# Skagit County
# Salmon Habitat Monitoring Program
# 2004/2005 Baseline Report

**Skagit County Public Works**
**Surface Water Management Division**
**1800 Continental Place**
**Mount Vernon, WA  98273**

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# Salmon Habitat Monitoring Program

## Baseline Report for 2004/2005

Jeff McGowan, Chris Kowitz and Derek Koellmann

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Skagit County Public Works Department
Surface Water Management Section
Mount Vernon, WA  98273
(360) 336-9400

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# Acknowledgements

**Project Development**
Derek Koellmann – Skagit County Public Works – Surface Water Management Section
(November 4, 2004 left employment at Skagit County)
Jeff McGowan – Skagit County Public Works – Surface Water Management Section

**Field Work and Data Collection**
Jeff McGowan
Chris Kowitz
Derek Koellmann
Rick Haley
Dan Gudmunson
Brian Cook

**2004/2005 Baseline Report**
Jeff McGowan
Chris Kowitz
Derek Koellmann
Meghan Knudson

**GIS Development and Support**
Dr. Joshua Greenburg – Skagit County GIS Department

**Project Oversight – Skagit County Public Works**
Ric Boge – Surface Water Manager
David Brookings – Natural Resource Division Manager
Chal A. Martin – former Public Works Director/County Engineer

**Agency Involvement**
Dr. Phil Kaufmann – US EPA Regional Ecology Branch – Corvallis, OR  97333
Dr. Phil Larsen – US EPA Regional Ecology Branch - Corvallis, OR  97333
Marlys Cappaert – US EPA Computer Sciences Corporation – Corvallis, OR  97333
Glenn Merritt – WA Department of Ecology
Dylan Monahan – WA Department of Ecology

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# Executive Summary

In 2004, Skagit County Public Works personnel initiated a Salmon Habitat Monitoring project. This effort is in response to Skagit County Resolutions #R20030210 and #R20040211, which specify actions the County will take to assess if Skagit County Code 14.24.120, Ongoing Agriculture, is adequately protecting critical areas on agricultural lands. The four objectives of the project are 1) to establish baseline conditions, 2) conduct additional monitoring to determine trends over time, 3) determine if habitat conditions are improving, degrading or remaining the same in Ag-Natural Resource Lands (NRL) and RRc-NRL zoned lands, and 4) provide a means to differentiate between trends in salmon habitat in Ag-NRL and RRc-NRL zoned lands versus other lands under Skagit County jurisdiction. After discussions with State and Federal resource agencies, the County determined that the Environmental Monitoring and Assessment Program (EMAP) developed by Environmental Protection Agency (EPA) would be the best method to document baseline conditions and track trends in habitat conditions. The study design called for a minimum of 60 stream reaches, randomly selected, for inclusion in the initial baseline sampling regime. In 2005-2008, 20 selected reaches established in 2004, will be resurveyed to provide information to be used for trend analyses. In 2009 a minimum of another randomly selected 60 reaches will be surveyed and the five-year data collection cycle will begin again.

Skagit County's Salmon Habitat Survey stems directly from the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program* from which we used all of the physical habitat protocols. Additional protocols and parameters, including stream bank stability assessment, stream typing and photography documentation were added to our assessment.

Skagit County personnel completed the first year of sampling under the Salmon Habitat Monitoring Program late in October 2004 but were not able to sample our goal of 60 sites. Between the 2004 and 2005 sampling seasons, after several conversations with EPA staff, County personnel decided to combine both sampling seasons into one baseline report. In 2005, 28 sites were sampled which should have given us 60 total sites to establish baseline conditions, with the 8 annual sites being revisited. One baseline site was converted to an annual site which did not get replaced with an additional baseline site. Consequently, a total of 59 total sites were surveyed.

The Physical Habitat Indicators section summarizes the result of our 2004/2005 samplings. Most of the results from the habitat indicators sampled are averaged and listed as either Ag or Non-Ag. The physical habitat indicators we sampled include temperature, channel form, substrate, sinuosity, canopy cover, riparian vegetation, large woody debris, bank stability, riparian disturbance and fish cover.

In section IV of the report we talk about some of the differences we observed within and between Ag sites and Non-Ag sites. Non-Ag sites typically had higher stream gradient, larger bankfull width, coarser substrate and greater sinuosity than Ag sites. Bank stability and fish cover were observed to be about the same on both Ag and Non-Ag sites. Large woody debris counts were greater for all size classes on Non-Ag sites. In addition, the Ag sites were observed to lack larger LWD (greater than the Small class).

This data will serve as our baseline and will be used for comparison and analysis after the 2009 60-site sampling season. At that time we will be able to conduct some limited trend analysis to identify changing conditions on both Ag and Non-Ag sites and how they relate to each other.

# I. INTRODUCTION

## A. Purpose

The purpose of the Skagit County Salmon Habitat Monitoring Program is to establish a baseline of current general physical salmonid habitat conditions in Water Resource Inventory Areas (WRIA) 3 & 4, determine whether habitat conditions are stable, improving or degrading over time and provide a means to differentiate between trends in salmon habitat conditions in Agriculture-NRL & Rural Resource-NRL zoned lands versus other lands under Skagit County jurisdiction. This effort is in response to Skagit County Resolution #R20030210 which specifies actions the County will take to ensure that Skagit County Code 14.24.120, Ongoing Agriculture, is adequately protecting critical areas on agricultural lands.

## B. Objectives

The specific objectives of this effort are:

1. Establish a statistically valid baseline of the current general physical habitat conditions in WRIAs 3 & 4 during the first year of the project.
2. Conduct additional habitat conditions monitoring in future years to be used to analyze trends in salmon habitat conditions over time.
3. Determine whether habitat conditions are improving, degrading, or remaining static in Ag-NRL and RRc-NRL zoned lands.
4. Provide a means to differentiate between trends in salmon habitat conditions in Ag-NRL and RRc-NRL zoned lands versus other lands under Skagit County jurisdiction, as defined by the Skagit County Comprehensive Plan.

## C. Background

Skagit County initiated development of the Skagit County Salmon Habitat Monitoring Program in response to comments from the Washington Department of Fish and Wildlife (WDFW) in regard to a preliminary draft of a Skagit County Critical Areas Ordinance (CAO) regulating critical areas on Agriculture-NRL and Rural Resource-NRL zoned lands. WDFW raised concerns that the “Do no harm” provision of the ordinance only addressed water quality issues and ignored potential changes to salmonid habitat that could result from agricultural practices. To address these concerns, WDFW suggested adding a salmon habitat monitoring program as a component of the ordinance.

To inventory all streams under the County’s Ag- CAO would have been cost prohibitive, consequently a plan to sub-sample watercourses throughout the County was deemed necessary. A representative of the Governor’s Salmon Recovery Office (GSRO) suggested that the County investigate use of Environmental Monitoring and Assessment Program (EMAP) as a means to conduct the salmon habitat survey. Skagit County staff, in turn, met with representatives from the GSRO and Washington State Department of Ecology (ECY) and determined that using EMAP methodologies could be a viable option for the County to conduct a habitat monitoring survey. During the summer of 2003 County staff attended three separate field training sessions with EMAP ECY crews. The ECY crews provided EMAP training for County staff and answered questions related to implementation, required equipment, and field procedures. The Lake Creek field training session was also attended by Bruce Crawford of WDFW who is the lead staff member for the development of a statewide comprehensive salmon habitat monitoring program. Mr. Crawford spoke highly of the EMAP program and recommended it for Skagit County's purposes. Upon completing the field training sessions, County staff determined that EMAP physical habitat field procedures were viable and feasible under the constraints faced by the County.

County staff held numerous subsequent conversations with the ECY regarding how to implement EMAP in Skagit County. Topics of conversation included, but were not limited to, obtaining additional information on EMAP protocols, review of ECY's EMAP programs and elements to be included in Skagit County's EMAP program. ECY staff also provided contact information for Environmental Protection Agency (EPA) staff in Corvallis, Oregon who were integral in the development of EMAP.

Using the information collected in the field visits, coupled with the subsequent conversations with the ECY and EPA, County staff developed a preliminary draft salmon habitat monitoring plan. The draft plan was distributed for comment to interested parties and the general public, and comments on the proposed plan were received. County staff worked with the ECY and EPA to address these comments and modified the plan to address said comments to the greatest degree practicable. The changes to the plan are detailed in section II of this report.

## D. Proposed Study Design

Skagit County staff used EMAP physical habitat survey protocols to conduct a salmon habitat survey for portions of Skagit County. Reaches were randomly selected using EMAP site selection protocols. A general overview of EMAP is provided below.

The study design called for a minimum of 60 stream reaches, randomly selected, for inclusion in the 2004 sampling regime. In 2005-2008, 20 selected reaches, established in 2004, will be resurveyed to provide information to be used for trend analyses. In 2009 a minimum of another randomly selected 60 reaches will be surveyed and the five-year data collection cycle will begin again. See Table 1 - Sampling Regime By Zoning Class and Year below.

**Table 1.** Sampling regime by zoning class and year.

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| AG/RR-Nrl | 30 | 10 | 10 | 10 | 10 | 30 | 10 | 10 | 10 | 10 |
| Other Lands | 30 | 10 | 10 | 10 | 10 | 30 | 10 | 10 | 10 | 10 |
| **Total # of sites** | **60** | **20** | **20** | **20** | **20** | **60** | **20** | **20** | **20** | **20** |

All sampling was conducted only on streams that are, or have the potential to be, salmonid-bearing and are wadeable. Sites selected were equally divided between those in Agriculture-Natural Resource Land (Ag-NRL) or Rural Resource-Natural Resource Land (RRc-NRL) zoned lands (as defined by the Skagit County Comprehensive Plan) and other lands within County jurisdiction. After initial reconnaissance of selected sites, only those deemed to be safely accessible, and with landowner permission for access, became part of the sample. For simplicity sake, sites will be referred to as Ag or Non-Ag throughout the rest of the report.

Further details regarding the *Skagit County Salmon Habitat Monitoring Program* and sampling site selection process can be found in Appendix A.

**Figure 1.** Recording thalweg information on Samish River.

## E. EMAP Overview

The Environmental Monitoring and Assessment Program (EMAP) is a research program developing the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the methodologies for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources (EPA website: http://www.epa.gov/emap/).

EMAP aims to advance the science of ecological monitoring and ecological risk assessment, guide national monitoring with improved scientific understanding of ecosystem integrity and dynamics, and demonstrate multi-agency monitoring through large regional projects. EMAP identifies and utilizes appropriate indicators to monitor the condition of ecological resources (EPA website: http://www.epa.gov/emap/ ).

The objectives of Skagit County's Salmon Habitat Monitoring Program are somewhat different from a standard EMAP sampling regime. The County's program is designed to track, not only overall status and trends in the Skagit Watershed, but also to track trends both in and between Ag/RR zoned lands and other Non-Ag lands under Skagit County jurisdiction. This is different than most EMAP programs that tend to look only at overall status and trends on a larger scale (i.e. state-wide or national).

## F. Public Outreach

The success of Skagit County's Salmon Habitat survey was predicated on obtaining Rights-of-Entry (ROE) to the public and private properties where the randomized stream segments to be surveyed were located. An intensive public outreach strategy was implemented to obtain ROE permission in order to gain access to the sample sites. Skagit County staff attended local conservation district and agricultural organization meetings to inform them of the County's efforts and to solicit their assistance. In the process of explaining the program it was emphasized that the success of the program depended upon landowners allowing County personnel to access the randomly selected parcels.

Public outreach to gain support for the project, especially from Ag landowners and Ag interest groups, began with a presentation to the Board of County Commissioners in March 2004. Subsequently, pertinent news releases were issued, staff met with local Ag groups and the Salmon Habitat Monitoring Plan was posted on the County's website. Under contract with the County, the Skagit Conservation District developed and conducted Ag-CAO educational activities targeting the local Ag community including information about the habitat monitoring program.

## **Some Useful Habitat Definitions**:

**Bankfull width** - The stream width measured at the average flood water mark.

**Canopy** - A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand.

**Channel** - An area that contains continuously or periodically flowing water that is confined by banks and a stream bed.

**Large Woody Debris** - Pieces of wood larger than 5 feet long (1.5m) and 4 inches (10.1cm) in diameter, in a stream channel.

**Riparian area** - An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains.

**Sinuosity** - The amount of bending, winding and curving in a stream or river.

**Stream gradient** - A general slope or rate of change in vertical elevation per unit of horizontal distance of the water surface of a flowing stream.

**Substrate** - The composition of the grain size of the sediments in the stream or river bottom, ranging from rocks to mud.

**Thalweg** - The deepest part of the stream.

## G. Staffing

All surveys during the two-year period were conducted exclusively by Skagit County staff or technical interns. The entire habitat survey crew consisted of three full-time staff members and two college interns hired specifically for this project. Individual survey crews ranged in size from 2 to 5 staff depending on the size of the stream to be surveyed. Each staff member was trained in all aspects of the habitat monitoring so that all crew-members could be used interchangeably as needed on any sampling day (see Appendix B).

