Monitoring and evaluation of Snoqualmie Stewardship Program riparian restoration projects in the Snoqualmie Valley 2001- 2007

Monitoring completed during Summer 2007

STEWARDSHIP PARTNERS

Helping Landowners Preserve the Environment

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SUMMARY

The Stewardship Partners Snoqualmie Stewardship Program has been working with private landowners in the Snoqualmie Valley, just east of the Seattle metropolitan area, for six years. There are currently eight active restoration projects associated with this program at which Stewardship Partners' crews that have cleared invasive species from riparian zones (along the riverbank), and planted native vegetation in an effort to restore productive riverside habitat and improve water quality and habitat for migrating native salmon. In order to determine the success of these projects, and ensure ongoing and future successes, Stewardship Partners monitored the sites in the summer of 2007. Monitoring included an inventory of all plants at each site identified by species for most (some plants, such as willows, were only identified to genus), and photo-point monitoring, which involved taking replicable photos throughout each site and comparing them to past years. Analysis of data obtained from monitoring showed that the restoration projects have been very successful at establishing native vegetation, removing and controlling invasive species, and minimizing mortality.

INTRODUCTION

Snoqualmie Stewardship Program

Stewardship Partners' Snoqualmie Stewardship Program is a multifaceted approach to engaging local landowners, particularly in the agricultural sector, in conservation efforts, and doing so in a way that meets their needs and interests through a variety of incentive-based tools. What began in 2001 as a restoration program on Oxbow Farm to create a model for riparian restoration compatible with agricultural practices has since developed into a rapidly expanding program that incorporates restoration, education, and collaboration among landowners, communities, and various other stakeholders.

The Snoqualmie Valley, while located just outside of the Seattle metropolitan area, has remained primarily a rural agricultural valley. However, the accumulating impacts of historical uses, agricultural practices, and increasing development puts the Snoqualmie River at risk. In fact in 2001, American Rivers named the Snoqualmie River to its annual list of America's "10 Most Endangered Rivers."[1] In addition to these risks, the majority of land in the Snoqualmie Valley is privately-owned, and the percentage is even higher when considering the ownership of only the land along the riverbanks. This program works through the acknowledgement that it is these private landowners who have the greatest potential to positively impact the Snoqualmie River through conscientious and sustainable land use practices. Many landowners are receptive to it because it differs from the typical regulatory approach which many of them have come to resent, because is not does not recognize the nuances of individual farms and traditional knowledge.

The Snoqualmie Stewardship Program promotes the use of agricultural best management practices and land management that benefits water quality as well as fish and wildlife habitat. Through a variety of incentive-based tools, we address environmental issues while promoting and enhancing the economic viability of agriculture in the Snoqualmie Valley. The Valley is an important local food resource, and the momentum building in the local and sustainable agriculture movement has been beneficial to the success of these programs. The Valley currently has 13 farms and other landowners engaged in projects which provide a solid foundation and many opportunities for collaboration.

Riparian Restoration

A major aspect of the Snoqualmie Stewardship Program is the riparian restoration projects that are being conducted on farms throughout the Snoqualmie Valley. There are currently seven farms in the Snoqualmie Valley on which Stewardship Partners has implemented a restoration project. More than three miles of restored stream bank and nearly 11 acres of native riparian vegetation buffers have been restored. Riparian restoration is an important part of ecosystem rehabilitation, because riparian areas, as the interface between land and water, are very productive habitats that support high biodiversity, improve water quality by reducing erosion and filtering pollutants, and limit the frequency and magnitude of flooding. In spite of these important ecosystem services

[1] American Rivers. (2001) *America's Most Endangered Rivers of 2001.* Retrieved June, 2007, from: American Rivers: http://www.americanrivers.org/site/PageServer?pagename=AMR_content_b441

that riparian zones provide, they are often degraded, highly impacted by human activities and development, and overrun with noxious weeds or invasive species such as reed canary grass and Himalayan blackberry, which do not offer the same ecological benefits as native vegetation. In Washington, it is estimated that more than three hundred species of wildlife rely on riparian habitat for food and shelter, underscoring the importance of restoring these critical areas.[2]

Riparian restoration projects are one of the most cost-effective ways to restore water quality, but their methods and impacts vary widely.[3] These projects often showcase a wide range of approaches to restoration, but have the common goal of rehabilitating the riparian ecosystem to its natural structure and function. The riparian restoration projects that Stewardship Partners undertakes are guided by this general goal, with a specific focus on restoring the riparian function to enhance water quality and habitat for migrating native salmon. It is estimated that throughout the United States, approximately $1 billion per year is spent on river restoration projects (including riparian revegetation), and only ten percent of those projects have been monitored or evaluated.[4] This monitoring project was undertaken in summer 2007 to provide a general analysis of the riparian restoration projects Stewardship Partners has implemented, to allow for adaptive management of those projects if results indicate the need for change, and to assess the level of success in achieving the aforementioned goals of the projects.

METHODS

Planting Methods

Riparian revegetation in the Snoqualmie Stewardship Program is guided in part by a report on the historic ecological conditions in the Valley.[5] This report examined conditions based on historical data from 1870, 1936 and 2000 and has been used in restoration projects to obtain a riparian plant community that is similar to the historic conditions. Planting methods may vary slightly by site; however, the general methods are relatively consistent.

Site Preparation

Once sites for restoration work are selected, work begins on clearing invasive species. This includes cutting down above-ground portions of the plants, most typically Himalayan blackberry, as well as grubbing out the roots. Once sites are cleared, they are usually disked and tilled to loosen the ground for planting. Landscape fabric is also typically laid down on the planting area to help with maintenance and to ward off invasive species.

Planting

Planting plans are developed based on the historical conditions report and our experiences in habitat restoration in the Snoqualmie Valley. Plants are installed within

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[2] Washington Department of Fish and Wildlife. *Restoring the Watershed: A citizen's guide to riparian restoration in Western Washington*. Retrieved August 29, 2007, from Washington Department of Fish and Wildlife: http://wdfw.wa.gov/outreach/volunter/riparian.pdf

[3] U.S. EPA (1995) *Ecological Restoration: A Tool to Manage Stream Quality.* Retrieved August 8, 2007, from Environmental Protection Agency, Office of Water: http://www.epa.gov/owow/nps/Ecology/

[4] Bernhardt, E. S. *et al*. (2005) Synthesizing U.S. River Restoration Efforts. *Science* 308(5722): 636-637.

[5] Collins, B.D. and A.J. Sheikh (2002) *Mapping historical conditions in the Snoqualmie River valley (RM 0- RM 40).* Department of Earth and Space Sciences, Univ. of Washington. Report to: King County Department of Natural Resources, Seattle, WA.

the planting area, usually on the landscape fabric that has been laid out. Live cuttings are also used to stake the riverbanks.

Maintenance

Restoration sites in the Snoqualmie Valley are maintained through the joint efforts of the Stewardship Partners crew and a Washington Conservation Corps (WCC) crew. They maintain the sites year-round by grubbing out blackberry roots, removing invasive species, cutting grass around plantings, and watering the sites, among many other tasks. After a restoration site is planted, Stewardship Partners makes a commitment to provide maintenance on the site for up to three years.

Monitoring Methods

Monitoring of restoration sites was completed in two phases: complete inventory of plantings, and photo-point monitoring. In addition, results of the inventory were analyzed in conjunction with site data and planting methods in order to determine which methods and sites have been most successful, and to adapt our methods accordingly.

Site Inventory

Site inventories were performed in May 2007 on all restoration sites in the Snoqualmie Valley: Oxbow Farm, Cherry Creek Equestrian Center, Blue Dog Farm, Ames Creek Farm, Fall City Farms, Jubilee Farm, Full Circle Farm, and Snoqualmie Falls Forest Theater. All plants were counted and identified to species, except for willows, roses and apples, which were only identified to genus (*Salix* spp., *Rosa* spp., and *Malus* spp., respectively). In some areas of dense plantings at Oxbow Farm, individuals were counted using sub-sampling. In these cases, the total number of a species were counted in a small area and then extrapolated to provide an estimate for the entire section.

In addition to counting live plants, dead plants were counted by species, when identifiable, and as "dead- miscellaneous" when identification was not possible. It is important to note, however, that the count of dead plants only includes plants that had died but were still present at the site. At some sites, plants were counted and identified as "healthy," "stressed," or "dead."

Results of the inventory were compiled and analyzed, including providing approximate species richness (number of species at a site), and calculating percent mortality as: (number of dead individuals ÷ number of total individuals (living and dead) * 100).

Photo-Point Monitoring

Photo-point monitoring was conducted in July 2007. It was conducted in the summer after all plants had leafed out and neared or reached their growing peak for the season. Because it was done somewhat retroactively, methods for photo-point monitoring may vary in the future, and methods varied for some sites.

Blue Dog Farm was the only site for which photo-points were set-up before the site was cleared and planted (the preferable method), this was done on September 12, 2006. In this case, a map and legend were made showing where photos were taken, at what compass heading, and any notes necessary to replication. Monitoring was done approximately one year after the original photo-points were set-up, and was completed by taking photos at the assigned points and headings. Photos were then compiled for comparison to the previous year's photos.

At all sites other than Blue Dog Farm, photo-point monitoring was not set up at the beginning of the restoration projects. Therefore, in order to use this technique, photos from each site were found which could be replicated as closely as possible, were taken at the beginning of the restoration project, preferably before the site had been cleared, and, when compiled, covered a majority of the restoration project. Once these photos were found and compiled, each site was diagrammed and the photos were replicated, noting location and compass heading (using magnetic direction) and other notes which would aid in future replication. Photos were compiled for comparison to previous photos and qualitative analysis. In all cases for photo-point monitoring, baseline photographs are considered year 0 data, and photographs from 2007 are year 1 data, regardless of how much time has passed between the original photos and the monitoring, this is done to eliminate confusion based on labeling and keep consistent sets of photos for subsequent photo-point replications.

