider only the restoration project area in this assessment. Rate only those elements appropriate to the restoration project.

	Score	Comments
Restoration Buffer Width (Left bank facing downstream)		
Restoration Buffer Width (Right bank facing downstream)		
Trees and Shrubs		
Herbaceous Vegetation		
Biodiversity (List native species present if known):		
Exotic Invasive Vegetation (Listspecies present if known):		
Bioengineering Techniques		

Total Points	
Number of Categories Scored	
OVERALL SCORE (Divide Total Points by Number of Categories Scored)	

< 4.0 = Poor
4.1 - 6.0 = Fair
6.1 - 8.9 = Good
> 9.0 = Excellent

Comments & Observations: (Describe any notable conditions about the restoration project not covered above)

Scoring Descriptions for Restoration Project Survey

Each assessment element is rated with a value of 1 to 10. Record the score that best fits the observations you make based on the narrative descriptions provided.

Restoration Buffer Width

Planted vegetation extends >75 feet from the active channel	Planted vegetation extends 50 feet from the active channel	Planted vegetation extends 35 feet from the active channel	Planted vegetation extends 15 feet from the active channel	Planted vegetation extends less than 1 foot from the active channel
10	7	5	3	1

Trees and Shrubs - note gaps with no trees in project area (could indicate mortality)

>90% of the project area has trees and shrubs that are healthy and growing	~70% of the project area has trees and shrubs that are healthy and growing	~50% of the project area has trees and shrubs that are healthy and growing	~30% of the project area has trees and shrubs that are healthy and growing	<10% of the project area has trees and shrubs that are healthy and growing
10	7	5	3	1

Herbaceous Vegetation

>90% of herbaceous vegetation is green and healthy with a height of at least six inches	~70% of herbaceous vegetation is green and healthy with a height of at least six inches	~50% of herbaceous vegetation is green and healthy with a height of at least six inches	~30% of herbaceous vegetation is green and healthy with a height of at least six inches	<10% of herbaceous vegetation is green and healthy with a height of at least six inches
10	7	5	3	1

Biodiversity - list species you can identify (do not include invasive species in count)

There are at least 16 different native plant species growing in the project area	There are at least 12 different native plant species growing in the project area	There are at least 8 different native plant species growing in the project area	There are at least 4 different native plant species growing in the project area	There is only one native plant species growing in the project area
10	7	5	3	1

Exotic Invasive Vegetation

No invasives present in the project area or general vicinity around project area	~25% of project area has invasive species present and competing with planted vegetation	~50% of project area has invasive species present and competing with planted vegetation	~75% of project area has invasive species present and competing with planted vegetation	Invasive species dominate the project area – few natives unaffected by invasives
10	7	5	3	1

Bioengineering techniques – only applicable to projects with bank regrading

>90% of all bioengineering materials intact and functioning; plants well-established	~70% of bioengineering materials intact; minor patches of erosion; majority of plants established	~50% of bioengineering materials intact; erosion common and compromising planted vegetation	~30% of bioengineering materials intact; high erosion areas with few surviving plants	<10% of bioengineering materials intact; bare soil, gullies and erosion dominate area
10	7	5	3	1

Appendix D - Vegetation Monitoring Worksheet

Site: Observer(s):

Date: Time:

	Transect							Vigor Assessment	
	Trans ID	Species Code	Intercept (m)	Height (m)	Diameter (cm)	Stem count		1=thrive, 2=alive, 3=stressed, 4=dead	Damage Code
1								1 2 3 4	
2								1 2 3 4	
3								1 2 3 4	
4								1 2 3 4	
5								1 2 3 4	
6								1 2 3 4	
7								1 2 3 4	
8								1 2 3 4	
9								1 2 3 4	
10								1 2 3 4	
11								1 2 3 4	
12								1 2 3 4	
13								1 2 3 4	
14								1 2 3 4	
15								1 2 3 4	
16								1 2 3 4	
17								1 2 3 4	
18								1 2 3 4	
19								1 2 3 4	
20								1 2 3 4	
21								1 2 3 4	
22								1 2 3 4	
23								1 2 3 4	
24								1 2 3 4	
25								1 2 3 4	
26								1 2 3 4	
27								1 2 3 4	