**Figure 2.** Recording thalweg information on Jones Creek.

# II. METHODS

This section of the report describes the procedures used to select sample sites, perform field sampling and analyze field results.

## A. Sample Site Selection

Sample sites for Skagit County's Salmon Habitat Monitoring Program were selected using EMAP site selection protocols and procedures to select a representative set of sampling locations (stream reaches) where habitat conditions were to be surveyed. Skagit County Geographic Information Services (SCGIS) staff worked with the EPA office in Corvallis, Oregon to identify and transfer the data necessary to develop Skagit County's randomized sample set. As a result of these efforts, sample sites have been identified for the first 20 years of the study.

A Generalized Random Tessellation Stratified (GRTS) survey design for a linear stream resource was used to select the stream segments that were sampled. The GRTS design included reverse hierarchical ordering of the selected sites. The total stream length in the sampling frame in the Skagit County study is 781.5 km with 243.2 km in the Ag/RR zoning designations and 538.2 km outside those zoning designations (Non-Ag).

All wadeable streams within Skagit County were included in the sample set. Larger non-wadeable rivers, including the Skagit, Cascade, Sauk, Suiattle and lower Nookachamps were excluded. Working from this baseline condition, these additional criteria were also included to narrow down the sample set:

- Only streams in WRIAs 3 & 4 were included in the study. Those portions of WRIAs 1 & 5 that fall within Skagit County's political jurisdiction were specifically excluded, except for the Colony Creek Watershed, which is located in WRIA 1.
- Stream segments outside of direct County jurisdiction were excluded from the sample set (e.g. stream segments in municipalities, federal forest, or national park lands).
- Sampling was limited to streams that are, or have the potential to be, salmonid-bearing. Salmonid-bearing status is based on the *Washington State Conservation Commission – Salmon and Steelhead Limiting Factors Water Resource Inventory Areas 3 & 4 Skagit Watershed* (June 2003). The specific species used to make this determination were Chinook, coho, chum, and pink salmon, cutthroat trout, steelhead, and native char (e.g. Bull Trout, Dolly Varden).

Selected sample sites were stratified equally between lands in *Agriculture – Natural Resource Lands* and *Rural Resource – Natural Resource Lands* (AG/RR) zoning designations and areas outside of those zoning designations (Non-Ag). In total, sixty sites were to be sampled in 2004 to establish baseline conditions; thirty in Ag and thirty in Non-Ag. However, because only 40 sites were completed in the 2004 sampling season, it was determined that the goal for 2005 would be 28 sites rather than 20 annual sites. This was done in order to combine the two years effort and establish the baseline conditions. Skagit County's ability to sample individual sites was further predicated on two additional factors; landowner willingness and safety. Sampling was only conducted on sites where landowners gave prior permission to enter the site. In addition, if a site was deemed to be unsafe to sample due to such factors as higher than anticipated stream flows or lack of access to the sampling site due to steep slopes, the site was not sampled regardless of permissions received. For each sample site, every effort was made to obtain landowner permission and/or determine a means by which the sample site could be safely reached.

## B. Sample Season

Preliminary field training for this project began in May 2004. County crews were trained on standard EMAP methodologies and the modified methodologies recommended by the ECY and EPA. Actual field work for the baseline report began in June 2004 and in order to achieve the goal of 60 sites, the baseline survey continued through the summer of 2005. The original end date of the 2004 baseline year was scheduled for October 1, 2004; however, as the anticipated 60 sites had not been reached, the sample season was extended through the end of October 2004. The final survey for the 2004 season was conducted on October 26. In 2004 sampling did not occur beyond this date as no sites remained that were safe to sample for which an ROE had been obtained. The 2005 sampling season began on June 8th and ended on September 28th.

## C. Monitoring Protocols

Aside from the exceptions listed below under the headings *Modified Methods, Additional Parameters, and Additional Protocols*, the methods, parameters, and protocols to be used for Skagit County's Salmon Habitat Survey stem directly from the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program* (http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/ewwsm01.html ). For a list of equipment used, see Appendix C. The forms used include standard EMAP datasheets (see Appendix D).

## D. Modified Methods

This section details the modifications Skagit County made to the protocols contained in the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program* (Field Ops Manual).

### i. Slope

Stream slope was calculated by hydrostatic leveling using two metric stadia rods and a length of 10-mm (3/8 inch) inside diameter clear tubing. Tubing was filled with water and extended along the streambed. When the water within the tubing stabilized, the change in height was determined by the difference in water column height between the upstream and downstream end.

### ii. Substrate Measurement

Sixteen substrate classes, (the Field Ops Manual calls for eleven), were used to help reduce variance associated with substrate measurements. These classes ranged from fine silt to car sized boulders. See Appendix A for a more detailed description of substrate sizes.

### iii. Bankfull Width

Bankfull measurements were conducted in accordance with the protocols contained in *A Guide for Field Identification of Bankfull Stage in the Western United States* **-** USDA, Forest Service, Stream Systems Technology Center Rocky Mountain Research Station (http://www.stream.fs.fed.us/ ).

### iv. Large Woody Debris Tallies

In addition to the procedure detailed in the Field Ops Manual for tallying large woody debris (LWD), the presence of large woody debris jams were documented in the comments portion of the *Thalweg Profile and Woody Debris* field form. Included in the comments was a visual estimate of the metric volume of any large woody debris jam (EPA 2001).

## E. Additional Parameters

This section details the additional variables that Skagit County surveyed beyond those contained in the Environmental Protection Agency's Field Ops Manual (2001).

### i. Stream Bank Stability

A stream bank stability protocol derived from a combination of the EPA volunteer stream monitoring methods (EPA 1997) and the EPA protocol by Bauer and Burton (1993) was used to assess bank stability. Stream banks (both left and right) along each transect were examined and assigned linear percentages to quantify bank shape, class, and coverage. Three types of bank shapes were considered: undercut (>90° angle), steep (>30° angle), and gradual (<30° angle). Two parameters were assessed to create a combination of four types of bank class conditions: covered stable, covered unstable, uncovered stable, and uncovered unstable. Finally, the composition of riparian vegetation at the edge of the active channel was recorded to evaluate what is functioning to stabilize the immediate bank.

### ii. Rosgen Stream Type

As indicated in the Quality Assurance Project Plan, (Appendix A), all 60 sites will be typed according to Rosgen (1996) stream classification.

## F. Additional Protocols

### i. Photography Protocol

A series of digital photographs were taken at each survey site to assist in documenting habitat conditions at individual sites. These photographs are stored by site on Skagit County's computer network server.

### ii. Remote Sensing Protocol

At five year intervals, in conjunction with the 60-site sampling regimes, Landsat ETM satellite derived land cover images will be used to estimate percentages of land use and land cover (impervious surface, vegetation, and other cover types), for the watersheds upstream of sample sites. Land use and land cover percentages will be compared with data collected during the sampling regimes to help associate channel habitat changes with landscape level changes. This information will also be used to address influences to habitat originating outside of the sample reaches.

### iii. Annual Sampling Site Protocol

Each site was monumented, using a combination of GPS coordinates and landmarks, (e.g. a particular tree), to ensure the same reach is surveyed annually. The length of stream to be surveyed for the annual sites was calculated in the first year based on 30 times the bankfull width as opposed to 40 times the wetted width to provide for consistency between sampling years. For future sampling years, stream lengths to be sampled will be standardized (stream reach length will remain constant from year to year).

## G. Physical Habitat Indicators

Physical habitat in streams includes all physical attributes that influence or provide sustenance to organisms within the stream, (Kaufmann in Peck et al., 2003).

Physical habitat varies naturally, as do biological and chemical characteristics, thus expectations of habitat condition differ even in the absence of anthropogenic caused disturbance. Degradation of aquatic habitats by nonpoint source activities is recognized as one of the major causes for the decline of anadromous and resident fish stocks in the Pacific Northwest, (Williams et al., 1989). Measurements of physical habitat parameters fall into one of the following three types of sampling method protocols:

1. Continuous measurements are collected along the entire length of the sample reach. Thalweg profile (a survey of depth along the stream channel), and presence/absence of soft sediments (fine gravel or smaller), were collected at either 100 or 150 equally spaced points along the stream reach. An observation of the geomorphic channel type, (e.g. riffle, glide, pool), was made at each point. Crews also tallied large woody debris along the reach.

2. Transect measurements are collected from 11 evenly spaced transects. Measures/

observations of bankfull width, wetted width, depth, substrate size, shade, and fish cover were taken at each transect. Measures and/or visual estimates of riparian vegetation structure, anthropogenic disturbance, and stream bank angle, incision and undercut are also collected at each transect. Gradient measurements and compass bearing between each of the 11 stations are collected to calculate reach gradient and channel sinuosity.

3. Reach measurements apply to the reach as a whole. Channel morphology class for the entire reach is determined, (Montgomery and Buffington, 1993), and instantaneous discharge is measured at one optimally chosen cross-section.

## H. Analysis

Data collected for Skagit County's Salmon Habitat Monitoring Program was input into an MSAccess database developed by Tetra Tech, Inc of Bothell, WA. Habitat metrics were developed in accordance with the protocols and procedures detailed in *Quantifying Physical Habitat in Wadeable Streams,* (Kaufmann et. al). Summaries of the 2004/2005 baseline sampling year's results are found in the Results and Discussion sections of this report.

# III. RESULTS

## A. Study Sites and Zoning

Skagit County personnel completed the first year of sampling under the Salmon Habitat Monitoring Program late in October, 2004. At that time we had not reached our goal to sample 60 sites due to a number of factors: lack of response to Right of Entry (ROE) requests, access denial, and sites that were unsampleable (see Figure 3). It was determined after the 2004 sampling season, and after consulting with scientists from EPA, that the effort to achieve the goal of 60 sampled sites to establish baseline conditions would be continued into the 2005 sampling season. Therefore, a total of 28 sites were required to be completed in 2005 rather than the planned 20 annual sites in order to get a 2004-2005 baseline of 60 sites sampled.

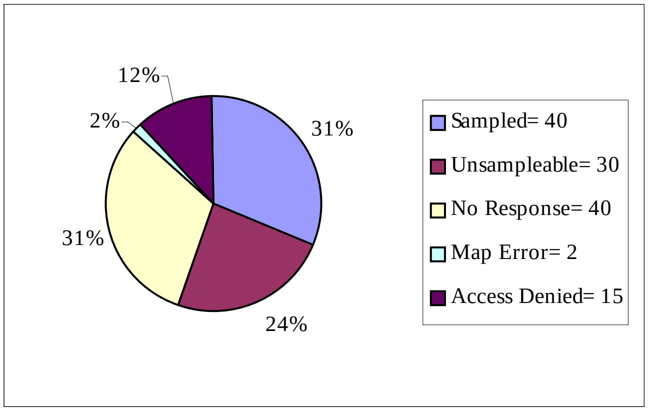


**Figure 3.** Summary of Survey Sites for the 2004 sampling effort. Unsampleable sites were those that we were unable to survey due to natural conditions (i.e. too deep, above bankfull height, etc).

In 2004 County personnel were able to complete a survey of 40 total sites, 8 of which are under the annual designation (3 Ag and 5 Non-Ag). Federal and State lands accounted for 9 of the 40 sampled sites and were sampled without specific ROEs. Crown Pacific, a timber holding corporation, allowed unrestricted access to all their lands representing 7 of the sites. Twenty-eight sites were sampled during the 2005 sampling season of which 19 were new sites and 9 were repeat or annual sites. (See Appendix E for a map of site locations and Appendices F and G for more detailed site information).

### i. 2004/2005 Sample Sites Zoning and Land Use

During the 2004/2005 sampling period, Skagit County staff surveyed 29 sites under the Ag-NRL or RR-NRL zoning designation and 30 sites on lands under other zoning. Of those sites under the Ag zoning, 22 were on lands zoned as Ag-NRL and 7 were zoned as RR-NRL. Of these 29 Ag sites, only 17 sites exhibited characteristics of on-going agriculture. Pasture was determined to be the adjacent land use on 5 of the 30 Non-Ag sites. See the Discussion section for further information and explanations of the survey efforts.

## B. Physical Habitat Indicators

### i. Temperature

Water temperature is an important variable for stream organisms and biota including salmonid species. Water temperature measurements for the 2004/2005 sampling seasons ranged from 8.5°C to18°C on Agriculture zoned lands (mean= 13.4°C) and 8.5°C to 18°C on Non-Ag lands (mean= 13.4°C). The extent of the seasonal sampling period (June 8th- October 26th) most likely influences this data. Although the average temperature for both Ag and Non-Ag are remarkably close, this data represents a one time measurement on the day of the survey and no conclusions can be or should be drawn from this limited data set. Skagit County conducts more intensive temperature monitoring as part of its water quality monitoring program (Haley 2005).

### ii. Channel Form

Our sample sites exhibited a large range of stream gradients on both Ag zoned sites and sites under other zoning (Ag- 0.02%-4.13%; Non-Ag- 0.11%- 18.74%). Sites on Non-Ag streams had larger mean stream gradient (3.58%) than on Ag sites (0.78%).