It is recommended that monitoring be done at years 0, 1, 3, 5 and 10 of each restoration project.[6] In the case of some of the restoration sites, that was not possible; however, in the future it should be adhered to at least for photo-point monitoring, if not also for inventory. In subsequent replication years for photo-point monitoring, photographing should be done based on the original (year 0) photos, and should be done in approximately the same time frame (mid-summer). In addition, for future restoration projects, photo-point monitoring should be set up and photographs taken at the beginning of a project, before any work is done on the site, in order establish a baseline for subsequent photo-point monitoring and comparison between years.[7]

RESULTS

Inventory

The results of the inventory were combined and are summarized here for all sites. There were a total of 10,671 living plants at all restoration sites combined, with only 190 dead plants, giving a percent mortality of 1.75% for the combination of sites. The average plant density, in terms of living plants per square foot, was 0.026, with a density of 0.016 trees/square foot and 0.006 shrubs/square foot. The total number of species present (species richness) at Stewardship Partners' restoration sites was approximately 34 (willow, rose, and apple were not identified to species); however, not all species were found at all sites. The average species richness was 18. Further, in relation to plant community composition at restoration sites, the percentage of trees that were conifers was 14%.

There is wide variation between the different restoration sites in the Snoqualmie Valley. Oxbow Farm had the highest number of living plants, with 4,064 individuals, while Fall City Farms had the fewest living plants, with 174. Jubilee Farm had the highest number of dead plants, 111, which were mostly alder, while Ames Creek Farm had no dead plants, because it was planted the most recently, in April 2007 (monitoring was done May-August, 2007). Percent mortality is a useful indicator for the health of a

[6] Crawford, B. (2004) P*rotocol for Monitoring Effectiveness of Riparian Planting Projects*. Retrieved April 26, 2007, from Washington Salmon Recovery Funding Board: http://www.rco.wa.gov/documents/srfb/Monitoring/MC-3_Riparian_Planting_Projects.pdf

[7] Hall, F.C. (2002) *Photo-Point Monitoring Handbook.* USDA Forest Service- Pacific Northwest Research Station. General Technical Report PNW-GTR-526. Retrieved July 2, 2007, from USDA Forest Service: http://www.fs.fed.us/pnw/pubs/gtr526/

site, because it gives a proportion of plants that are surviving, rather than raw data, which is more difficult to evaluate. Fall City Farms had the highest percent mortality, at 9.84%, with Ames Creek and Forest Theater the lowest, at 0%. The average percent mortality was 2.87%, whereas the median was 0.91%. In this case, the median is a more accurate generalization of the results, since the mean is skewed by the high mortalities at only a few sites; however, both numbers are quite low and indicate that the vast majority of plants are surviving at the restoration sites. Three sites (Oxbow Farm, Cherry Creek Equestrian Center, and Blue Dog Farm) had a small number of volunteer plants, which were not originally planted.

The overall results for each site are summarized in table 1 below; some of this summary data is also be seen by species in graph form (fig. 1 and fig. 2). Table 2 shows a summary of the data broken down by species. More detailed evaluations of each site can be found in the following individual site reports.

Table 1. Summary of plant inventory data for Stewardship Partners' restoration sites in the Snoqualmie Valley.

Farm Name	**Total Living**	**Total Dead**	**Percent Mortality**	**Species Richness**	**Density (plants/ft^2)**
Oxbow Farm	4,064	12	0.29	33	0.034
Cherry Creek Eq. Ctr.	2,084	8	0.38	26	0.018
Blue Dog Farm	1,019	5	0.49	21	0.049
Fall City Farms	174	19	9.84	14	0.012
Ames Creek Farm	205	0	0	16	0.044
Jubilee Farm	1,476	111	6.99	18	0.017
Full Circle Farms	1,620	35	2.11	15	0.015
Forest Theater	23	0	0	3	0.022

Analysis solely of dead plants indicates that red alders suffered the highest mortality (fig. 3); however, when you analyze plant mortality based on the percent mortality rather than overall mortality, the trend is different (fig. 4). Percent mortality by species shows that both western hemlock and cascara buckthorn had the highest mortality, 10%, and that red alder had the third highest percent mortality at 4.9%. Interestingly, red alder also was one of the most prevalent living plant species, at 25% of the total. Unidentifiable dead plants were not included in the calculation of percent mortality, because there was no living counterpart with which to pair the data to calculate a percentage.

At Cherry Creek Equestrian Center, data were collected and analyzed as to how many individuals of a species were not only living and dead, but among those living, how many appeared healthy and how many appeared stressed. It was found that between healthy, stressed, and dead conifers (Sitka spruce, Douglas fir, western red cedar, and shore pine), there were significantly more healthy trees than dead (t-test, P=0.04); however, the differences were not statistically significant between healthy and stressed, or between stressed and dead. Despite this, though, a clear trend can be seen in the data when graphed (fig. 5), in that there are consistently more healthy individuals, fewer stressed individuals, and still fewer dead individuals. This is an especially pronounced

trend for Sitka spruce, Douglas fir, and shore pine, but it is not as pronounced for western red cedar. It is important to note that the distinction between healthy and stressed plants was in this study a qualitative one, based on plant appearance. Notations were also made at other sites to record western red cedar, Douglas fir, and western hemlock as stressed. Status for broadleaf trees was not recorded, because there were very few that appeared stressed.

In addition to the data provided by the inventory, qualitative observations were also made to aid in assessing the restoration projects. At three sites (Oxbow Farm, Cherry Creek Equestrian Center, and Full Circle Farm) western red cedars were all, or mostly, stressed (evidenced by their red or brown foliage). This is thought to be due to excess light stress. Additionally, at Full Circle Farm, Douglas firs appeared stressed as well. In planting these restoration sites, many staked cuttings are used, most of which appear to do very well. At Blue Dog Farm there were many salmonberry stakes that were still alive, but had not yet leafed out by mid-summer. On a return to the site later in August, they appeared to be doing better, and the delay in their leaf-out might have been related to the timing of planting.

Photo-Point Monitoring

Photo-point monitoring provides us with a visual chronicle of the changes in a site over time. This is the first year we have done photo-point monitoring and while not definitive and inherently qualitative in nature, the photos provide some good basic evidence. The photo-point monitoring clearly shows that the plantings are thriving. For sites where we have pictures taken before any clearing was done (Blue Dog Farm, Ames Creek Farm, and parts of Jubilee Farm, Oxbow Farm, and Fall City Farms), the photos reveal that the changes brought about by restoration are even more pronounced. Invasive species such as blackberries have been removed and kept in check by maintenance, and the plantings appear to be growing and thriving. As the photo-point monitoring is replicated in future years, the improvements brought about by these restoration projects will become even more apparent.

DISCUSSION

The primary goal of riparian restoration is to rehabilitate the riparian ecosystem as nearly as possible to its original native structure and function. While there is little data on the historical condition of riparian forests in the Snoqualmie Valley, the data available provides useful points of comparison to assess the success of Stewardship Partners' restoration plantings. In looking at historical data as well as recommendations and guidelines for current restoration projects, we can see that these restoration projects in the Snoqualmie Valley have been successful so far, and as the plantings grow and the program expands will contribute to the restoration of riparian forests in this area.

The inventory for all of Stewardship Partners' restoration sites in the Snoqualmie Valley indicates that restoration has been successful thus far in establishing native vegetation and limiting invasive species. The high survivorship of plants at the restoration sites strongly suggests that planting and maintenance methods are successful in both implementing and maintaining the projects, and the presence of volunteer plants at some sites indicates that they are successful at recruiting new native plants, and thus the natural function is being restored to some extent as well. Moreover, invasive species

have largely been kept in check, with vigilant monitoring and maintenance, allowing the native vegetation a chance to become established and thrive. Results from the site inventory provide a lot of information that is useful in examining other trends as well and provide us with an opportunity to assess our techniques and adapt them accordingly.

The species percent mortality calculated from the inventory results had a mean of 8.25%, meaning that roughly eight out of every one hundred plants that were planted at restoration sites died, and there was, correspondingly, a 91.75% survival rate. However, the inventory-calculated mortality rate is artificially low. Because we do not have an estimate of the original planting size for all sites, the dead plants included in these data are the ones that were still present at the site and identifiable, we can assume that more plants actually died than were counted, and thus, that the actual percent mortality for the restoration sites is in reality slightly higher than 8.25%. That being said, the actual percent mortality is most likely not substantially higher than our inventory numbers, and based on those numbers it falls within a reasonable range. The United States Department of Agriculture estimates that in riparian revegetation projects a mortality of 10% is expected.[8] In addition, other sources estimate mortality rates of 50% in the early years following planting, to 10% after the planting has been established.[9] The Sonoma Creek project is a riparian revegetation project located in California that uses many of the same species as the Stewardship Partners' projects.[10] In their "Restoration/Revegetation Plan" the criteria for success include a 50% survival rate for plantings. One reason the California mortality rate is high may be that they are planting some species from seed, as opposed to the established potted and salvaged plants that Stewardship Partners' uses. Nonetheless, Stewardship Partners' survival rate surpasses other projects' rates for all species and at all restoration sites. In general, the survivorship at Stewardship Partners' restoration sites is within, if not slightly higher than, the expected range, and thus the sites are in good condition.