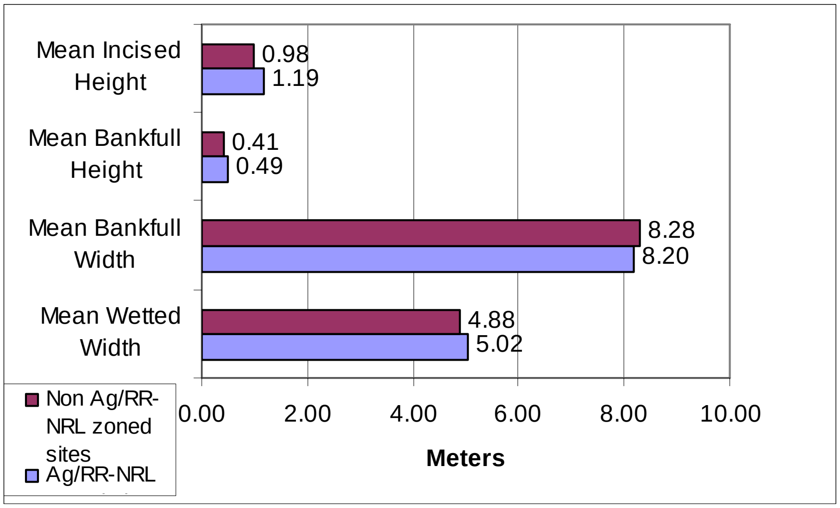


**Figure 4.** Mean calculations for channel form characteristics.

The mean wetted width and bankfull width were both larger on Non-Ag sites, but not appreciably so. Mean bankfull height and mean incised height were nearly the same for both Ag and Non-Ag sites (see Figure 4). Mean thalweg depths were higher on Ag zoned sites (36.5cm) than on Non-Ag sites (25.3cm).

### iii. Substrate

Substrate size and embeddedness are evaluated at each of the 11 transects. Substrate is also sampled at the midpoint of each transect for a total of 21 cross sections. At each transect, substrate is sampled at five locations across the channel. Substrate size is broken down into 16 different particle sizes (see Table 2).

Substrate is an important component of physical stream habitat structure; it provides habitat for macroinvertebrates, spawning salmonid species as well as cover and protection for juvenile fish. Substrate composition varies greatly, but generally, substrate is coarser in the upper reaches of a stream and finer in the lower reaches. However, an excess of fine sediment can decrease the quantity and quality of this habitat by filling in the spaces between larger particles (i.e. gravels-cobbles). See Table 2 for a description of substrate particle sizes.

**Table 2**. Substrate Particle size description

| Description of Particle Size | | Mm | Skagit County Size Class |
|---|---|---|---|
| BEDROCK | SMOOTH | >4096 | BEDROCK SMOOTH (RS) |
| | Rough | >4096 | Bedrock Rough (RR) |
| Hardpan | | >4096 | Hardpan (HP) |
| Boulder | Large | 1024-4096 | Large Boulder (LB) |
| | Small | 256-1024 | Small Boulder (SB) |
| Cobble | Large | 128 – 256 | Large Cobble (CL) |
| | Small | 64 – 128 | Small Cobble (CS) |
| Gravel | Very Coarse | 32 – 64 | Very Course Gravel (GV) |
| | Coarse | 16 – 32 | Course Gravel (GC) |
| | Medium | 8 – 16 | Medium Gravel (GM) |
| | Fine | 2 – 8 | Fine Gravel (GF) |
| Sand | Course | 0.500 0 - 2 | Course Sand (SC) |
| | Fine | 0.063 – 0.500 | Fine Sand (SF) |
| Silt/Clay | | 0.00024 - 0.063 | Fines (FN) |
| Wood | | Regardless of Size | Wood (WD) |
| Other | | Regardless of Size | Other (OT) |

We found that gravel was the prominent substrate type for Non-Ag sites; however, other size classes were also common. Sites on Ag had an appreciably larger amount of fines than those on Non-Ag sites. Fine sediment accounted for 36.8% of the sediment samples from the Ag sites (Figure 5). Fine sediment is generally defined as silt, clay or muck that is not gritty. The highest percentage of sediment (28.4%) observed in Non-Ag samples is large coarse gravel (16-64mm).

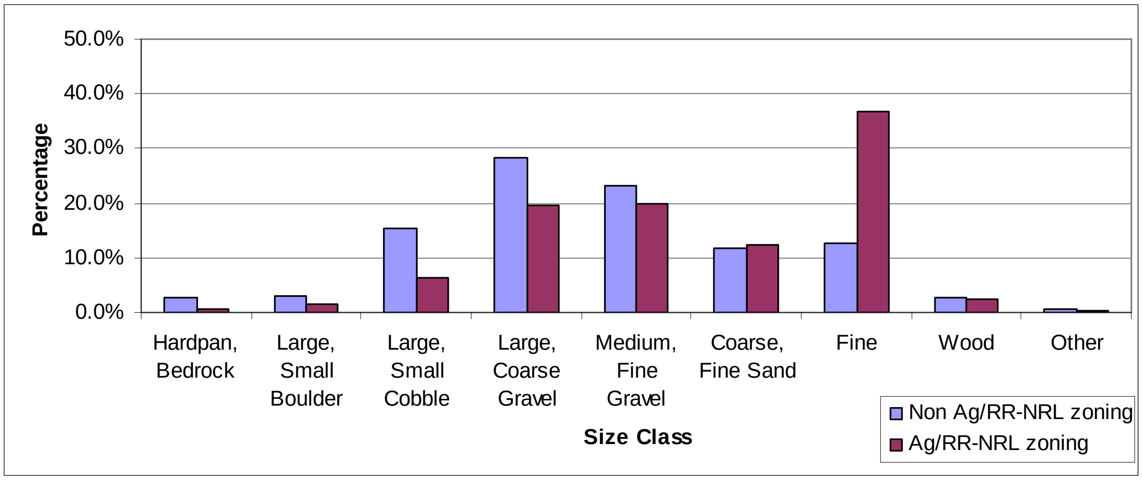


**Figure 5.** Substrate percentage by size class for Ag/RR-NRL zoned sites and Non-Ag/RR-NRL zoned sites. Classifications are explained in Table 2.

### iv. Sinuosity

Sinuosity is described as the degree of winding and turning of the stream channel as observed from above (See Figure 6). A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms or flooding. The absorption of this energy helps protect invertebrates and fish during storm events and also helps prevent excess erosion during these events (EPA, 2006). Sinuosity values were calculated according to Kauffman, et al., 1999. Using back-sighting compass readings with reach and transect length, we were able to calculate sinuosity values for both Ag and Non-Ag sites.

**Table 3.** Sinuosity Values (adopted from Bain et al. 1999).

| **Sinuosity Values** | |
|---|---|
| 1.0 | No Sinuosity |
| <1.2 | Low |
| >1.2 | Moderate |
| >1.4 | High |
| >1.5 | Very High |

Non-Ag/RR-NRL sites had a higher average sinuosity value (mean 1.22) than Ag/RR-NRL (mean 1.13) sites.

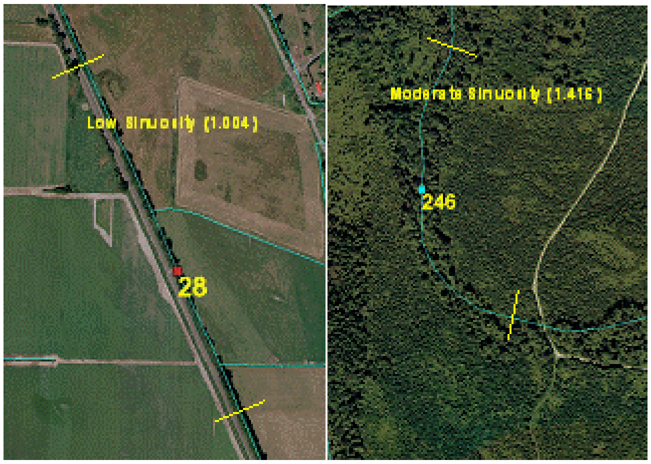
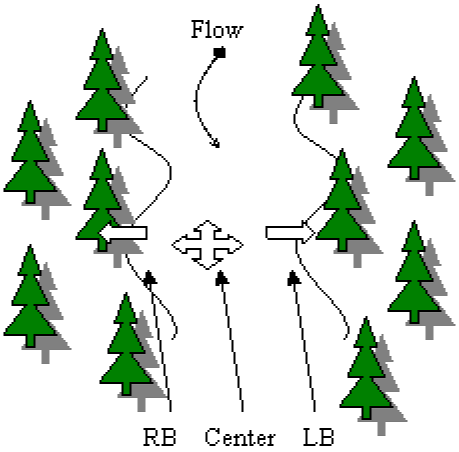


**Figure 6.** Visual example of streams exhibiting low (<1.2) and moderate (>1.2) sinuosity values.

## v. Canopy Cover

Densiometer measurements were taken at 3 locations at each transect of a site reach (see Figure 7). While positioned in the center of the stream, four measurements were taken (upstream, downstream, left bank, right bank). At the right bank and left bank locations, only one measurement was taken. Thus, when we analyzed this data, we divided the analysis between center densiometer measurement and bank densiometer measurements. Analysis of this data was done in accordance with EPA guidelines (Kauffman et al, 1999).

**Figure 7.** Visual depiction of data collection locations for densitometer measurements.



For both zoning classes, densiometer measurements ranged from 0– 17. The mean densiometer measurements from Ag and Non-Ag were converted into percent shade by dividing the sampling data by 17 and multiplying by 100 (see Table 4).

**Table 4.** Mean Stream shading results

| Zone | Mean Percentage Shade | | Mean Densiometer Reading | |
|---|---|---|---|---|
| | Mid-channel | Bank | Mid-Channel | Bank |
| **Ag** | 74.92 | 87.78 | 12.74 | 14.92 |
| **Non-Ag** | 78.57 | 88.46 | 13.36 | 15.04 |

Sites under the Ag zoning had a higher percentage of center stream canopy cover (Ag/RR mean 74.92%; Non-Ag mean 78.57%). Bank stream canopy cover was slightly larger on Non-Ag sites (88.94%) than on Ag sites (86.22%).

## vi. Riparian Vegetation

Riparian vegetation was measured in 3 layers at each transect. (Table 5) The data collected describes the estimated aerial cover that these layers provide. Aerial cover is defined as the amount of shadow that would be cast by a particular layer alone if the sun were directly overhead.

**Table 5** – Riparian Vegetation Height layers

| **Riparian Vegetation<br>Woody Vegetation Layers** | |
|---|---|
| Canopy | > 5 m height |
| Mid level | .5m – 5m |
| Ground cover | < .5m |

Vegetation was also separated by type which, when averaged, yields canopy composition percentage. Ag sites had a higher composition of deciduous cover and ‘no’ cover while Non-Ag had a higher composition of coniferous and mixed canopies (see Figure 8).

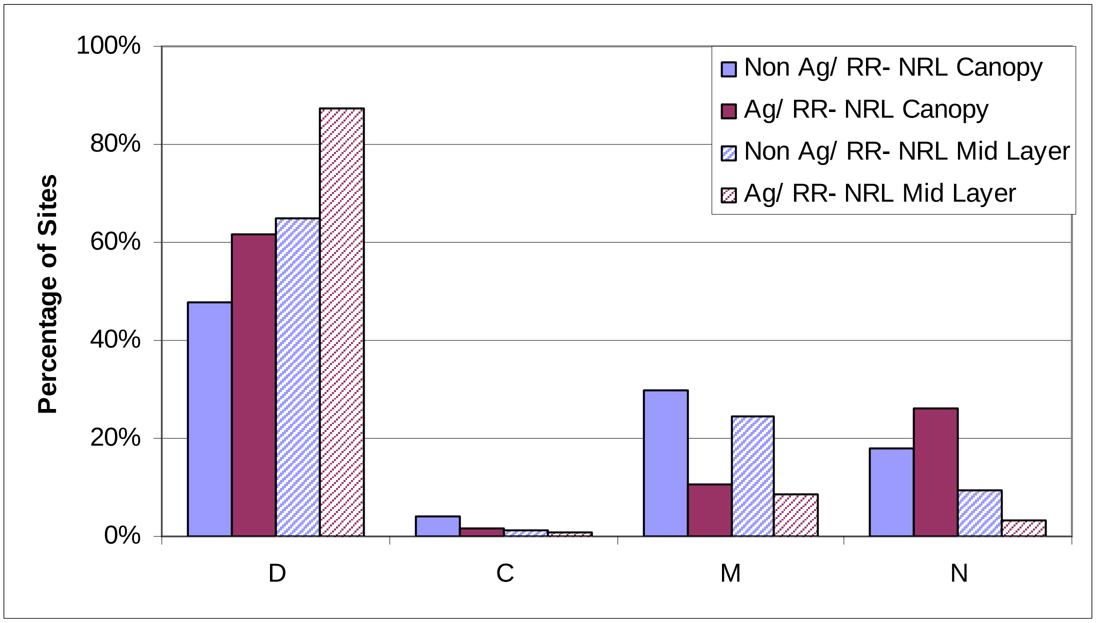


**Figure 8.** Percentage of Canopy Composition types for each transect in both Ag/RR (n=338) and Non-Ag/RR (n= 525) sites. (D= Deciduous; C=Coniferous; M= Mixed Canopy; N= No Canopy Present above .5 m).