In addition to the mortality and survivorship of the plantings, density is a useful indicator of the success of the restorations. While we do not have historical data on riparian forest density, current guidelines from the King County Department of Development and Environmental Services provide an idea of what is considered natural and healthy. In their guidelines for riparian restoration projects, the planting plans recommend 81 square feet of land for every tree, and 36 square feet per shrub, or a density of 0.012 trees/square foot, and 0.028 shrubs/square foot, which is approximately 0.04 plants/square foot.[11] The average density for Stewardship Partners restoration sites is 0.016 trees/square foot and 0.006 shrubs/square foot. The overall density for the restoration sites is 0.026 plants/square foot. Although the restoration sites are slightly less densely planted than King County recommends, this recommendation is based on a restoration project that will be planted and not maintained, therefore a higher mortality is expected than at Stewardship Partners' sites. Because Stewardship Partners conducts

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[8] Hoag, J.C. (1997) *Riparian/Wetland Project Information Series No. 2: Planning a Project*. Retrieved August, 2007, from USDA Natural Resources Conservation Service: http://plant-materials.nrcs.usda.gov/pubs/idpmcarwproj2.pdf

[9] Manci, K.M. and K.A. Schneller-MacDonald (1989) *Riparian Ecosystem Creation and Restoration: A Literature Summary*. Retrieved August, 2007, from USGS Northern Prairie Research Center: http://www.npwrc.usgs.gov/resource/habitat/ripareco/eval.htm

[10] Sonoma Creek Project (2005-2007) *TAdN Arundo Eradication and Coordination Program: Restoration/Revegetation Plan*. Retrieved August, 2007, from Team Arundo del Norte: http://www. teamarundo.org/eradproject/restor_plan_scrk_083005.pdf

[11] King County DDES (2007) *Critical Areas Restoration and Enhancement in King County.* Retrieved August, 2007, from King County DDES: http://www.metrokc.gov/ddes/forms/lg-guide-rest.pdf

maintenance at restoration sites for up to three years following the planting, the initial density can be lower to achieve a similar outcome to sites that receive no maintenance. The density is therefore in line with expectations for this type of environment and maintenance schedule for most sites. At some sites where the plants appeared stressed, such as Cherry Creek Equestrian Center and Fall City Farms, the low density may contribute to the physical stress, but overall the planting densities are generally in line with expectations outlined in various riparian planting guidelines.

In order to assess the effectiveness and success of these projects, it is necessary to look beyond just survivorship and density, to other aspects of restoration that support ecosystem function, such as community composition. Understanding the historical conditions of riparian ecosystems in the Snoqualmie Valley gives us a benchmark with which we can determine the baseline for restoration success. A study performed in 2002 by the University of Washington for King County Department of Natural Resources mapped and analyzed historical conditions in the Snoqualmie Valley based on information from approximately 1870, 1936, and 2000.[12] This study provides us with important background information on what these areas looked like before widespread changes were made in the landscape. In the information on the pre-Euro-American-settlement environment in the Snoqualmie Valley (~1870), Collins and Sheikh report that hardwoods, including red alder, willow, bigleaf maple, and black cottonwood were the primary trees in the riparian areas of the Snoqualmie Valley, and that western red cedar and Sitka spruce, while not as prevalent as other species, were the largest trees in the area. The riparian zones were described as shrub-scrub wetlands, meaning there were few trees and mostly shrubs. Of the trees present, red alder and willow were dominant streamside species, while bigleaf maple and black cottonwood dominated in terms of basal area. Conifers occupied only about 7% of the riparian zone.[13] Species richness of riparian zones in the Snoqualmie prior to settlement is not explicitly stated in the report; however sixteen species listed in their field notes provide evidence of richness. We can assume that the actual species richness was in fact higher than this, but it is a good basis for comparison.

Comparing the data on community composition at restoration sites in the Snoqualmie Valley to the historical conditions outlined in the 2002 University of Washington report brings similarities to light that indicate that the Stewardship Partners' projects are indeed restoring the riparian forests and improving their natural structure and function. The report states that hardwoods are the dominant trees in the riparian zones, which is the case at Stewardship Partners' restoration sites; where overall the percentage of hardwood trees present was 85.6%. The historical conditions report also states that conifers comprised 7% of the riparian forests in the Valley, whereas at Stewardship Partners' restoration sites 14% of the trees are conifers. The percentage of conifers at current restoration sites is only slightly higher than the historic level. The species richness at restoration sites is similarly in line with historical conditions. We know from the report that there were at least sixteen different species that made up riparian forests around 1870. The average species richness of restoration sites currently is twenty. It is not surprising that these numbers are close, since the planting plans were based on the report; however their similarity strengthens the assertion that the riparian restorations are

[12] Collins and Sheikh, 2002
[13] Collins and Sheikh, 2002

succeeding at returning sites to their historical conditions. Overall, the community composition of the restoration sites compared to the data in the historical conditions report suggests that these restorations are, thus far, successful. This is important, because beyond simply adding plants to a riverbank, the goal of restoration is to restore native habitat that is important to many native species, including migrating salmon.

The area of greatest variation between sites was percent mortality. Two sites, Fall City Farms and Jubilee Farm, which had the highest percent mortality (9.84% and 6.99%, respectively) were also the sites which endured the greatest extent of flood damage in the November, 2007 flood. While a substantial portion of the mortality at Jubilee is also thought to be due to the mishandling of red alder plants between their collection and planting, some is likely due to flooding as well. At Fall City Farms, flooding was very damaging and removed many plants that had been planted the previous spring, therefore the percent mortality was in fact probably even higher than what was calculated based on the plants that were still present in summer 2007. Another area of variation between sites was plant density (number of plants/acre). Density was highest at the two smallest sites, Blue Dog Farm and Ames Creek Farm, but those sites were planted predominantly with shrubs and are adjacent to small creeks, not the Snoqualmie River. Based on qualitative evidence, the sites adjacent to the Snoqualmie River also had similar community compositions, albeit differing from the creek-side sites in that they were planted with more trees in order to increase shade over the river. Moderating water temperature extremes by shading is an important aspect of riparian restoration, especially in connection with salmon restoration efforts, and while at a smaller creek shrubs can accomplish this, at the wider river, having more trees is important to achieving this goal.

In the breakdown of the inventory results by species, there are a number of interesting trends. Red alder and willow had the highest percentage of total living plants compared to all others, trees and shrubs combined, at approximately 25% each, while western hemlock and cascara buckthorn both had the highest percentage of dead plants, approximately 10%. There was a high percentage of red alder present that was living, and red alder also had the third highest percent mortality. This may seem contradictory; however there were so many alders planted that even though a number of them died, the overall percentage relative to other species remains high. These data are suggestive of the relative abilities of these plants to cope with the conditions present at these sites.

Typically, restoration sites are highly exposed to the elements and may present more challenging physical environments than an established forest or riparian area. These physical stresses include higher exposure to sun, wind, and cold temperatures, as well as soil that is low in nutrients.[14] The effects of this can be seen in that in the few areas in which we planted native trees and shrubs under the canopy of an existing riparian forest known as underplanting, there were no dead plants present (such as at Full Circle Farm and Jubilee Farm). The effects of the physical stresses for plants at a restoration site can also be seen in the data from Cherry Creek Equestrian Center (fig. 5). The initial planting area of Cherry Creek was not planted on landscape fabric, leading to high weed growth and an increase in the population of voles. Due to this, about half of the trees planted in this area were girdled by voles and subsequently died. At the time of monitoring, Sitka spruce had the highest proportion healthy plants; western red cedar had almost as many

[14] *Riparian Restoration and Management.* Retrieved August, 2007, from Washington Department of Fish and Wildlife: http://wdfw.wa.gov/hab/ahg/shrg/10-shrg_riparian_restoration.pdf

healthy individuals as those observed to be stressed and dead. These data suggest that Sitka spruce are more tolerant of the physical stresses of a restoration site, namely high exposure to extremes in temperature, wind, and precipitation, than western red cedar. Douglas fir and shore pine were the other two conifer species at Cherry Creek for which these data were collected, and they both fared well, having noticeably more healthy individuals than stressed or dead. That being said, the objective of riparian restoration is to restore stream banks, and this necessitates creating an environment that is physically stressful to plants in order to eventually establish a healthy, native riparian forest. It is important, then, that plants are chosen that will be able to withstand these pressures, which is, by and large, the case at the Stewardship Partners' restoration sites.

CONCLUSION & RECOMMENDATIONS

The overall health of the riparian restoration projects in the Snoqualmie Valley is good. Looking both at the combined results from all sites, and the individual site reports, the restoration appears to be returning the sites to a more natural and ecologically functional state. Based on historical data, we know that the community composition is similar at these sites to its status circa 1870, and plantings' survivorship is higher than expected based on county guidelines and reports from similar projects. Invasive species have been removed at all sites and regular maintenance is succeeding at keeping these species and noxious weeds controlled, giving native vegetation a chance to become established. The presence of volunteer plants at some sites is a positive sign that the restoration is working to rehabilitate the site and recruit additional native species to the area.

The purpose of this monitoring project was not solely to assess the health of the restoration sites, but also to provide recommendations for adaptive management. A major cause of mortality at one site, Jubilee Farm, was the mishandling of red alder plants between their collection and planting. There were over one hundred dead alder plants at Jubilee, most of which could have been prevented if the plants had been handled properly between being salvaged and re-planted. This is an easily preventable mistake and should be avoided in the future. Another recommendation is meant to minimize the stress plants experience at the restoration sites. As previously mentioned, many of the conifer species that were planted appeared stressed upon their inventory, particularly western red cedar. It may be useful in the future to consider physical stresses in the planting plan, and perhaps return to the site after establishing more hardy pioneer species to then plant species which are known to be susceptible to these stresses, or provide extra care to plants that appear stressed, by mulching or other means. Successional planting such as this would increase success and mimic natural patterns, and given Stewardship Partners' commitment to maintenance and to restoration in the Snoqualmie Valley, successional planting is the optimal method. Some Stewardship Partners sites have used successional planting, most notably Oxbow Farm's alder buffer, and it has been successful thus far. Finally, live stakes have done well at all of the restoration sites and since they can be collected easily and inexpensively, they are a cost-effective planting method that provides measurable results, especially when planting on the steep stream banks that line the Snoqualmie River. Stewardship Partners should do further research about optimal timing

of plantings, and the use of live cuttings: investigating the timing, depth of planting, and species variations in success in order to maximize our effectiveness.

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TABLES & FIGURES

Table 2. Summary of data on each tree or shrub species found at Stewardship Partners restoration sites in the Snoqualmie Valley.