Mid-layer compositions percentage on Ag sites was dominated by deciduous vegetation (92%), with less than 1% of the sites having pure coniferous vegetation. Non-Ag sites had more variation; deciduous was still dominate (65%), followed by mixed vegetation (both deciduous and coniferous) (24%).

In order to convert field data into a cover or composition percentage, we used the following matrix (Table 6), as presented in Kaufmann, et. al, 1999.

**Table 6.** Vegetative cover matrix.

| **Field Data** | **Midpoint Values** |
|---|---|
| 0 (Absent) | 0 |
| 1 (Sparse) | 5% |
| 2 (Moderate) | 25% |
| 3 (Heavy) | 57.5% |
| 4 (Very Heavy) | 87.5% |

For the canopy layer (>5 meters high) of the riparian vegetation we calculated the percentage canopy cover provided by large (>0.3m DBH) and small (<0.3m DBH) trees for both Ag and Non-Ag. Ag had a larger average percentage of canopy cover provided by larger trees (13.7%) than on Non-Ag sites (12.89%). Non-Ag had a higher percentage of canopy cover from small trees (24.8%) than Ag sites 14.2%.

Lastly, we calculated the percentage of woody cover in mid-layer ( 0.5 meters to 5 meters high) and ground cover layers (<0.5 meters). Non-Ag sites had a higher average percentage of woody cover (93.0%) than on Ag sites (68.3%). Non-woody cover percentage for the mid and ground layers was greater on Ag sites (85.5%) than on Non-Ag sites (61.9%).

The total percentage of cover can be greater than 100% since both ground layer woody percentage and mid-layer woody percentage are combined (each of which has a possibility of 100%).

### vii. Large Woody Debris

Large Woody Debris (LWD) inputs have a large influence on stream morphology and habitat characteristics. The size of LWD is also of importance, as smaller pieces play a lesser role in a stream system than do larger pieces. The data collected in the field is categorized into 5 size classes (very small, small, medium, large and very large) based on the following matrix (Table 7).

**Table 7**. LWD matrix.

| **Diameter Class (m)** | **Length Class (m)** | | |
|---|---|---|---|
| | **1.5- 5** | **>5- 15** | **>15** |
| **0.1- 0.3** | Very Small | Small | Medium |
| **>0.3- 0.6** | Small | Medium | Large |
| **>0.6- 0.8** | Small | Large | Large |
| **>0.8** | Medium | Large | Very Large |

LWD was more prominent for all size classes on Non-Ag. Very small and small sized pieces were fairly common on both Ag and Non-Ag; however, there was a lack of larger pieces (medium– very large) on Ag sites (Figure 9).

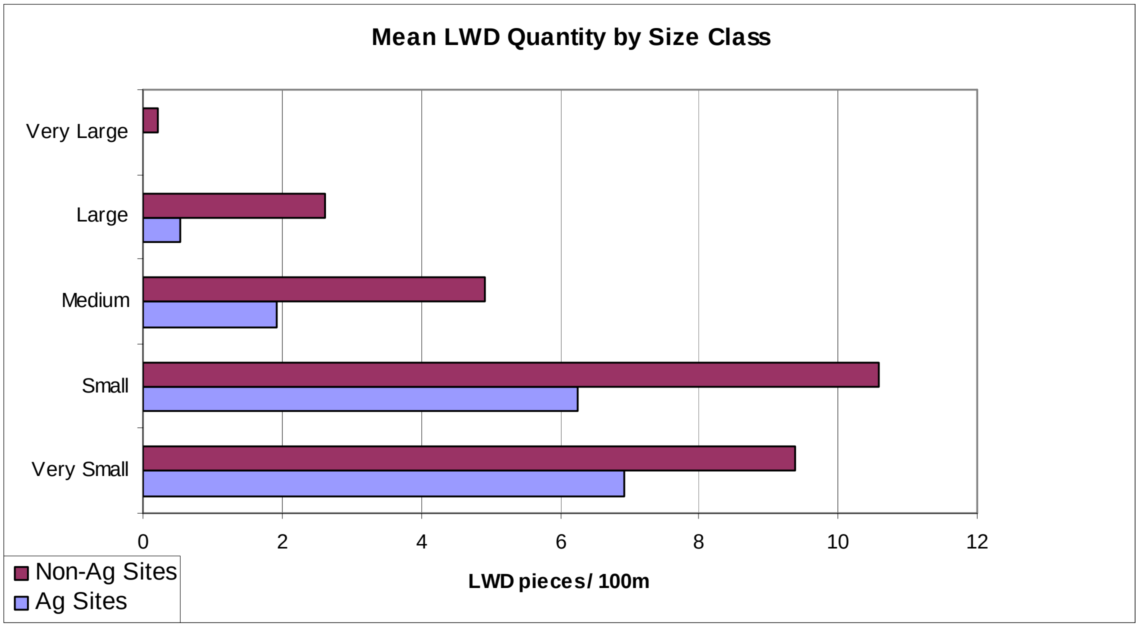


**Figure 9.** Mean LWD frequency per 100 meters

### viii. Bank Stability

Bank Stability was very similar on both Ag and Non-Ag sites; however, sites on Non-Ag zoned lands exhibited greater variation. Non-Ag sites had a bank stability of 82%; Ag site bank stability was slightly less (79%) (Figure 10). An average linear length of 18 % for Non-Ag sites and 22% for Ag sites were considered to be unstable.

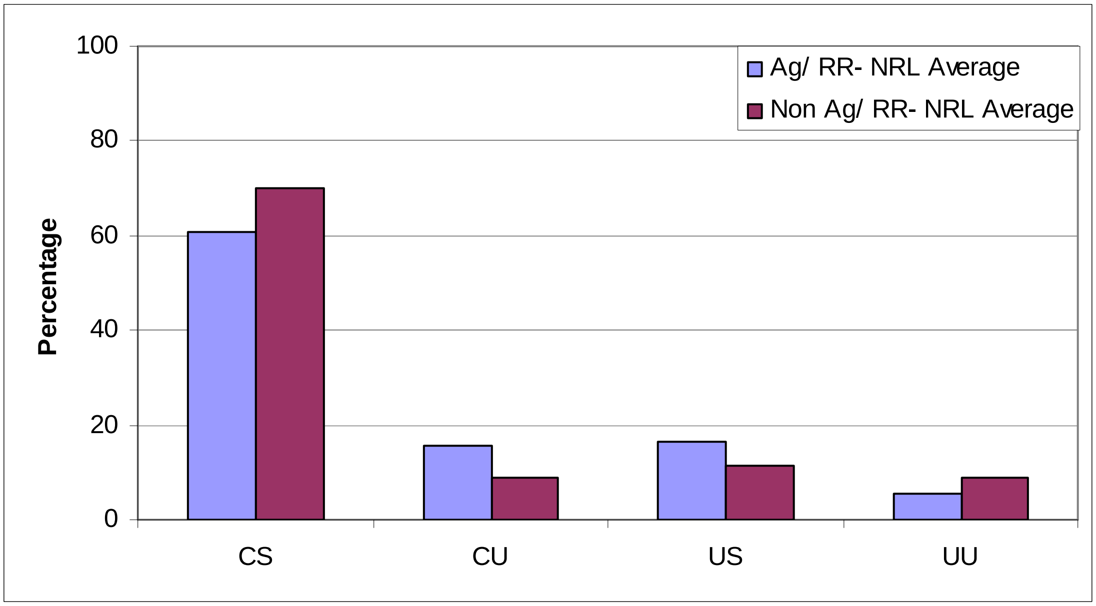


**Figure 10.** Bank stability for both Ag and Non-Ag sites C.S. = covered stable; C.U. = covered unstable; U.S. = uncovered stable; U.U. = uncovered unstable

## ix. Riparian Disturbance

Riparian disturbance data was collected at each of the 11 transects of a study reach. Values were given for each influence, depending on its proximity to the stream. These values were then used to determine the Proximity Weighted Disturbance Index (PWDI) for each reach according to Kauffman, et al, 1999 (See Table 8).

**Table 8.** Categories of anthropogenic influence based on the Proximity Weighted Disturbance Index (PWDI) for each site. (Adapted from Hayslip et al., 2004)

| Data Range | Level of Anthropogenic Influence |
|---|---|
| 0 –.4 | Low |
| > .4 - .8 | Medium |
| > .8 - 1. 2 | High |
| > 1.2 | Very High |

This index combines the extent of the disturbance as well as the proximity of the disturbance to the stream (Hayslip et al., 2004). The most prominent riparian disturbance in Ag is dikes followed by pasture. Logging followed by roads are the most prominent disturbance in Non-Ag. See the Discussion section for land use comparisons between Ag and Non-Ag sites. Most PWDI values were below .4, (See Figure 11), which according to Hayslip, et al, 2004 would be a “Low” level of anthropogenic influence. Only the influence of dikes in Ag would be considered a “Medium” influence.

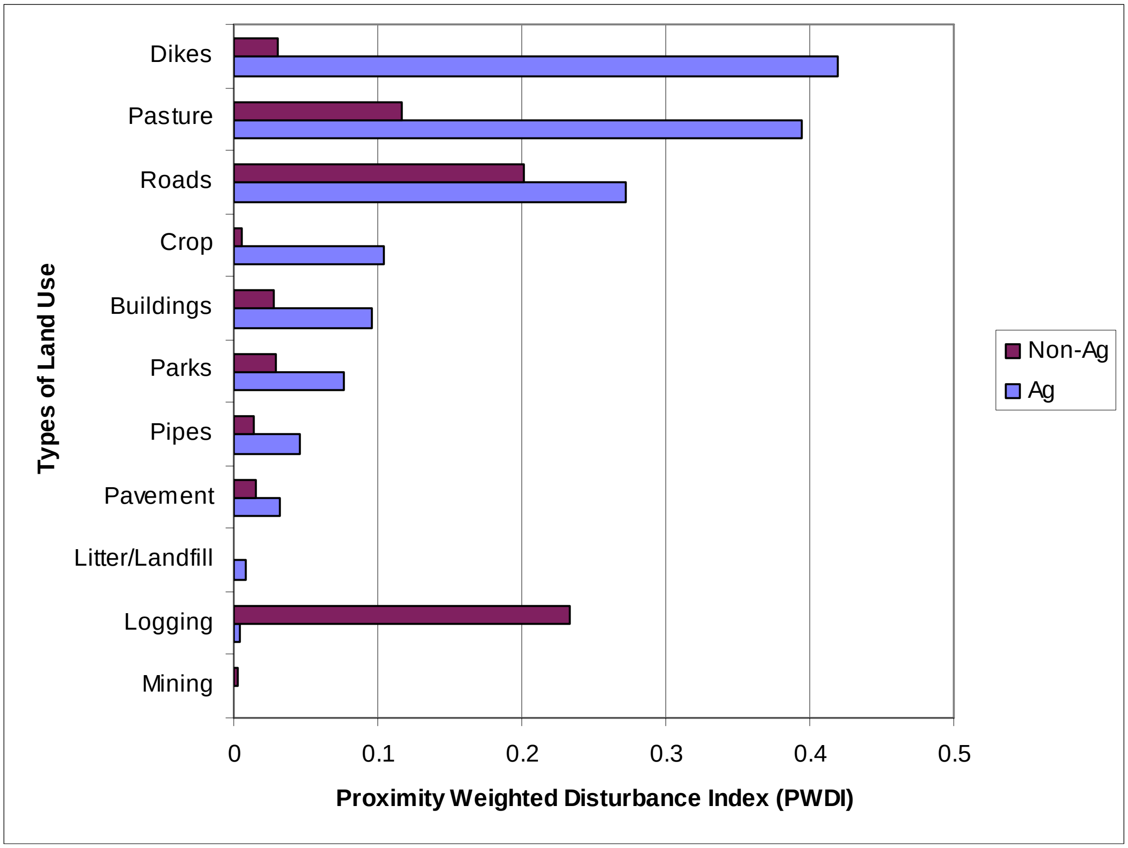


**Figure 11.** PWDI values for land use types

## x. Fish Cover

Fish cover data was analyzed using the same weighted index as the 'Riparian Vegetation' index, but data collection methodology was slightly different. Field crews estimated the percentage of aerial cover in four classes (Table 9). Eight fish cover types were measured between each of the 11 transects along the study reach. Fish cover types recorded were: filamentous algae, aquatic macrophytes, LWD, brush and small woody debris, in-channel live trees and roots, overhanging vegetation (including grasses and other non-woody species), undercut banks, boulders and artificial structures. For our analysis we examined only natural cover, excluding algae and macrophytes.

**Table 9.** Cover percentage estimate used when collecting fish cover data.

| Fish Cover Category | % Cover Estimate |
|---|---|
| Absent | 0 |
| Sparse | 0-10 |
| Moderate | 10-40 |
| Heavy | 40-75 |
| Very Heavy | > 75 |

Natural fish cover percentage was higher on Non-Ag sites than on Ag sites. There were also differences in live tree cover and cover from undercut banks. For both of these categories, Non-Ag sites had a larger percentage of live tree cover and Ag sites had more undercut bank cover (see Figure 12).

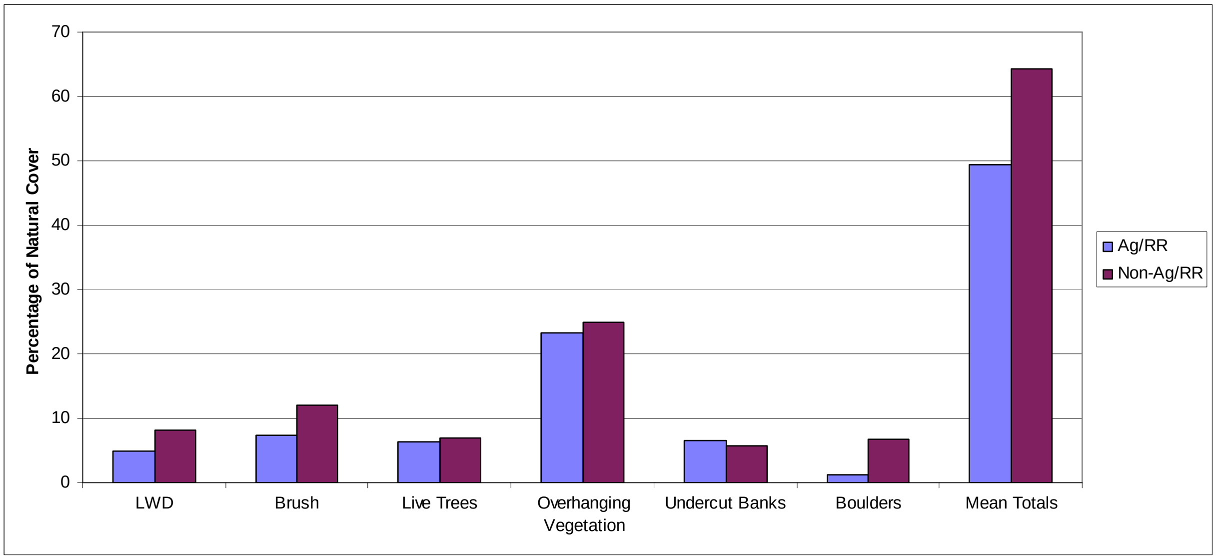


**Figure 12.** Fish cover types by percentage. In addition, mean totals for both Ag and Non-Ag are shown.

### xi. Rosgen Stream Type

As indicated in the Quality Assurance Project Plan (Appendix A), all 60 sites will be typed according to Rosgen (1996) stream classification. However, it was determined that many of the sites surveyed have been significantly altered from their natural state. As a result of these anthropogenic alterations many of the lowland streams no longer fit into the Rosgen stream typing system. It was determined that little could be derived from this analysis; therefore, it has not been done.

## IV. Discussion

In the 2004 sampling season we did not achieve our goal of 60 sites surveyed necessary to establish baseline conditions. During the fall of 2004 it was decided, after consultation with EPA scientist, that in 2005 Skagit County personnel will continue our sampling efforts with the objective of completing the original 60 sites. This report summarizes the data from these two sampling years which is combined to establish a 2004/2005 baseline year. Since the goal of the 2004/2005 sampling years was to establish one set of data for baseline conditions, staff was unable to conduct any type of trend analysis. After five years of data collection we will be able to do limited trend analysis on selected habitat indicators. Consequently, in this section we will only discuss some of the differences we observed between the two sampling zones; Ag and Non-Ag.

### i. Sample Sites

During the June to October 2004 sampling season, great efforts were made to achieve the program’s goal of 60 sites. Over 328 Right of Entry requests were sent out, of which 82 were returned to the County. This represents a 26% response rate. Of these 82 responses, most gave permission to access their land.

**Table 10** – 2004 Right of Entry Summary

| | |
|---|---|
| TOTAL ROEs SENT TO PRIVATE LANDOWNERS | 310 |
| TOTAL ROEs SENT TO PUBLIC LANDOWNERS | 18 |
| NUMBER OF SITES REPRESENTED BY MAILING | 143 |
| TOTAL RESPONDING TO ROE REQUESTS | 82 |
| RECIEVED AG ROEs | 37 |
| RECIEVED NON-AG ROEs | 45 |
| TOTAL RECIEVED ROEs UTILIZED TO SAMPLE 40 SITES* | 37 |
| RECIEVED AG ROEs UTILIZED TO SAMPLE 16 SITES * | 12 |
| RECIEVED NON-AG ROEs UTILIZED TO SAMPLE 24 SITES* | 25 |

* Some ROEs were obtained verbally through public and private landowner meetings and phone conversations or involved State or Federal lands not requiring a ROE.

Many sites required multiple ROEs, which further compounded the ‘access’ problem. This lack of permission to access a site from all adjacent landowners was the main reason for interruptions to the sampling schedule and restricted the County to sampling only 40 of the original 60 sites goal. Table 10 summarizes the County’s initial efforts to obtain Rights of Entries.

During 2004, we surveyed a total of 40 sites– 24 of those were on Non-Ag/RR zoned lands (5 are annual) and 16 on Ag/RR zoned lands (3 are annual). The plan going into the 2005 sampling season was to 1) resurvey the 8 annual sites surveyed in 2004 and 2) survey an additional 20 sites to make up for the shortcoming on baseline sites in 2004. In 2005, 28 sites were sampled which should have given us 60 total sites to establish baseline conditions, with the 8 annual sites being revisited. One baseline site was converted to an annual site which did not get replaced with an additional baseline site. Consequently, we ended up with 59 total sites surveyed. Failure to achieve our goal of 60 baseline sites surveyed will only have a minor effect on our ability to detect trends later in the study.

### ii. Land Use

Ongoing agricultural activities were less prevalent than what might be expected on the Ag sites sampled (see Figure 13).

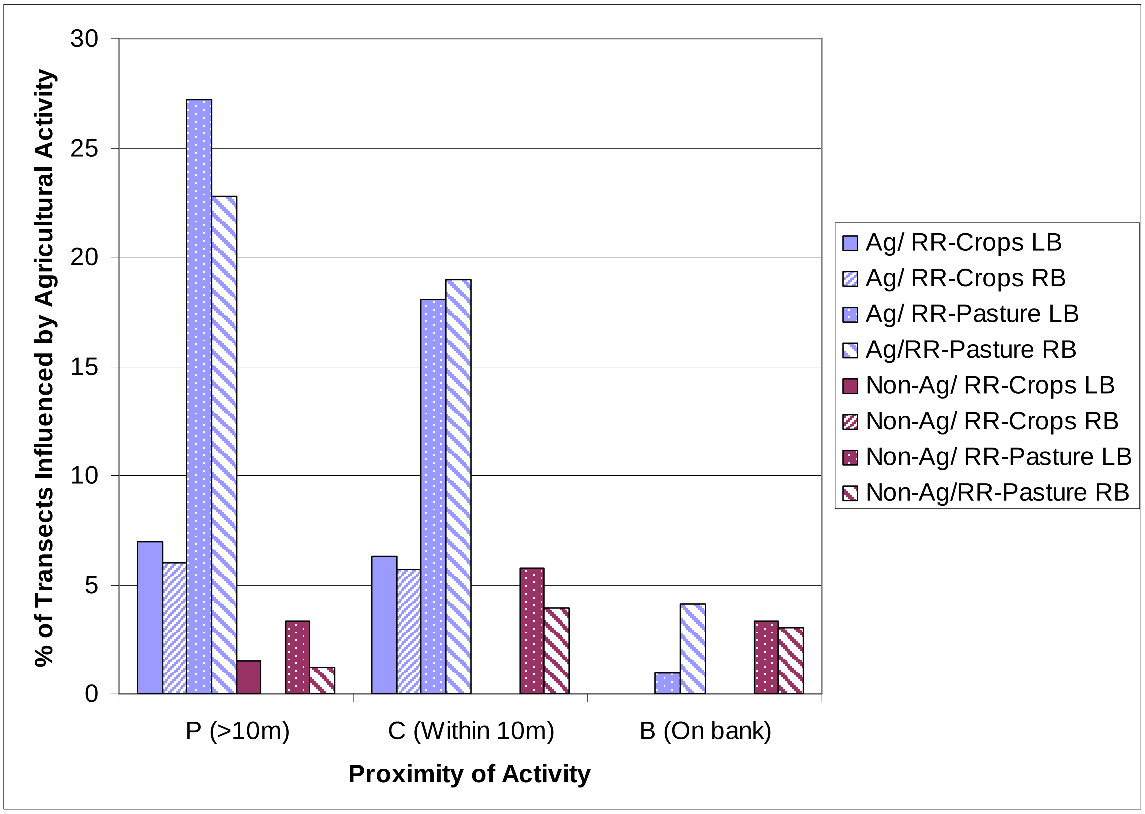


**Figure 13.** Percentage of agriculture activities along 2004/2005 sample site reaches. Agricultural activities are divided amongst zoning, then by proximity to the stream bank and finally by which side the stream that activity was occurring (LB or RB looking downstream).

Figure 11 shows the most prevalent land-use effects for each zoning class. Diking, pasture lands, crop lands and roads were the greatest anthropogenic influences on Ag sites. These types of activities result in a number of effects that can be seen in riparian and stream habitats. The replacement of natural forest, grasslands, and wetlands with annual crop and/ or pasture lands can leave large areas un-vegetated during part of the year and can also dramatically alter the function of plants and microbes in the tilled areas. The repeated disturbance of tillage, fertilization and harvest permanently alters soil characteristics, resulting in reduced infiltration and increased surface runoff. These changes have effects on seasonal streamflow patterns by increasing high flows, lowering water tables and reducing summer base flows (Spence et al., 1996). Diking and channelizing streams on agricultural lands provides a means to attempt to control flood events and provide drainage. As a consequence of changing the geometry of stream channels on cropped lands, these straightened channels facilitate more rapid routing of water to the stream channel, thereby increasing peak flows downstream (Spence et al., 1996). In general, the agricultural practices of diking, channelization, snag removal, and removal of riparian vegetation reduce habitat complexity, decrease channel stability, and alter the food base of the stream. As a result, many streams on agricultural lands typically support smaller fish and fewer fish species (Spence et al., 1996).

On Non-Ag lands, two sites did exhibit signs of ongoing agriculture (see Figure 13). Much of the adjacent land-use on Non-Ag sites involved logging on secondary and industrial forests. Logging practices have a profound effect on riparian and stream habitat, including the removal and disturbance of natural vegetation and disturbance and compaction of soils. The construction of roads can also negatively affect stream habitat when culverts fail or become impassable (Spence et al., 1996). Site disturbance and road construction usually increase the amount of sediment delivered to the streams through mass wasting and surface erosion. This process can increase the percentage of fine sediment, which fills interstitial spaces between spawning gravel, thus rendering those areas unsuitable for spawning (Spence et al., 1996). Forest practices also reduce the recruitment of LWD into a stream, thus altering the hydrology and sediment transport systems. As a result, this reduces the complexity of micro and macrohabitats and can lead to the loss of pools and sinuosity (Spence et al., 1996). Changes in habitat conditions, as a result of these processes, may affect fish assemblage structure and diversity, alter age-structure of salmonid populations and disrupt the timing of life-history events. Other effects are also apt to occur, including reduced embryo survival and fry production, decreased growth efficiency, increased susceptibility to disease and predation, lower over-winter survival and blocked migration (Spence et al., 1996).

### iii. Temperature

Temperature data collected for this program should not, and will not, be used for any type of trend analysis or hypotheses. Only over 59 temperature measurements were taken. These measurements span over nearly 5 months (June to October) and were taken at different times during the day. We therefore expected a large amount of variance from such a small data set. For a more detailed analysis of stream temperature in the Skagit River Basin, see the *Skagit County Monitoring Program* annual report (Haley, 2005), which is available on Skagit County's website (http://www.skagitcounty.net/scmp ).

### iv. Channel Form

Non-Ag sites had a mean stream gradient steeper than Ag sites which can partially be explained by the general geographic location of the study sites within the watershed.

With the addition of the data from the 2005 sampling season the wetted width and bankfull width were not appreciably larger on Non-Ag than on Ag sites that we surveyed. In comparing Ag sites and Non-Ag sites the data show a remarkable similarity in the channel form. Mean bankfull width was 8.28 meters for Non-Ag sites and 8.20 meters for Ag sites.

Ten of the 29 streams surveyed under Ag zoning had been, or are currently, undergoing channelization or straightening and five are being, or have historically been dredged. Both of these anthropogenic activities can yield narrower stream channels which reduces wetted and bankfull widths. Only 2 sites under Non-Ag zoning had any signs of dredging or channelization, past or present.