Common Name	Total Number	% of Total	# Dead	% Mortality
Sitka spruce	418	3.93	9	2.11
Douglas fir	450	4.23	8	1.75
Western Red Cedar	186	1.75	9	4.62
Western Hemlock	9	0.08	1	10.00
Shore Pine	24	0.23	0	0
Bigleaf Maple	354	3.33	5	1.39
Vine Maple	10	0.09	0	0
Red Alder	2719	25.57	140	4.90
Oregon Ash	188	1.77	0	0
Cottonwood	393	3.70	11	2.72
Bitter Cherry	49	0.46	0	0
Beaked Hazelnut	4	0.04	0	0
Hawthorn	144	1.35	0	0
Cascara Buckthorn	18	0.17	2	10.00
Apple	5	0.05	0	0
Willow	2669	25.10	9	0.34
Red-Osier Dogwood	802	7.54	5	0.62
Red-Flowering Currant	152	1.43	0	0
Mock-Orange	60	0.56	0	0
Pacific Ninebark	389	3.66	1	0.26
Salmonberry	477	4.49	0	0
Red Elderberry	132	1.24	1	0.75
Indian Plum	164	1.54	0	0
Rose	128	1.20	0	0
Snowberry	532	5.00	1	0.19
Thimbleberry	4	0.04	0	0
Twinberry Honeysuckle	33	0.31	0	0
Serviceberry	54	0.51	0	0
Oceanspray	51	0.48	0	0
Sweetgale	2	0.02	0	0
Oregon Grape	7	0.07	0	0
Rose spiraea	9	0.08	0	0
unknown	7	0.07	37*	N/A*

*The ‘unknown’ category encompasses more than one species of plants that were not identifiable; therefore, the number of dead unknown individuals is not comparable to the number of living unknown individuals, and the percent mortality cannot be calculated.

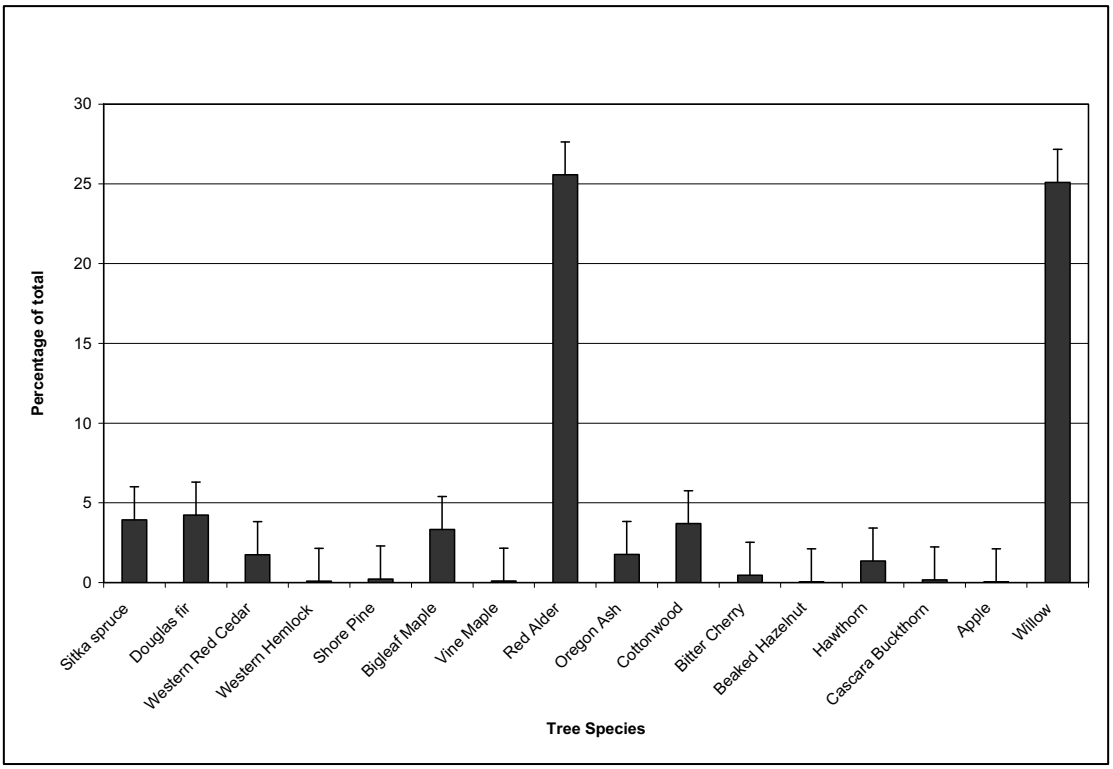


Figure 1. Tree species planted at Stewardship Partners' restoration sites in the Snoqualmie Valley shown as a percentage of the total planted individuals. Error bars show standard error.

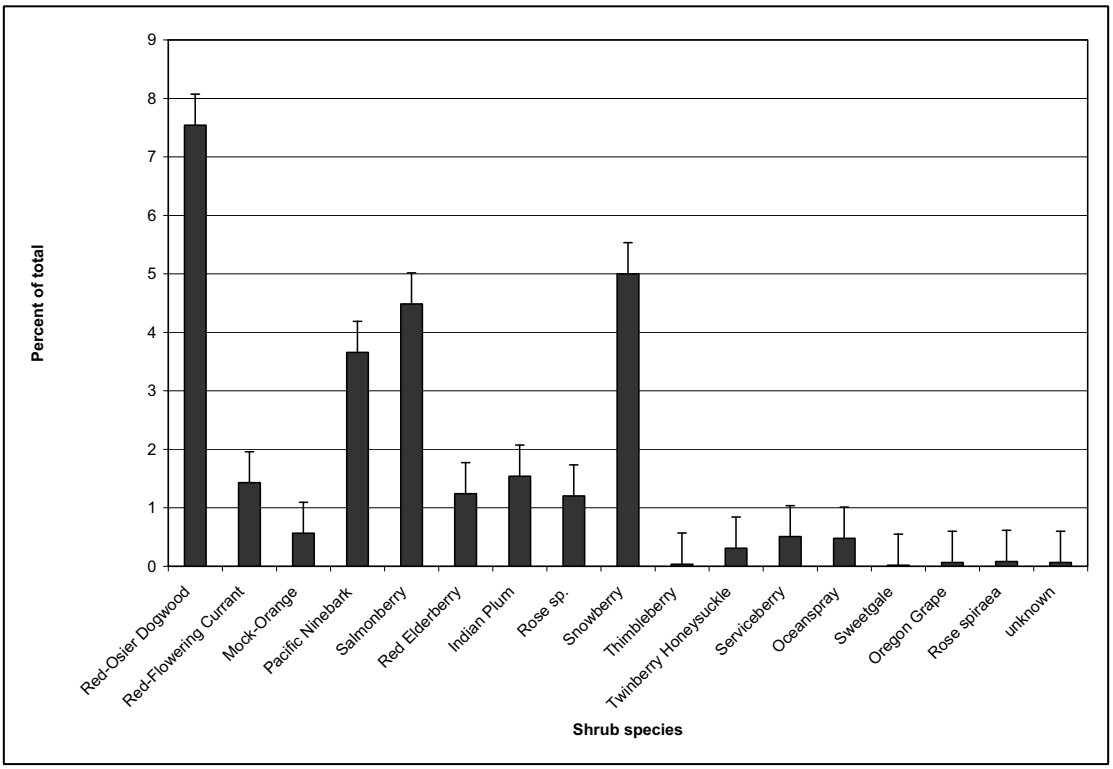


Figure 2. Shrub species planted at Stewardship Partners' restoration sites in the Snoqualmie Valley shown as a percentage of the total planted individuals. Error bars show standard error.

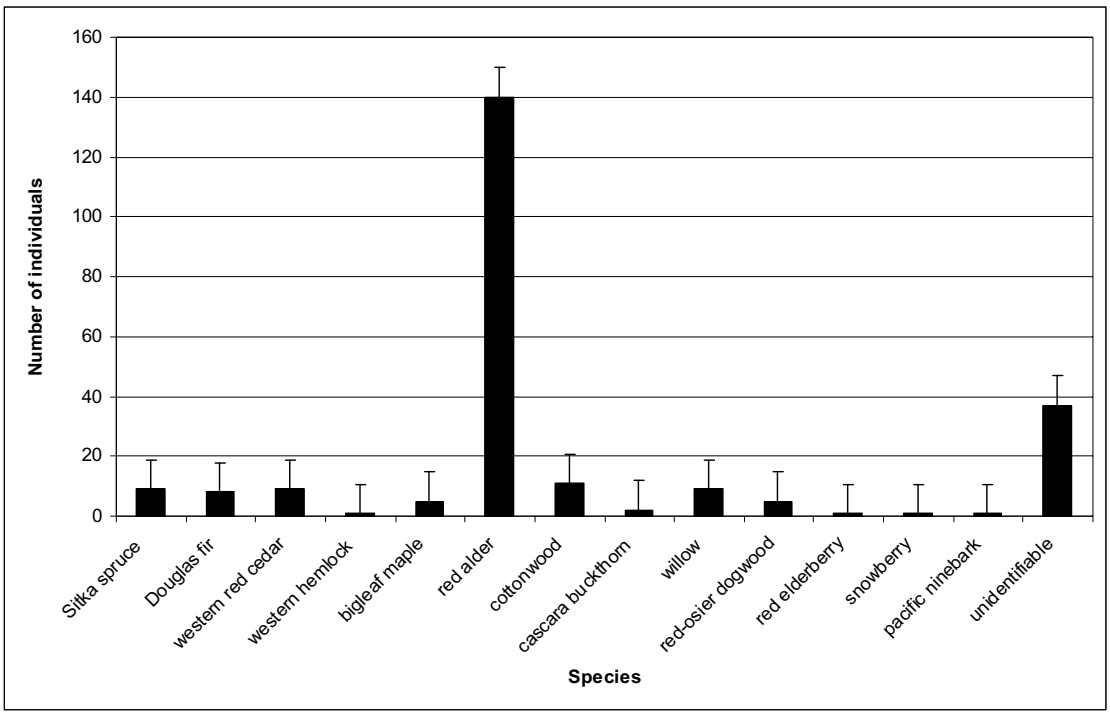


Figure 3. Number of dead individuals, by species, at all restoration sites in the Snoqualmie Valley. Individuals that could be identified as being dead, but not identified to species are in the column marked "unidentifiable." Error bars show standard error.

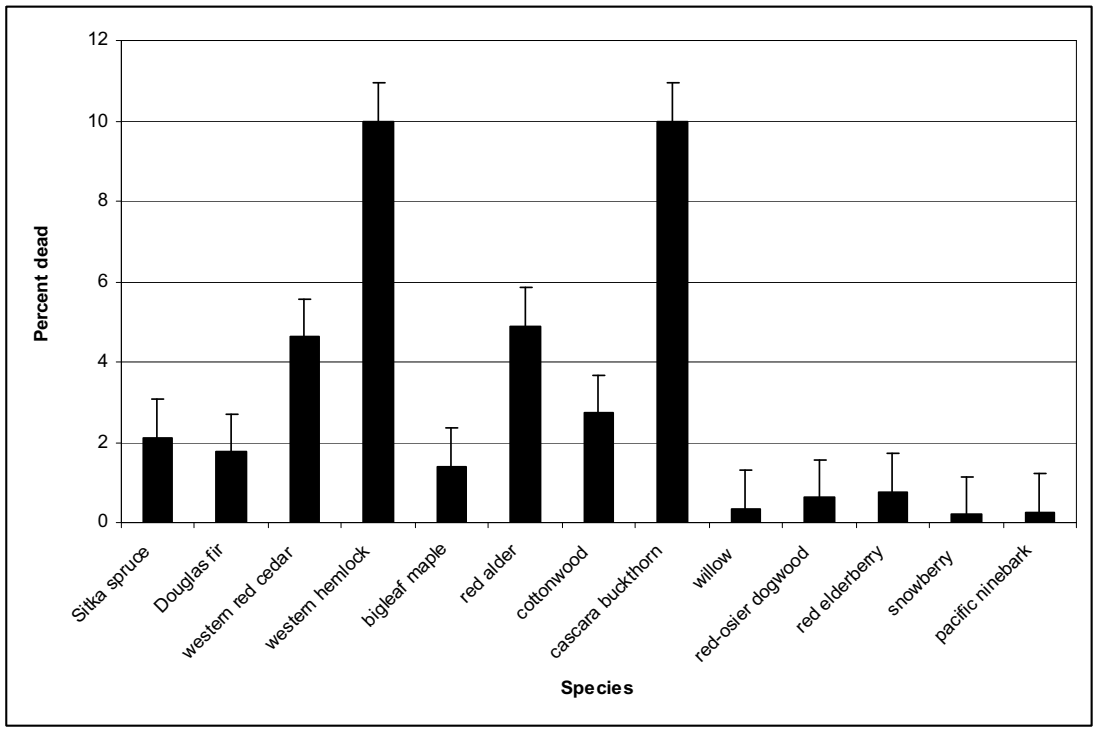


Figure 4. Individuals dead shown as a percentage of the total number of individuals planted over all restoration sites in the Snoqualmie Valley. Error bars show standard error.

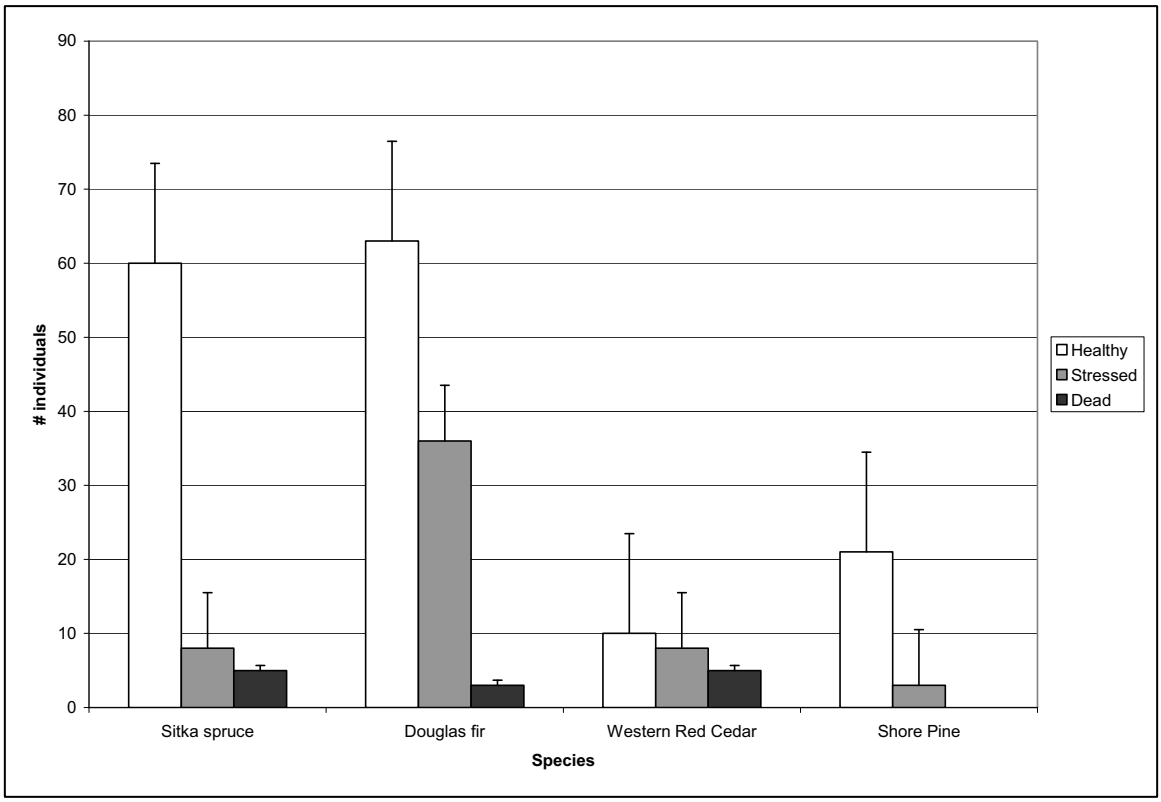


Figure 5. Conifer health at Cherry Creek Equestrian Center restoration site as of May, 2007. White bars show healthy individuals, gray show stressed individuals, and black show dead individuals. Error bars show standard error. Statistics show that there were significantly more healthy individuals than dead (t-test, P=0.04), but no other statistically significant relationships were found.

[Sample] Inventory Data Sheet
Site:
Date: **Name:**

Common Name	Number living	Number stressed	Number dead
Sitka spruce			
Douglas fir			
Western Red Cedar			
Western Hemlock			
Shore Pine			
Bigleaf Maple			
Vine Maple			
Red Alder			
Oregon Ash			
Cottonwood			
Bitter Cherry			
Beaked Hazelnut			
Hawthorn			
Cascara Buckthorn			
Apple			
Willow			
Red-Osier Dogwood			
Red-Flowering Currant			
Mock-Orange			
Pacific Ninebark			
Salmonberry			
Red Elderberry			
Indian Plum			
Rose sp.			
Snowberry			
Thimbleberry			
Twinberry Honeysuckle			
Serviceberry			
Oceanspray			
Sweetgale			
Oregon Grape			
Rose spiraea			
unknown			

Site Reports

A Summary of Snoqualmie Stewardship Program Restoration Sites

Cherry Creek Equestrian Center
Oxbow Farm
Ames Creek Farm
Blue Dog Farm
Full Circle Farm
Jubilee Farm
Fall City Farms
Snoqualmie Fall Forest Theater

CHERRY CREEK EQUESTRIAN CENTER

Cherry Creek Equestrian Center is located in the Snoqualmie Valley floodplain where Cherry Creek flows into the Snoqualmie River. The center provides horse boarding, riding trails, and equestrian lessons. They have a state of the art manure composting facility, carefully planned pasture management, and have established an extensive riparian restoration project along a mile section of the Snoqualmie River. This restoration project was originally planted in March 2005 (photo-points 1, 2, and 3), and extended further upstream in October, 2006 and January, 2007 (photo-points 4, 5, 6, 7, and 8).

Table 3. Summary data from inventory of Cherry Creek Equestrian Center.

Parameter	**Data**
Area of site (acres)	2.657
Total # individuals	2092
# Living	2084
# Dead	8
% Dead	0.38
Species Richness (# sp.)	26
Plant density (#/ft^2)	0.018
Density of trees (#/ft^2)	0.015
Density of shrubs (#/ft^2)	0.003

The results provide useful information on the status of the restoration project at Cherry Creek Equestrian Center. Percent mortality is very low, and species richness is higher than average. Plant density at this site is lower than the King County recommendation, with the majority of plants being trees. This may have contributed to the stress of some of the plants, in that in more densely planted sites, the plants gain some level of protection from having more plants around them. Figure 5 shows the status (healthy, stressed, or dead) of the conifers planted at Cherry Creek Equestrian Center and these trends are discussed more fully in the discussion section of the monitoring report. There were more stressed plants at Cherry Creek than any other site; however it did not have the lowest density, so there may be other explanations for this result. One possible

explanation is that the portion of the site planted in 2005 was not covered with landscape fabric, leading to increased weed growth and a spike in vole population. The voles girdled about half of the trees initially planted at the site, killing them. Many were later replanted, however the density at the site remains low.

Photo-Point Monitoring

Although there were no photos taken at the restoration site at Cherry Creek Equestrian Center, comparing recent photos to those taken during planting nonetheless provides a useful point of comparison. In all photo-point sets it is clear that the planting is growing and doing well. While there were a number of plants, particularly conifers, that showed signs of physical stress, it is expected that as the plants mature, these signs and the number of plants displaying them will decrease. Overall this is a healthy site that, because of its large size, will be likely to contribute to substantial benefits for the Snoqualmie River and associated riparian habitat.

Photo-point 1 shows an overview of the northern portion of the site. Before picture (left) was taken in 2005.

Photo-point 2 shows the northern planting area looking north.

Photo-point 3 shows the northern planting area looking west towards the river.

Photo-point 4 of the middle planting area. Before photo (left) was taken in October, 2006.


Photo-point 5 shows the middle planting area.


Photo-point 6 shows the southernmost planting

Photo-point 7 shows the southernmost planting area looking northeast

Photo-point 8 is another view of the southernmost planting

Species Abundance

Table 4. A breakdown of the restoration site at Cherry Creek, by species.