### v. Substrate

All sizes of substrate were observed in our samplings. Coarse gravels were the largest component of substrate from the Non-Ag sites, whereas fine sediment is the dominant substrate for the Ag sites. The considerable amount of fines/silts and the lack of substrate larger than gravel in the Ag sites can be linked to the location on the Skagit River Delta and the underlying alluvium. As gradient decreases, it is expected that bedload and suspended load compositions will change in size and distribution (Allan 1995).

Anthropogenic activities including dredging, poor agricultural practices, road run-off and channelization could also explain the large percentage of fines observed. Fine sediments are a natural element of stream gravel; however, large inputs of fine sediment into streams can bury spawning gravel, thereby precluding its use (Platts and Megahan 1975). The presence of excessive fine sediments within redds has been shown to reduce egg to fry survival due to a reduction in inter-gravel flow. This reduces the availability of dissolved oxygen required by eggs and fry (Peters 1962). Suttle et al. (2004) associated decreased steelhead growth and survival with increased fine sediment deposition. With increased fine sediment, invertebrate prey species assemblage shifted from available exposed organisms to unavailable burrowing taxa. Suttle et al. (2004) defined fine sediment as a particle size less than 2 mm median diameter. Fine sediment (<.063 mm), Fine Sand (< .5 mm) and Course Sand (<2mm) accounted for over 49% stream bed material sampled for the Ag sites and 24% for Non-Ag site.

A majority of the substrate found on Ag sites larger than gravel was not naturally occurring (i.e. rip-rap around bridges, etc.) streambed material. Dredging also removes these types of substrate, leaving only sand and fine sediment behind.

### vi. Sinuosity

Streams naturally exhibit a certain amount of sinuosity relative to stream flow, substrate, LWD and gradient. A larger degree of sinuosity typically represents more complex and diverse stream habitat. Historically, sites that fall under the Puget Lowlands Ecoregion would generally have a degree of sinuosity greater than 1.2 (A sinuosity of one would be a totally straight channel) (Rosgen, 1996). However, we found that Ag sites had a mean sinuosity value of 1.12. This could be the result of channelization of streams on the lower elevations of the Skagit River Basin, in particular, on the Skagit River Delta. Eleven of the 30 Ag sites we surveyed exhibited characteristics of dredging, channelization, or both.

Streams above the Puget Lowlands Ecoregion would typically exhibit a larger range of sinuosity (> 1.2), depending on valley width, landforms, soils and substrate (Rosgen 1996). We found that Non-Ag sites had a mean sinuosity value of 1.32; however, it is difficult to draw any conclusion from this data since sinuosity on these sites can be so variable.

### vii. Canopy Cover

Shade provided by riparian canopy cover on Ag and Non-Ag sites averaged over 75% (see Table 4). Shade was not provided solely by trees but also by less permanent vegetation such as small shrubs and grasses, as was the case on many Ag sites. Very few sites that we surveyed had no riparian vegetation. Of those that did, it was either a result of vegetation removal or, as on the larger streams, the stream meandered and was dynamic enough to remove larger trees and shrubs. The mean bankfull width and mean wetted width were very similar for both Ag and Non-Ag sites. This would help explain the similarity in riparian cover.

### viii. Riparian Vegetation

Deciduous trees were dominant on both Ag and Non-Ag sites; however, there was an obvious lack of coniferous trees on Ag sites. Coniferous trees provide a greater function in streams due to the decay-resistance of the wood and their larger size (Hayslip et al, 2004). The loss of the recruitment source of LWD from the adjacent riparian areas can, over time, result in the loss of habitat complexity for both invertebrate and salmonid species. Canopy cover provided by large trees (>0.3m dbh) was slightly higher on Ag sites (13.7%) compared to Non-Ag sites (12.8%). This could be partially explained by the number of Ag sites located on the Samish River which tend to have an intact riparian area with large trees despite its location in Ag/RRL zoning. Canopy cover provided by small trees (<0.3m dbh) was much higher on Non-Ag sites (24.8%) than on Ag sites (14.20%). This is generally more aligned to what might be expected. Even though few sites had no trees, Non-Ag sites generally had a greater density of trees around our study reaches.

Woody cover in the mid and ground layers was also greater on Non-Ag sites. On some Ag streams, particularly where a dike was present, the vegetation in the mid and ground layers was predominately non-woody (i.e., Reed Canary Grass) which is reflected in the non-woody cover percentage (Non-Ag 61.9%, Ag 85.5%). On Non-Ag sites, much of the vegetation consisted of woody shrubs (i.e., Salmon Berry).

### ix. Large Woody Debris (LWD)

LWD counts were greater for all size classes on Non-Ag sites versus Ag sites (Figure 14). However, of greater implications is the lack of larger LWD (greater than the Small class) on Ag sites (See Figure 9). LWD provides many functions in a stream channel, including the formation of pools, sorting/retention of sediment used for spawning, and flow variations (Hayslip, 2004). The shortage of larger trees on many Ag sites, in conjunction with stream maintenance and historic LWD removal, likely account for this deficiency.

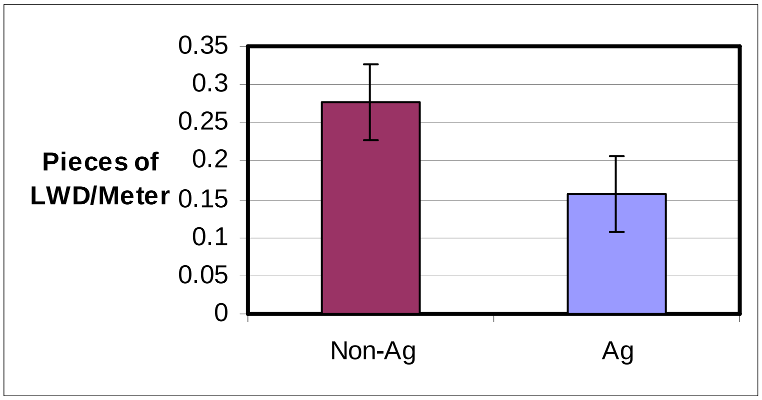


**Figure 14** – LWD/meter stream in Non-Ag and Ag

LWD is also less likely to 'anchor' on sites that are disconnected from their floodplain, especially those that have been straightened and/or diked. These streams do not provide an area for LWD to become incorporated into the channel when they exhibit these characteristics.

The National Marine Fisheries Service (NMFS) (1996) suggests that streams should have > 5 pieces per 100m of LWD >24 inches to function properly. On average, neither Ag nor Non-Ag sites meet this standard. The amount of LWD that would be considered to be at an adequate level are dependent on stream attributes such a width, gradient and watershed. With the wide variety of stream types we sampled it is difficult to assess if the sampled streams have the appropriate LWD loading levels. Additional analysis could be done to partition out observed loading level versus stream widths, but it was not done for this report. The amount of LWD we observed in the Non-Ag streams was similar to what Hayslip (2004) observed in the Western Cascade Lowlands and valley sub-ecoregion.

### x. Bank Stability

The mean bank stability was 79% for Ag and 82% for Non-Ag sites. NMFS (1996) suggested that a stream stability of less than 80% would fall into the category of "Not Properly Functioning" and to be considered "Properly Functioning" no more than 10 % of the banks can be actively eroding. Since the criteria we used as stable or unstable may not be equivalent to what is being referred in the NMFS (1996), the percentage we express should not be assumed to be equivalent. Our data does suggest a marginal level of bank instability in the streams we sampled.

### xi. Riparian Disturbance

The removal, or severe alteration, of riparian habitat and vegetation can reduce the quality and quantity of habitat in a stream system (Hayslip, 2004). We used a proximity–weighted disturbance index, (PWDI) (Kaufmann, et al. 1999), to determine the extent of riparian disturbances caused by anthropogenic activities around the sites we surveyed.

Nearly all types of land-use influences, as outlined in the EMAP protocols, were observed at both Ag and Non-Ag sites. On Ag sites, the most prevalent (> 0.2 PWDI) land-use disturbances were associated with dikes, pasture land and roads. On Non-Ag sites, the most prevalent disturbances were associated with roads and logging (> 0.2 PWDI), (Figure 11). Other influences were measured, but their effects were generally not as great. The influence of both crop production and buildings in Ag-zoned areas were low, (~0.1 PWDI) but much larger than on Non-Ag sites. Anthropogenic disturbances measured at a particular site were, for the most part, similar to land-use practices around that study site.

### xii. Fish Cover

Mean natural fish cover was higher on Non-Ag sites and the composition of this cover also differed between zonings. For example, much of the overhanging vegetation on Ag sites was a result of an excess of Reed Canary Grass or Blackberries (both exotic species) growing on the bank or, on occasion, in the water. In contrast, much of the overhanging vegetation on Non-Ag sites was caused by native woody shrubs and small trees. The higher levels of LWD loading on Non-Ag sites (See Figure 14) is also reflected in the higher percent of habitat associated with LWD on Non-Ag sites compared to Ag sites (See Figure 11). These types of distinctions are sometimes lost in this data but are important, due to their individual longevity as cover and habitat types, and their effectiveness of providing cover for invertebrates and fish species.

### xiii. General Discussion

Since this program uses zoning to differentiate between Ag and Non-Ag sites, it makes it difficult, in a baseline report, to completely assess whether activities associated with agriculture are having a greater, same, or less of an effect on stream habitat than other land-use activities. We surveyed many sites under Ag zoning that showed little or no signs of ongoing agriculture. More often than not, we found the major influences on these streams stemmed from previous dredging, channelization, the resulting loss of floodplain connectivity, the scarcity of mature riparian canopy and the absence of LWD.

There were, however, sites that were strongly influenced by past and on-going agriculture and related activities. Prior to the implementation of this program, as outlined by Skagit County Resolutions #R20030210 and #R20040211, it was already an accepted reality that salmonid habitat on most streams adjacent to ongoing agricultural activities had already been degraded in some capacity (i.e., loss of riparian structure and composition, increased fine sediment inputs, loss of LWD recruitment, etc.). We found that, in most cases, when agriculture was actively occurring near a stream course there was a lack of LWD, riparian vegetation, shade from woody vegetation and a high percentage of fine sediments and non-woody vegetation.

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# APPENDIX A

# SKAGIT COUNTY SALMON HABITAT MONITORING PROGRAM

## QUALITY ASSURANCE PROJECT PLAN

May 20, 2004

________________________________

Derek Koellmann, Salmon Recovery Coordinator/Project Manager
Surface Water Management Section
Skagit County Public Works

## PROJECT SUMMARY

Skagit County will conduct a survey of physical channel and in-stream habitat conditions to document, quantify, and track salmon habitat conditions in the Skagit River Watershed over time. To accomplish this end, the County will use Environmental Monitoring and Assessment Program (EMAP) site selection protocols and procedures to select a representative set of sampling locations (stream reaches) where habitat conditions will be surveyed. The County will also primarily use EMAP survey protocols and procedures to conduct the habitat surveys; however, certain methods have been modified to increase the level of precision associated with this survey and to collect additional data.

The objectives of this effort are to establish a baseline of current general physical habitat conditions in WRIAs 3 & 4, determine whether habitat conditions are stable, improving or degrading over time, and provide a means to differentiate between trends in salmon habitat conditions in Agriculture-NRL & Rural Resource-NRL zoned lands versus other lands under Skagit County jurisdiction. This effort is in response to Skagit County Resolution #R20030210, which specifies actions the County will take to ensure that Skagit County Code 14.24.120, Ongoing Agriculture, is adequately protecting critical areas on agricultural lands.

Selected sampling sites will be equally stratified between Agriculture-NRL & Rural Resource-NRL zoned lands and other lands under Skagit County jurisdiction. Sampling will be conducted only on wadeable streams that have been determined to be salmonid bearing or have the potential to be salmonid bearing per the *Washington State Conservation Commission – Salmon and Steelhead Limiting Factors Water Resource Inventory Areas 3 & 4 Skagit Watershed* (June 2003). Furthermore, sampling will only be conducted on sites where county staff has been granted permission by the landowners to enter to surveying the site.

## PROJECT ORGANIZATION AND RESPONSIBILTITY

### Personnel

Project Manager: Derek Koellmann
Salmon Recovery Coordinator
Surface Water Management Section
Skagit County Public Works
1800 Continental Place
Mount Vernon, WA 98273
360-336-9400

Assistant Manager: Jeff McGowan
Salmon Habitat Specialist
Surface Water Management Section

Skagit County Public Works
1800 Continental Place
Mount Vernon, WA 98273
360-336-9400

Field Technician(s): Chris Kowitz
Skagit County Public Works
1800 Continental Place
Mount Vernon, WA 98273
360-336-9400

Supervisor: Ric Boge
Natural Resource Project Manager
Surface Water Management Section
Skagit County Public Works
1800 Continental Place
Mount Vernon, WA 98273
360-336-9400

## SCHEDULE

### Year 1

March 2004

Begin preliminary site survey to establish problem sites, unusual circumstances, etc.

April 2004

Field training with Washington State Department of Ecology
- Begin work on rights of entry (ROE) for proposed 1st year monitoring sites.

Continue preliminary site surveys

May – September 2004

Initiate and complete 1st year Baseline Study encompassing 60 sampling sites (study period ends October 1, 2004)
Continue to pursue ROEs
Ongoing data entry

October 2004 - October 2005

Review data, establish baseline habitat conditions, and draft report

### Years 2-5

March 2005, 2006, 2007, 2008 respectively

Begin work on rights of entry (ROE) for proposed 2nd – 5th year monitoring sites.

June-August 2005, 2006, 2007, 2008 respectively

Initiate and complete 2nd – 5th year Baseline Study encompassing 20 sampling sites per year (study period ends on October 1 of each year).

Ongoing data entry

October 2005, 2006, 2007, 2008 respectively

Review data and analyze habitat trends

**Years 6-10**

Repeat procedures from years 1-5 with year 6 being a 60 site sampling year.

**Years 11-15**

Repeat procedures from years 1-5 with year 11 being a 60 site sampling year.

**Years 16-20**

Repeat procedures from years 1-5 with year 16 being a 60 site sampling year.

## STUDY DESIGN

Skagit County staff will use EMAP physical habitat survey protocols to conduct a salmon habitat survey for portions of Skagit County. Reaches will be randomly selected using EMAP site selection protocols. A general overview of EMAP is provided below.

A minimum of 60 stream reaches will be randomly selected for inclusion in the 2004 sampling regime. In 2005-2008, 20 randomly selected reaches per year will be surveyed to provide information to be used for trend analyses. In 2009 another randomly selected 60 reaches will be surveyed and the five-year data collection cycle will begin again. See Table 1 - Sampling Regime By Zoning Class And Year, below.

### TABLE 1. SAMPLING REGIME BY ZONING CLASS AND YEAR

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| AG/RR-Nrl | 30 | 10 | 10 | 10 | 10 | 30 | 10 | 10 | 10 | 10 |
| Other Lands | 30 | 10 | 10 | 10 | 10 | 30 | 10 | 10 | 10 | 10 |
| **Total # of sites** | **60** | **20** | **20** | **20** | **20** | **60** | **20** | **20** | **20** | **20** |

All sampling will be conducted only on streams that are or have the potential to be salmonid-bearing and are wadeable. Salmonid-bearing status is based on the *Washington State Conservation Commission – Salmon and Steelhead Limiting Factors Water Resource Inventory Areas 3 & 4 Skagit Watershed* (June 2003). Sites selected will be equally divided between those in Agriculture-Natural Resource Land (Ag-NRL) and Rural Resource-Natural Resource Land (RRc-NRL) zoned lands (as defined by the Skagit County Comprehensive Plan) and other lands within County jurisdiction. After initial reconnaissance of selected sites, only those deemed to be safely accessible and with landowner permission for access will become part of the sample.

Details regarding the sampling site selection process can be found in Appendix A, *Skagit Basin Streams Survey Design*.

## EMAP OVERVIEW

The Environmental Monitoring and Assessment Program (EMAP) is a research program to develop the tools necessary to monitor and assess the status and trends of national ecological resources. EMAP's goal is to develop the methodologies for translating environmental monitoring data from multiple spatial and temporal scales into assessments of current ecological condition and forecasts of future risks to our natural resources.

EMAP aims to advance the science of ecological monitoring and ecological risk assessment, guide national monitoring with improved scientific understanding of ecosystem integrity and dynamics, and demonstrate multi-agency monitoring through large regional projects. EMAP identifies and utilizes appropriate indicators to monitor the condition of ecological resources.

The objectives of Skagit County's Salmon Habitat Monitoring Program are somewhat different from a standard EMAP sampling regime. The county's program is designed to track not only overall status and trends in the Skagit Watershed, but also to track trends both in and between Agriculture-NRL & Rural Resource-NRL zoned lands and other lands under Skagit County jurisdiction. This is different than most EMAP programs that tend to look only at overall status and trends.

## STUDY AREA

The study area encompasses those areas of WRIAs 3 & 4 under direct jurisdiction of Skagit County government. Areas specifically excluded from the study area include National Park and Forest lands, incorporated municipalities, and those portions of WRIAs 1 & 5 that fall within Skagit County's political jurisdiction.

Survey reaches will be equally divided between those in Agriculture-Natural Resource Land (Ag-NRL) and Rural Resource-Natural Resource Land (RRc-NRL) zoned lands (as defined by the Skagit County Comprehensive Plan), and other lands within County jurisdiction. Sampling will be limited to wadeable streams that are or have the potential to be salmonid-bearing per the *Washington State Conservation Commission – Salmon and Steelhead Limiting Factors Water Resource Inventory Areas 3 & 4 Skagit Watershed* (June 2003). Further, sampling will only be conducted on sites where county staff has been granted permission by the landowners to enter to surveying the site.

## PROJECT OBJECTIVES

Establish a statistically valid baseline of the current general physical habitat conditions in WRIAs 3 & 4 during the first year of the project.

Conduct additional habitat conditions monitoring in future years to be used to analyze trends in salmon habitat conditions over time.

Determine whether habitat conditions are improving, degrading, or remaining static in Ag-NRL and RRc-NRL zoned lands.

Provide a means to differentiate between trends in salmon habitat conditions in Ag-NRL and RRc-NRL zoned lands versus other lands under Skagit County jurisdiction.

## STUDY CONSTRAINTS

Skagit County's salmon habitat survey is limited to lands under direct Skagit County jurisdiction, surveys will be conducted only on wadeable streams, and entry to sampling sites will require approval from the landowners of the surrounding areas. As such, Skagit County understands that it can only make statements related to the stream network covered by the survey.

## MONITORING PARAMETERS AND PROTOCOLS

Save for the exceptions listed below, the parameters and protocols used for Skagit County's Salmon Habitat Survey stem directly from the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program*. [http://www.epa.gov/emap/html/pubs/docs/groupdocs/surfwatr/field/ewwsm01.html]

A survey reach is defined as a stream reach with a minimum length of either 40 times its low flow wetted width or 30 times its bankfull width for sites requiring annual revisits. Measurement points are systematically identified to represent the entire reach. Stream depth and wetted width are measured at tightly spaced intervals, whereas channel cross-section profiles, substrate, bank characteristics and riparian vegetation structure are measured at larger spacings. Large Woody Debris (LWD) is tallied along the full length of the survey reach, and discharge is measured at one location. The tightly spaced depth and width measures allow calculation of indices of channel structural complexity, objective classification of channel units such as pools, and quantification of residual pool depth, pool volume, and total stream volume.

### Types of Measurements

**Stream Discharge** – Discharge (flow) is a measure of the amount of water flowing in a watercourse. Stream discharge is equal to the product of the mean current velocity and vertical cross sectional area of flowing water.

**Thalweg Profile** – A longitudinal survey of depth, habitat class, presence of soft/small sediment deposits, and off-channel habitat along a stream's centerline between the two ends of the sampling reach. "Thalweg" refers to the flow path of the deepest water in a stream channel.

**Large Woody Debris Tally** – A visual survey allowing for quantitative estimates of the number, size, total volume and distribution of wood within the stream reach. LWD is defined here as woody material with a small end diameter of at least 10 cm (4 in.) and a length of at least 1.5 m (5 ft.).

**Channel and Riparian Characterization** – Measurements and/or visual estimates of channel dimensions, substrate, fish cover, bank characteristics, riparian vegetation structure, presence of large (legacy) riparian trees, non-native (alien) riparian plants, and evidence of human disturbances. In addition, measurements of the stream slope and compass bearing between stations are obtained, providing information necessary for calculating reach gradient, residual pool volume, and channel sinuosity.

**Assessment of Channel Constraint, Debris Torrents, and Major Floods –** An overall assessment of the above mentioned characteristics for the whole reach including identifying features causing channel constraint, and estimating the percentage of constrained channel margin for the whole reach and the ratio of bankfull/valley width.

### Variables Calculated from the Field Data

Habitat metrics will be calculated from field data according to procedures described in Kaufmann et. al. (1999). The metric list in Appendix B is a subset of the EMAP habitat variables and only includes those most often used by EMAP.

## MONITORING PROTOCOLS

Save for the exceptions listed below under the headings *Modified Methods, Additional Parameters, and Additional Protocols*, the methods, parameters, and protocols to be used for Skagit County's Salmon Habitat Survey stem directly from the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program*.

### Modified Methods

This section details the modifications that Skagit County has made to the protocols contained in the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program*.

**Slope -** Stream slope will be calculated by hydrostatic leveling using two metric stadia rods and a 20-meter length of 10-mm (3.8 inch) inside diameter tubing. The tubing is filled with water and extended along the streambed. When the water within the tubing stabilizes, the change in height is determined by the difference in water column height between the upstream and downstream end. The slope is the height (m) difference divided by length (m). The resulting ratio is unitless, but will be multiplied by 100 and reported as a percentage (Davis et. al. 2001)

**Substrate Measurement –** Sixteen substrate classes (the Field Ops Manual calls for eleven) will be used to help reduce variance associated with substrate measurements. The additional size class distinctions are detailed in Table 2 - Increased Substrate Sampling Size Classes.

## TABLE 2. INCREASED SUBSTRATE SAMPLING SIZE CLASSES

| Description of Particle Size | Mm | EMAP STANDARD Size Class | Skagit County Size Class | |
|---|---|---|---|---|
| Bedrock**TABLE 2. INCREASE SUBSTRATE SAMPLING SIZ CLASSES** | Smooth | >4096 | Bedrock Smooth (RS) | Bedrock Smooth (RS) |
| | Rough | >4096 | Bedrock Rough (RR) | Bedrock Rough (RR) |
| Hardpan | | >4096 | Hardpan (HP) | Hardpan (HP) |
| Boulder | Very Large | 2048 - 4096 | Boulder (BL) | Large Boulder (LB) |
| | Large | 1024 - 2048 | | |
| | Medium | 512 - 1024 | | Small Boulder (SB) |
| | Small | 256 - 512 | | |
| Cobble | Large | 128 - 256 | Cobble (CB) | Large Cobble (CL) |
| | Small | 64 - 128 | | Small Cobble (CS) |
| Gravel | Very Coarse | 32 - 64 | Course Gravel (GC) | Very Course Gravel (GV) |
| | Coarse | 16 - 32 | | Course Gravel (GC) |
| | Medium | 8 - 16 | Fine Gravel (GF) | Medium Gravel (GM) |
| | Fine | 4 - 8 | | Fine Gravel (GF) |
| | Very fine | 2 - 4 | | |

| | | | | |
|---|---|---|---|---|
| Sand | Very Coarse | 1 - 2 | Sand (SA) | Coarse Sand (SC) |
| | Coarse | 0.500 – 1 | | |
| | Medium | 0.250 -0.500 | | Fine Sand (SF) |
| | Fine | 0.125 -0.250 | | |
| | Very fine | 0.063 -0.125 | | |
| Silt/Clay | | 0.00024 - 0.063 | Fines (FN) | Fines (FN) |
| Wood | | Regardless of Size | Wood (WD) | Wood (WD) |
| Other | | Regardless of Size | Other (OT) | Other (OT) |

**Bankfull width** - Bankfull measurements will be conducted in accordance with the protocols contained in *A Guide for Field Identification of Bankfull Stage in the Western United States* - USDA, Forest Service, Stream Systems Technology Center Rocky Mountain Research Station. http://www.stream.fs.fed.us/

**Large Woody Debris Tallies** – In addition to the procedure detailed in the Field Ops Manual for tallying large woody debris (LWD), the presence of large woody debris jams will be documented in the comments portion of the *Thalweg Profile and Woody Debris* field form. Included in the comments will be a visual estimate of the metric volume of any large woody debris jam.

## Additional Parameters

This section details the additional variables that Skagit County will survey beyond those contained in the Environmental Protection Agency's *Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams – Environmental Monitoring and Assessment Program*.

**Streambank Stability** - A streambank stability protocol derived from a combination of the EPA volunteer stream monitoring methods (EPA, 1997) and the EPA protocol by Bauer and Burton (1993) will be used to assess bank stability. Stream banks of a discrete habitat unit will be examined and assigned percentages to quantify bank shape, class, and coverage. Within each category (shape, class, and coverage), each bank, left and right, counts as 50% of the unit, with both sides adding up to 100% for each parameter. During data analysis, all the habitat units of a reach are assessed to compile a bank stability profile of an entire reach.

Bank Shape

Three types of bank shapes are considered: undercut, steep, and gradual. An undercut bank overhangs the stream and usually has been undercut by water movement. It is not necessary for water to be flowing under the bank at the time of the survey, as long as the undercut shape serves as the bank of the active channel. “Steep” bank slopes exceed a 30-degree angle and tend to be vulnerable to erosion. A “gradually sloping” bank has a slope of 30 degrees or less. Although a gradual bank is less vulnerable to erosion, it does not provide much streamside cover (EPA, 1997).

Bank Class

Two parameters are assessed to create a combination of four types of bank class conditions: covered stable, covered unstable, uncovered stable, and uncovered unstable. A bank is considered “covered” if perennial vegetation ground cover is greater than 50%, roots of vegetation cover more than 50% of the bank, at least 50% of the bank surfaces are protected by rocks of cobble size or larger, or at least 50 % of the bank surfaces are protected by logs with diameters of four inches or more. If the bank does not meet any of these criteria, it is considered “uncovered”. A bank with visible signs of deterioration, including breakage, slumping, fractures, and erosion, is considered “unstable” (Bauer & Burton, 1993).