Common Name	***Scientific Name***	**# Individuals**
Sitka spruce	*Picea sitchensis*	60
stressed- Sitka spruce		8
dead- Sitka spruce		5
Douglas fir	*Pseudotsuga menziesii*	63
stressed- Douglas fir		36
dead- Douglas fir		3
Western Red Cedar	*Thuja plicata*	10
stressed- Western Red Cedar		8
dead- Western Red Cedar		5
Shore Pine	*Pinus contorta*	21
stressed- Shore Pine		3
Bigleaf maple	*Acer macrophyllum*	74
dead- Bigleaf maple		1
Red Alder	*Alnus rubra*	897
dead- Red Alder		10
Cottonwood	*Populus balsamifera spp. trichocarpa*	97
stake- Cottonwood		1
Bitter Cherry	*Prunus emarginata*	7
Hawthorn	*Crataegus L.*	126
Cascara buckthorn	*Frangula purshiana*	17
dead- Cascara buckthorn		2
Apple	*Malus sp.*	3
Willow	*Salix spp.*	47
stake- Willow		300
dead- willow		8
Red-Osier Dogwood	*Cornus stolonifera*	11
stake- Red-Osier Dogwood		82
Red-Flowering Currant	*Ribes sanguineum*	2
stake- Red Flowering Currant		2
Pacific Ninebark	*Physocarpus capitatus*	7
stake- Pacific Ninebark		4
Salmonberry	*Rubus spectabilis*	16
stake- Salmonberrry		48
stake- Red Elderberry	*Sambucus racemosa*	2
Indian Plum	*Oemleria cerasiformis*	24
Rose sp.	*Rosa sp.*	1
stake- Rose		11
volunteer- Rose		5
Snowberry	*Symphoricarpos albus*	41
stake- Snowberry		9
volunteer- Snowberry		33
Twinberry Honeysuckle	*Lonicera involucrata*	7
stake- Rose Spiraea	*Spiraea douglasii*	6
Dead- miscellaneous		24

OXBOW FARM

Oxbow Farm is a 100-acre certified organic farm, whose edges are surrounded by the Snoqualmie River. The predominant feature of the farm is an oxbow pond, connected to the river by a small channel, serving as rearing habitat and over-wintering for young Coho salmon to develop before making the journey downstream. Since 2001, Oxbow Farm and Stewardship Partners have been working together on this property. It is a Salmon-Safe certified farm, with restoration sites on almost three acres of the riverbank and the edges of the oxbow pond. Different portions of the restoration project were planted in 2001, 2004, 2006, and 2007.

Table 5. Summary data from the inventory of the restoration site at Oxbow Farm.

Parameter	**Data**
Area of site (acres)	2.772
Total # individuals	4077
# Living	4065
# Dead	12
% Dead	0.29
Species Richness (# sp.)	33
Plant density (#/ft^2)	0.034
Density of trees (#/ft^2)	0.025
Density of shrubs (#/ft^2)	0.008

The restoration project at Oxbow is one of the most successful to date. Not only does it cover a large area, but the density is high and the mortality is very low. A large proportion of the riverbank and oxbow-bank at Oxbow Farm has so far been restored through riparian planting and removal of invasive species, making it a prime example of the importance of riparian restoration and its compatibility with farming practices. The alder buffer at Oxbow is an example of planting methods that mimic natural succession. The area was originally cleared and cover-cropped, to aid in planting, and planted primarily with red alders planted close together. After the alders had matured

slightly, conifers were underplanted in the area. This method has been very successful, and Stewardship Partners is replicating it at other sites. In addition to the restoration projects, Oxbow Farm plays host to the Environmental Discovery Program, an environmental education program that brings elementary school students out to the farm to teach them about salmon, habitat, and other field activities. The restoration site at Oxbow Farm was also the subject of monitoring completed by Seattle Urban Nature, in which similar conclusions were made about the health of this site.[15]

Photo-Point Monitoring

Photo-points 4, 5, and 6 show that the site has improved greatly from when it was planted in 2004 and 2006 to when the photo-points were taken in 2007. These photo-points show the alder buffer, which is the furthest upstream portion of the restoration project which is planted with primarily red alder, as well as a mixture of other species. Portions of this buffer were planted at different times, but on the whole it is doing very well. In addition to the alder, willow and other live stakes were used to stabilize the riverbank, which is a common technique that is successful once the plants become established. Photo-points 2 and 3 shows areas bordering the oxbow pond and photo-point 1 shows the Point, a sandy area that was planted in 2007. These areas are all younger and show some improvement. The Point has areas where Japanese knotweed is a problem, but it is kept in check by regular maintenance.

Photo-point 1 shows the Point, taken from across the river on NE 100th Street.

[15] Elman, E. and N. Salisbury (2007) *A Survey of Ambient Conditions at Ten Recently Restored Stream Sites.* Prepared for: Community Salmon Fund Program and EarthCorps by Seattle Urban Nature: http://www.seattleurbannature.org/Projects/EC_KC/Stream_Restoration_Assessment.pdf


Photo-point 2 shows the planting along the oxbow pond.


Photo-point 3 shows the planting at the bend in the oxbow pond.


Photo-point 4 shows the alder buffer looking downstream.

Photo-point 5 shows the alder buffer looking upstream.

Photo-point 6 shows the southeasternmost portion of the alder buffer.

Species Abundance

Table 6. A breakdown of the restoration site at Oxbow Farm, by species.

Common Name	Scientific name	# Individuals
Sitka spruce	*Picea sitchensis*	108
Dead- Sitka Spruce		1
Douglas fir	*Pseudotsuga menziesii*	144
Dead- Douglas fir		1
Western Red Cedar	*Thuja plicata*	75
Dead- Western Red Cedar		1
Western Hemlock	*Tsuga heterophylla*	6
Bigleaf Maple	*Acer macrophyllum*	80
Vine Maple	*Acer circinatum*	6
Red Alder	*Alnus rubra*	979
Dead- Red Alder	*Alnus rubra*	8
Oregon Ash	*Franxinus latifolia*	94
Cottonwood	*Populus balsamifera* spp. *trichocarpa*	65
Bitter Cherry	*Prunus emarginata*	10
Beaked Hazelnut	*Corylus cornuta*	4
Hawthorn	*Crataegus* L.	17
Volunteer- Hawthorn		1
Non-native Hawthorn		1
Cascara Buckthorn	*Frangula purshiana*	1
Apple	*Malus* sp.	2
Willow	*Salix* spp.	1335
Stake- Willow		137
Red-Osier Dogwood	*Cornus stolonifera*	189
Stake- Red-Osier Doqwood		91
Volunteer- Red-Osier Dogwood	*Cornus stolonifera*	1
Dead- Red-Osier Dogwood		1
Red-Flowering Currant	*Ribes sanguineum*	48
Mock-Orange	*Philadelphis lewisii*	21
Pacific Ninebark	*Physocarpus capitatus*	76
Stake- Pacific Ninebark		14
Salmonberry	*Rubus spectabilis*	76
Stake- Salmonberry		24
Red Elderberry	*Sambucus racemosa*	24
Indian Plum	*Oemleria cerasiformis*	97
Rose sp.	*Rosa* sp.	26
Stake- Rose		18
Snowberry	*Symphoricarpos albus*	175
Volunteer- Thimbleberry	*Rubus parviflorus*	2
Twinberry Honeysuckle	*Lonicera involucrata*	26
Serviceberry	*Amelanchier* sp.	55
Oceanspray	*Holodiscus discolor*	23
Sweetgale	*Myrica gale*	2
Oregon Grape	*Mahonia aquifolium*	6
Rose spiraea	*Spiraea douglasii*	2
unknown		1
unknown		2

AMES CREEK FARM

The portion of Ames Creek Farm that contains the Stewardship Partners' restoration site is on Growing Things Farm. Growing Things is a small acreage farm committed to sustainable farming practices in raising poultry, beef, pork, and growing a variety of vegetables. Owner Michaele Blakely is a community leader and strong advocate for sustainable agriculture, and she utilizes her farm to experiment with various agricultural techniques. The entirety of Ames Creek Farm, 178.5 acres, has been preserved through the PCC Farmland Trust. The restoration site at Ames Creek Farm was planted in April, 2007 and is located along a creek that is a tributary to Ames Creek, which itself is a tributary to the Snoqualmie River.

Table 7. Summary data from inventory of Ames Creek Farm restoration site.

Parameter	Data
Area of site (acres)	0.1075
Total # individuals	205
# Living	205
# Dead	0
% Dead	0
Species Richness (# sp.)	16
Plant density (#/ft^2)	0.044
Density of trees (#/ft^2)	0.012
Density of shrubs (#/ft^2)	0.032

The site inventory of Ames Creek Farm shows the site to be in a very good condition. This site was the most recently planted of all Stewardship Partners' restoration projects, and the inventory shows that it is doing well. The survivorship remains at 100%, and the density is high. Like Blue Dog Farm, another site that was planted adjacent to a creek, the density of shrubs is higher than that of trees by design. At this site, however, only one side of the creek has been planted. In order to obtain the full impact of habitat restoration, planting both sides of the creek is recommended.

[16] Logo from http://www.pccnaturalmarkets.com/farmtrust/

Photo-Point Monitoring

The photo-point monitoring at this site shows the beginnings of an improvement at Ames Creek Farm. Prior to the planting, the site was a relatively homogenous grass environment. With the planting of shrubs and trees, the site promises to become a more diverse habitat that will be able to support a broader diversity of native species. From the photo-point monitoring it is clear that the site is in the beginning stages of this process; however, even after only a few months between the planting of the site in April and when the photos were taken in August improvements are visible.


Photo-point 1 at Ames Creek Farm shows the planting area facing east.


Photo-point 2 at Ames Creek Farm shows the planting area facing west.

Photo-point 3 at Ames Creek Farm shows the planting area and the creek that it borders.

Species Abundance

Table 8. A breakdown of the restoration site at Ames Creek Farm, by species.

Common Name	Scientific Name	# Individuals
Sitka Spruce	*Picea sitchensis*	10
Douglas Fir	*Pseudothuga menziesii*	2
Western Red Cedar	*Thuja plicata*	2
Bigleaf Maple	*Acer macrophyllum*	11
Red Alder	*Alnus rubra*	10
Oregon Ash	*Fraxinus latifolia*	5
Cottonwood	*Populus balsamifera ssp. trichocarpa*	6
Bitter Cherry	*Prunus emarginata*	10
Red-Osier Dogwood	*Cornus stolonifera*	20
Red-Flowering Currant	*Ribes sanguineum*	20
Mock Orange	*Philadelphis lewisii*	11
Pacific Ninebark	*Physocarpus capitatus*	24
Salmonberry	*Rubus spectabilis*	18
Red Elderberry	*Sambucus racemosa*	20
Indian Plum	*Oemleria cerasiformis*	9
Snowberry	*Symphoricarpos albus*	27

BLUE DOG FARM

Blue Dog Farm is a 50-acre certified organic farm located along Ames Creek, a tributary of the Snoqualmie River. It was a dairy farm from 1915 until 1997, when it was purchased by current owners, Scott and Amy Turner, and converted into a berry farm. Their primary crop is blueberries, but they also grow raspberries, strawberries and blackberries, and have chickens, geese and cattle on the property. In addition to cropland, part of their land is occupied by a diverse forest. In partnership with Stewardship Partners and other local conservation groups, the farm completed a restoration project on the entire portion of Ames Creek that runs through the property. The Stewardship Partners' restoration site at Blue Dog Farm was planted in October, 2006. Ames Creek is an important habitat to restore because it flows into the Snoqualmie River, and it provides a habitat for native species such as Coho salmon, which are often seen at Blue Dog Farm.

Table 9. Summary data from inventory of Blue Dog Farm

Parameter	Data
Area of site (acres)	0.479
Total # individuals	1024
# Living	1019
# Dead	5
% Dead	0.49
Species Richness (# sp.)	21
Plant density (#/ft^2)	0.049
Density of trees (#/ft^2)	0.011
Density of shrubs (#/ft^2)	0.038

The inventory of the restoration site at Blue Dog Farm shows that the restoration is in very good condition. With only 0.49% of plants having died, the survivorship is much higher than expected. The density at this site is slightly higher than the King

[17] Logo from http://www.bluedogfarm.com/

County recommendation of 0.04 plants/square foot, resulting from a higher density of shrubs than trees. The planting plan for this site was developed to include more shrubs than trees. Since it is a creek-side site, the need for large trees to provide shade and woody debris is not as great as along the river, which is much wider and requires larger plants to accrue an ecological benefit. Planting mostly shrubs and some trees is expected to provide an adequate measure of shading and other ecosystem benefits such as woody debris and invertebrates to the stream.

Photo-point Monitoring

Results from the photo-point monitoring at this stage show a marked difference from the previous year. All before photos were taken prior to any clearing of the site, so the improvement from a thicket of Himalayan blackberries lining both sides of the creek, to what is now a diverse riparian buffer is clearly evident. Although the buffer is only a year old, with the regular maintenance it will grow to become an increasingly effective and important restored habitat.

Photo-point 1 facing upstream. Before photos (left) were all taken in 2006.

Photo-point 2 shows the site facing downstream from the culvert.


Photo-point 3 shows the site facing upstream from the culvert.


Photo-point 4 shows the upstream portion of the site, looking downstream from the fence.


Photo-point 5 (option 2) shows the upstream portion of the site facing downstream from the fence.

Photo-point 6 faces upstream from the culvert.

Photo-point 7 shows the site facing downstream from the culvert.

Photo-point 8 faces upstream from the northernmost (furthest downstream) end of the site.


Photo-point 9 is an overview of the downstream portion of the site.


Photo-point 10 is an overview of the upstream portion of the site.

Species Abundance

Table 10. A breakdown of the restoration site at Blue Dog Farm, by species.

Common Name	Scientific Name	# Individuals
Sitka Spruce	*Picea sitchensis*	14
Douglas Fir	*Pseudotsuga menziesii*	14
Western Red Cedar	*Thuja plicata*	5
Bigleaf Maple	*Acer macrophyllum*	18
stake- Bigleaf Maple		2
Vine Maple	*Acer circinatum*	3
Red Alder	*Alnus rubra*	11
Oregon Ash	*Fraxinus latifolia*	9

Cottonwood	*Populus balsamifera ssp. trichocarpa*	1
Bitter Cherry	*Prunus emarginata*	11
stake- Willow	*Salix* spp.	145
Red-Osier Dogwood	*Cornus stolonifera*	21
stake- Red-Osier Dogwood		178
Red-flowering currant	*Ribes sanguineum*	37
Mock Orange	*Philadelphis lewisii*	19
Pacific Ninebark	*Physocarpus capitatus*	98
Salmonberry	*Rubus spectabilis*	93
stake- Salmonberry		64
Red Elderberry	*Sambucus racemosa*	40
stake- Red Elderberry		7
dead- Red Elderberry		1
Indian Plum	*Oemleria cerasiformis*	34
Rose	*Rosa sp.*	1
stake- Rose		66
Snowberry	*Symphormicarpos albus*	73
stake- snowberry		51
volunteer- snowberry		2
Thimbleberry	*Rubus parviflorus*	1
stake- Hardhack	*Spiraea douglasii*	1
dead- unknown		4

FULL CIRCLE FARM

Full Circle Farm was one of the first farms to become involved in the Snoqualmie Stewardship Program and plays host to a large restoration project on the banks of the Snoqualmie River. It is a 260-acre certified Salmon-Safe and organic farm that is well-known in the Puget Sound area as a major supplier of organic produce with a large CSA (community-supported agriculture) program. The farm has received numerous awards and recognition for their involvement in conservation programs. The restoration site at Full Circle Farm, which was first planted in 2005, encompasses a large stretch of riverbank, as well as underplanting in a wooded area near the river.

Table 11. Summary data from inventory of the restoration site at Full Circle Farm.

Parameter	Data
Area of site (acres)	2.532
Total # individuals	1655
# Living	1620
# Dead	35
% Dead	2.11
Species Richness (# sp.)	15
Plant density (#/ft^2)	0.015
Density of trees (#/ft^2)	0.010
Density of shrubs (#/ft^2)	0.004

The restoration site at Full Circle Farm is a large site with a lot of potential, and the data show that it is doing well. The mortality is low, showing that most of the plants are surviving; however, qualitative evidence suggests that many plants at the site appeared stressed. The density of plants at Full Circle is lower than the King County

[18] Logo from www.fullcirclefarm.com

recommendation, but combined with its large size, the low density is most likely not of high concern. Higher density may allow plants to become less stressed by buffering the plants from the high exposure at the sites, but as the plants grow and the site is better established this will be less of a problem. Live stakes on the banks of the river appeared to be doing very well and once established will be an effective means of bank stabilization. Initially, there were problems at this site with beavers, which ate plants that were not on landscape fabric. To solve this problem, fabric was placed at the edge of the site close to the river to keep beavers away from the restoration planting.

Photo-Point Monitoring

The photo-point monitoring is a good indicator that the plants at this restoration site have grown; however, the lack of pictures taken prior to clearing the site makes it difficult to see a large change in the landscape. Photo-point 3 clearly shows the improvements from placing live stakes on the sloping riverbank. All of the before shots for the photo-point monitoring were taken in November, 2005, after the plants had lost their leaves, making it more difficult to compare the photos. Overall, though, it is apparent from these photo-point comparisons that the restoration site is in good condition.

Photo-point 1 at Full Circle Farm shows the planted area facing east.


Photo-point 2 shows the planting area and staked bank.


Photo-point 3 shows the planting area facing west.


Photo-point 4 faces southwest down the planting


Photo-point 5 shows the forested area west of the buffer that is underplanted with trees and shrubs.

Species Abundance

Table 12. A breakdown of the restoration site at Full Circle Farm, by species.

Common Name	Scientific Name	# Individuals
Sitka spruce	*Picea sitchensis*	129
Dead- Sitka spruce		2
Douglas fir	*Pseudotsuga menziesii*	103
Dead- Douglas fir		1
Western Red Cedar	*Thuja plicata*	44
Bigleaf maple	*Acer macrophyllum*	71
Dead- Bigleaf maple		2
Red Alder	*Alnus rubra*	224
Dead- Red Alder		11
Oregon Ash	*Fraxinus latifolia*	43
Cottonwood	*Populus balsamifera* spp. *trichocarpa*	73
Dead- Cottonwood		7
Bitter Cherry	*Prunus emarginata*	9
Willow	*Salix* spp.	444
Dead- Willow		1
Red-Osier Dogwood	*Cornus stolonifera*	147
Dead- Red-Osier Dogwood		4
Red-Flowering Currant	*Ribes sanguineum*	43
Pacific Ninebark	*Physocarpus capitatus*	97
Salmonberry	*Rubus spectabilis*	68
Red Elderberry	*Sambucus racemosa*	39
Snowberry	*Symphoricarpos albus*	85
Dead- Snowberry		1
Thimbleberry		1
Dead- miscellaneous		5

JUBILEE FARM

Started in 1989 by retired Alaskan salmon fisherman, Eric Haakenson, Jubilee Farm runs along over a mile section of the Snoqualmie River, with numerous wetlands, and an unnamed Snoqualmie tributary that runs through the property. The farm is a successful operation that produces a wide variety of fruits and vegetables using sustainable, biodynamic processes. The restoration site at Jubilee Farm was started in April, 2005, with additional areas planted in March, 2006.

Table 13. Summary data from the inventory of Jubilee Farm's restoration site.

Parameter	Data
Area of site (acres)	1.982
Total # individuals	1587
# Living	1476
# Dead	111
% Dead	6.99
Species Richness (# sp.)	18
Plant density (#/ft^2)	0.017
Density of trees (#/ft^2)	0.014
Density of shrubs (#/ft^2)	0.003

The Jubilee Farm restoration project is doing relatively well, but the mortality is high, especially for such a large site. At Jubilee Farm, the vast majority of dead plants (102 individuals) were red alders. It is most likely that this large-scale mortality occurred as a result of mishandling the plants between the time they were harvested and when they were planted. This is an easily avoidable cause of death, and has been largely avoided at most of the other sites; however, at Jubilee Farm it has caused a high percent mortality. Most areas of the restoration are doing quite well though. The older alder sections are well-established and provide a generous buffer. The plant density at this site is similar to other sites this size, that is, lower than the King County recommendation. The site is becoming well-established though and the low-density is not thought to be a problem,

[19] Logo from http://www.jubileefarm.org/

especially since most of the plants are trees, so will provide more cover and shade as they grow.

Photo-Point Monitoring

Photo-point monitoring at Jubilee Farm is a very effective way to show the changes in this site because we have a good set of pictures taken before any clearing was done for many of the photo-points. The before picture for photo-point 3 was taken in 2006, whereas all other before pictures were taken in 2005. Photo-point 5 is a good example of how much an area can improve in only two years. Results are not as clear for the area of the planting that is the furthest upstream, but it is evident that the blackberries have been cleared and kept out, and some native plants are growing in their place.

Photo-point 1 shows the buffer facing upstream.

Photo-point 2 shows the buffer facing downstream from the river bend.


Photo-point 3 shows the buffer along the furthest upstream section of the river.


Photo-point 4 shows the buffer near the barn.


Photo-point 5 shows the downstream portion of the buffer.

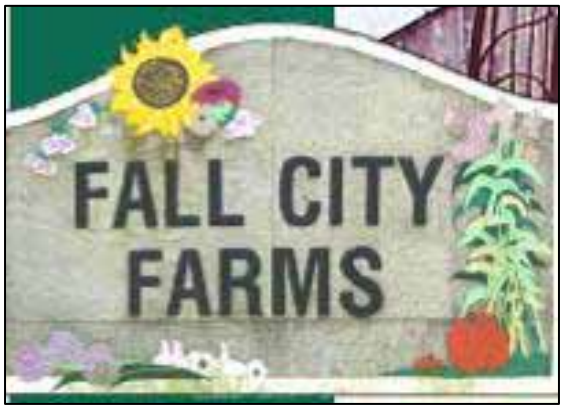

Photo-point 6 shows the buffer from the furthest point upstream, facing downstream.

Species Abundance

Table 14. A breakdown of the restoration site at Jubilee Farm, by species.

Common Name	Scientific Name	# Individuals
Sitka Spruce	*Picea sitchensis*	80
Dead- Sitka Spruce		1
Douglas fir	*Pseudotsuga menziesii*	78
Stressed- Douglas Fir		3
Dead- Douglas fir		2
Western Red Cedar	*Thuja plicata*	37
Stressed- Western Red Cedar		3
Dead- Western Red Cedar		3
Western Hemlock	*Tsuga heterophylla*	1
Bigleaf Maple	*Acer macrophyllum*	87
Dead- Bigleaf Maple		2
Red Alder	*Alnus rubra*	564
Dead- Red Alder		102
Oregon Ash	*Fraxinus latifolia*	31
Cottonwood	*Populus balsamifera* spp. *trichocarpa*	76
Bitter Cherry	*Prunus emarginata*	2
Willow	*Salix* spp.	258
Red-Osier Dogwood	*Cornus stolonifera*	58
Mock Orange	*Philadelphis lewisii*	9
Pacific Ninebark	*Physocarpus capitatus*	67
Dead- Pacific Ninebark		1
Salmonberry	*Rubus spectabilis*	62
Snowberry	*Symphoricarpos albus*	36
Saskatoon serviceberry	*Amelanchier alnifolia*	1
Oceanspray	*Holodiscus discolor*	22
Oregon Grape	*Mahonia aquifolium*	1

FALL CITY FARMS



Fall City Farms is located just outside of Fall City along the Snoqualmie River's most productive salmon spawning area. The riparian forest buffer along the river is one of the most intact examples of floodplain forest remaining in the lower Snoqualmie Valley. Over the years, they have evolved from a heifer-raising operation to a specialty produce U-pick and direct farm market. The restoration project at Fall City Farms was installed in two stages. The first section, along the riverbank, was planted in March, 2005, and the second section was planted a year later, in March, 2006. The major floods of November, 2007 took a large toll on Fall City Farms, and the floodwaters removed or killed some areas of the restoration project.

Table 15. Summary data from inventory of Fall City Farms

Parameter	Data
Area of site (acres)	0.347
Total # individuals	193
# Living	174
# Dead	19
% Dead	9.84
Species Richness (# sp.)	14
Plant density (#/ft^2)	0.012
Density of trees (#/ft^2)	0.010
Density of shrubs (#/ft^2)	0.001

Overall, Fall City Farms is a small but important restoration project. It is located at a critical reach of the Snoqualmie River for salmon, and an area that already has a largely intact riparian forest buffer. The restoration planting serves to add to and enhance the existing forest. The planting is small and only about one third as dense as the King County recommendation of 0.04 plants/ft^2. Part of the reason for this low density is the damage inflicted from heavy flooding; however, the main stretch of the project, along the river, did not have as much damage as other areas, such as along the guardrail, but was

[20] Photo from www.fallcityfarms.com

also very sparsely planted. In the future, as the planting grows, it may be advantageous to install additional plants within the planted area to increase the density and account for those plants that were lost in the floods. Increasing the density of the planting may also benefit plants by providing more protection from exposure. There was a high percent mortality at Fall City Farms and some of this might be attributed to low density and high exposure, but is most likely due to flood damage.

Photo-Point Monitoring

It is somewhat difficult to see results in the photo-point monitoring for Fall City Farms because the before pictures were all taken in March, before any plants had leafed out, and because many of the before pictures were taken after clearing had been completed. In photo-points 1, 2, and 3, you can see the improvements made from the removal of blackberries to the installation of native plant material. Photo-point 1 shows the area that incurred the heaviest flood damage, which can be seen in that there is little new plant material visible. Photo-points 3, 4, 5, and 6 show the low density of the planting, especially compared to the established riparian forest you can see in the background of the photos. Some of this difference is due to the obvious fact that the plants in the restoration site are much younger; however, the low density does not provide much protection for the plants, nor will it be likely to provide as many benefits to the river.

Photo-point 1 at Fall City Farms shows the planted area along the roadside.


Photo-point 2 shows the planted section at the guardrail.


Photo-point 3 shows the planted area along the field.


Photo-point 4 shows the planted area along the field looking the opposite direction from photo-point 3.


Photo-point 5 is taken from within the planted area.


Photo-point 6 shows plantings on the slope of the riverbank.

Species Abundance

Table 16. A breakdown of the restoration site at Fall City Farms, by species

Common Name	Scientific Name	# Individuals
Sitka Spruce	*Picea sitchensis*	14
Douglas Fir	*Psuedotsuga menziesii*	7
Dead- Douglas Fir		1
Western Red Cedar	*Thuja plicata*	2
Western Hemlock	*Tsuga heterophylla*	1
Stressed- Western Hemlock		1
Dead- Western Hemlock		1
Bigleaf Maple	*Acer macrophyllum*	11
Vine Maple	*Acer circinatum*	1
Red Alder	*Alnus rubra*	34
Dead- Red Alder		9
Oregon Ash	*Fraxinus latifolia*	6
Cottonwood	*Populus balsamifera spp. trichocarpa*	74
Dead- Cottonwood		4
Willow	*Salix spp.*	3
Red-Osier Dogwood	*Cornus stolonifera*	4
Pacific Ninebark	*Physocarpus capitatus*	2
Salmonberry	*Rubus spectabilis*	8
Oceanspray	*Holodiscus discolor*	6
Dead- unknown		4

SNOQUALMIE FALLS FOREST THEATER

Snoqualmie Falls Forest Theater, which was started in 1965 as a community theater, is surrounded by 95 acres of forestland, and borders about one third of a mile of the Snoqualmie River. Located at the foot of Snoqualmie Falls, Forest Theater is home to many different species of wildlife, including bears and deer, and a salmon-bearing stream called O'Creek. This stream was the site of a Stewardship Partners restoration project in 2005 to improve fish passage. Weirs and a new bridge were installed to lessen the grade of the stream for salmon and improve the trail for visitors, and after construction was completed new plants were planted to replace vegetation that was removed in the process.

Table 17. Summary of data from Snoqualmie Falls Forest Theater

Parameter	Data
Area of site (acres)	0.0242
Total # individuals	23
# Living	23
# Dead	0
% Dead	0
Species Richness (# sp.)	3
Plant density (#/ft^2)	0.022
Density of trees (#/ft^2)	0.010
Density of shrubs (#/ft^2)	0.011

The Forest Theater restoration project differs from the other Stewardship Partners projects in the Snoqualmie Valley. There were very few new plants installed at the site; however even through those few plants the site appears to be quite successful. Because of an absence of invasive species in this area, the planted sections are difficult to distinguish

[21] Logo from http://www.foresttheater.org/

from the native areas of the site. This site does not require any maintenance and is successfully returning to the condition it was in before construction began.

Photo-Point Monitoring

Photo-point monitoring is limited for this site, due to its small size and a lack of 'before' shots. Photo-points one and two were taken to show the area of the site where the majority of the planting took place. It is clear from the 'after' shots that the plantings are doing well and becoming a part of the natural landscape. Photo-point three shows the instream portion of the project. Weirs were installed to lessen the gradient of the stream, thereby aiding juvenile fish in their passage out of the stream.

Photo-point 1 shows the upstream portion of the restoration site, while being planted in 2006 (left), and in 2007 (right).

Photo-point 2 shows the downstream portion of the site in 2007. There is no corresponding 'before' picture for this area.

Photo-point 3 shows the fish passage aspect of this project, in the decreased gradient of the stream from before the project (left) to after (right).

Species Abundance

Table 18. A breakdown of the restoration site at Forest Theater, by species.

Common Name	Scientific Name	# Individuals
Sitka spruce	*Picea sitchensis*	3
Western red cedar	*Thuja plicata*	8
Western swordfern	*Polystichum munitum*	12