Bank Coverage

Vegetation adjacent to the stream provides resistance to erosion, shade for the creek, and can provide cover and organic material for fish and wildlife. As part of the bank assessment, the composition of riparian vegetation at the edge of the active channel is recorded to evaluate what is functioning to stabilize the immediate bank. Bank cover is recorded as a percentage of a category (conifer, deciduous, shrub, grass/fern, and other – boulder, cobble, large woody debris). The species or type of cover is also identified next to each percentage.

**Rosgen Stream Type –** Upon completion of a field survey, USGS quad maps will be used in the office to determine the flood prone width (valley width) of the surveyed stream reach. This information will be used in conjunction with field survey data to identify the Rosgen (1996) channel type of the surveyed reach.

## Additional Protocols

**Photography Protocol –** A series of photographs will be taken at each survey site to assist in documenting habitat conditions at individual sites. All photos will include a date and time stamp and will also be individually recorded on the *Photo Documentation* form as photos are taken.

Photos taken for each site shall include:

Photos upstream and downstream of the most upstream transect (2 total).
Photos upstream and downstream of the most downstream transect (2 total).
Photos upstream and downstream of the median transect (2 total).
Photos as necessary to identify a particular survey site (e.g. monument photos)
Photos to document any unusual features found in the survey reach (e.g. LWD jams, significant erosion, bridges, etc.)

**Remote Sensing Protocol –** At five year intervals, in conjunction with the 60-site sampling regimes, Landsat ETM satellite derived land cover images will be used to estimate percentages of land use and land cover (impervious surface, vegetation, and other cover types) for the watersheds upstream of sample sites. Land use and land cover percentages will be compared with data collected during the sampling regimes to help associate channel habitat changes with landscape level changes. This information will also be used to address influences to habitat originating outside of the sample reaches.

Land use will be categorized into classes based on a modified Anderson classification shown in Table 3 – Remote Sensing Land Use Classes.

| | | | | |
|---|---|---|---|---|
| 10 | WATER | | | |
| | | 11 | Open Water | |
| | | 12 | Perennial Ice/Snow | |
| | | 14 | Water Transition | |
| | | 15 | Riparian Exposed* | |
| | | 19 | Shadow | |
| 20DEVELOPED | | | | |
| | | 21 | Low Intensity Residential | (Suburban) |
| | | 22 | High Intensity Residential | (City) |
| | | 23 | Commercial/Industrial/Transportation | (Roads, Strip malls) |
| 30 | BARREN | | | |
| | | 31 | Bare Rock/ Sand/Clay | |
| | | 32 | Quarries/Strip Mines/ Gravel Pits | |
| | | 33 | Transitional | |
| | | 35 | Mudflats | |
| | | 36 | Bare Alpine | |
| | | 37 | Bare Forest | |
| | | 38 | Bare Mid-Elevation | |
| | | 39 | Sandbar | |
| 40FORESTED UPLAND | | | | |
| | | 41 | Deciduous Forest | |
| | | 42 | Evergreen Forest | |

| | | |
|---|---|---|
| | 43 | Mixed Forest |
| | 44 | Recent Cut |
| | 45 | Second Growth Forest |
| 50SHRUBLAND | | |
| | 51 | Shrub |
| 60NON_NATURAL WOODY | | |
| | 61 | Orchards/Vineyards/Tree Farms |
| 70HERBACEOUS UPLAND | | |
| | 71 | Grasslands/Herbaceous |
| 80HERBACEOUS PLANTED/CULTIVATED | | |
| | 81 | Pasture/Hay |
| | 82 | Row Crops |
| | 83 | Small Grains |
| | 84 | Fallow |
| | 85 | Urban/ Recreational Grasses |
| 90WETLANDS | | |
| | 91 | Woody wetlands |
| | 92 | Emergent Herbaceous Wetlands |
| 99 | 99 | UNKNOWN |

**Annual Sampling Site Protocol –** For each annual sampling site, the following protocols will be implemented to ensure consistency and increase precision between years.

Each site will be monumented using a combination of GPS coordinates and landmarks (e.g. a particular tree) to ensure the same reach is surveyed annually. Specific landmarks will be photo-documented for future reference.

The length of stream to be surveyed for the annual sites will be calculated in the first year based on 30 times the bankfull width as opposed to 40 times the wetted width to provide for consistency between sampling years. In addition, stream lengths to be sampled will be standardized (stream reach length will remain constant from year to year).

**Non-Sampleable Site Protocol –** Documentation will be provided for each site that is determined to be unsampleable (e.g. survey crews are unable to obtain landowner permission to enter the site, access to the site is too steep to be safely traversed, etc.)

## QUALITY CONTROL PROCEDURES

### Field QC Procedures

Field instruments will be tested and calibrated prior to each sampling event and operated as per the manufacturers' instructions. Suspect readings from field meters will result in the examination of probes, recalibration if necessary, and/or repeated measurement.

Before leaving a sample reach, the team leader will review all of the data forms for accuracy, completeness, and legibility. When reviewing field data forms, the team leader will ensure that all required data forms for the reach have been completed and confirm that the site identification code, the year, the visit number, and the date of the visit are correct on all forms. On each form, all information will be verified to ensure it has been recorded accurately, is legible, and that any flags are explained in the comments section. The crew will also verify that the recorded data makes logical sense. After reviewing each form, the team leader will initial the upper right corner of each page of the form.

### Corrective Procedures

Corrective procedures related to the survey program will take place as they are warranted. The Project Manager will be responsible for corrective actions regarding field data collection and documentation. These actions may include additional data collection, field equipment training, equipment checks, calibrations standard verification, and recalibration in the field. Office activities may include correction of the database, meetings with monitoring team members, instrument repair, and revision of procedures. In addition, personnel with the Environmental Protection Agency (EPA) and/or the Washington State Department of Ecology (ECY) may be contacted to assist in resolving outstanding technical issues.

### Data Quality Objectives

The goal of this program is to generate sufficient reliable data to detect trends in salmon habitat conditions in Ag-NRL and RRc-NRL zoned lands under Skagit County jurisdiction and compare those trends, if any, to those zoned lands under Skagit County jurisdiction outside of Ag-NRL and RRc-NRL .

#### Bias

Bias will be minimized by use of standardized procedures by a trained staff. Surveys will be conducted according to written procedures and instruments will be calibrated and operated according to manufacturer’s instructions.

#### Precision

Precision will be estimated at two levels. The first level consists of estimates of precision (or uncertainty) with which the overall habitat condition of the Skagit County stream reaches are estimated. This uncertainty is estimated from the specific design applied to the selection of reaches and the spatial structure of the habitat indicators. Data will be summarized as a frequency distribution of metric scores; the uncertainty of this description will be approximately +/- 12% with a sample size of 60 sites; precision will likely be better if the habitat characteristics are spatially correlated.

The second level of precision will be estimated by resurveying ten percent (10%) of the total sampling reaches in each sampling year. Each resample survey will be conducted by a different sampling crew than conducted the original survey. Data collected from the resurvey will be compared with that published in Kaufmann, et al.(1999) to compare the precision of Skagit County's study with an expected precision for many of these habitat metrics. This level of precision depends not only on measurement precision but also on the variation in metrics within the interval chosen as the seasonal survey window.

The USEPA's EMAP program will assist in calculating the survey precision after the first year's data have been compiled. Once the first year survey precision calculations are complete, relative timeframes for detecting trends can be identified. Over time, refinement of the estimates occurs as the information about within year and between year variability increases (i.e., effective sample size for estimating these components increases).

## Measurement Data Quality Objectives

Measurement data quality objectives (measurement DQOs or MQOs) for the Skagit County Salmon Habitat Monitoring Program are given in Table 3. The MQOs given in Table 4 represent the maximum allowable criteria for statistical control purposes. Precision is determined from results of revisits by a different crew (field measurements) and by duplicate measurements by the same individual on a different day or by a different individual (map-based measurements).

The completeness objectives are established for each measurement *per site type* (e.g., EMAP sites, revisit sites). Failure to achieve the minimum requirements for a particular site type results in regional population estimates having wider confidence intervals. Failure to achieve requirements for repeat and annual site revisits reduces the precision of estimates of index period and annual variance components, and may impact the representativeness of these estimates because of possible bias in the set of measurements obtained.

**TABLE 4. MEASUREMENT DATA QUALITY OBJECTIVES: PHYSICAL HABITAT INDICATOR**

| Variable or Measurement | Precision | Accuracy | Completeness |
|---|---|---|---|
| Field Measurements and Observations | ±10% | NA | 100% |
| Map-Based Measurements | ±10% | NA | 100% |

NA = not applicable

Table 5 - *Precision Of Physical Habitat Metrics For Quantitative Stream Channel Morphology In The Mid-Atlantic Region And Oregon* is a portion of a table from

Kaufmann et. al. (1999) detailing the Root Mean Square Error (RSME) associated with specific physical habitat metrics. For the purposes of Skagit County's study, the RSMEs represent a "worst case scenario" for the expected precision associated with the Salmon Habitat Monitoring Program. Further information on precision associated with other habitat metrics in the Mid-Atlantic Region and Oregon studies can be found in Section 4 of Kaufmann et. al. (1999).

### TABLE 5 - PRECISION OF PHYSICAL HABITAT METRICS FOR QUANTITATIVE STREAM CHANNEL MORPHOLOGY IN THE MID-ATLANTIC REGION AND OREGON

| VARIABLE NAME – DESCRIPTION CHANNEL MORPHOLOGY METRICS$^{A}$ | RMSE =Ơ$_{REP}$ (IN units of metric) | |
|---|---|---|
| | MID-ATLANTIC | OREGON |
| XDEPTH – Thalweg Mean Depth (cm) | 6.4 | 6.2 |
| SDDEPTH- Thalweg Std. Deviation of depth (cm) | 1.7 | 3.4 |
| XWIDTH-- Mean Wetted Width (m) | 0.93 | 0.89 |
| SDWIDTH-- Std. Deviation of Wetted Width (m) | 0.58 | 0.60 |
| XWXD-- Mean Width- Depth Product ($m^2$) | 0.79 | 0.80 |
| SDWXD-- Standard Deviation of Width-Depth Product ($m^2$) | 0.32 | 0.75 |
| WD_RAT-- Mean ratio of Wetted Width to Thalweg Depth | 6.8 | 2.6 |
| SDWD_RAT-- Standard Deviation of Width-Depth Ratio | 6.5 | 3.4 |
| **Areasum**-- Residual Pool Vertical Profile Area ($m^2$/ reach) | 4.6 | 7.6 |
| **RP100--** Mean Residual Depth ($m^2$/ 100m= cm) | 1.6 | 2.2 |
| **RPGT75--** Number of Residual Pools with Depth > 75 cm (number/ reach) | 0.60 | 0.98 |
| **RPXAREA**-- Mean Residual Pool Vertical Profile Area ($m^2$/ pool) | 0.69 | 1.0 |

| | | |
|---|---|---|
| **RPMDEP--** Maximum Residual Depth of Deepest Pool in Reach (cm) | 14 | 34 |
| XINC_H-- Mean Incision Height (m) | 0.38 | 0.76 |
| XUN-- Mean Bank Lateral Undercut Distance (m) | ---- | 0.025 |
| XBF_H-- Mean Bankfull Height (m) | 0.33 | 0.13 |
| XBF_W-- Mean Bankfull Width (m) | 1.7 | 1.1 |
| XBKA-- Mean bank angle (degrees) | 8.1 | 8.4 |
| XSLOPE-- Mean Channel Gradient (%) | 0.80 | 0.87 |
| VSLOPE-- Std. Deviation of Channel Gradient (%) | 0.40 | 0.66 |
| **SINU--** Channel Sinuosity | 0.10 | 0.25 |

## DATA ASSESSMENT PROCEDURES

### QA/QC Process

The Project Manager will review field data and notes to validate field techniques, calculate precisions, account for bias, and verify completeness. In addition, the reports will be reviewed and summarized annually during the project.

### Data Entry and Review

Data will be entered into the Skagit County Salmon Habitat Monitoring Database. After entry in the database, printouts will be compared with field sheets to detect and correct data entry errors. For analysis, data will be exported to spreadsheets and reviewed to focus on parameters of interest. Trends will be tracked and analyzed using graphical formats and other tools as deemed appropriate. Because all of the field analyses are standard procedures major problems with quality control are not expected. Nevertheless, data reports will be reviewed regularly by the Project Manager.

### Statistics

Statistical summaries will include frequency distributions for each of the major habitat attributes of interest along with the uncertainty estimates associated with these frequency distributions. For some habitat metrics, “criteria” that evaluate whether habitat is in good/poor condition will be used to evaluate what proportion of the stream network is in poor habitat condition (along with an estimated uncertainty associated with this proportion). The approximate uncertainty with which these proportions can be estimated with sample sizes of 60 sites is approximately +/- 12%. For example, the survey might suggest that 30% +/- 12% of the stream network has excess fine sediment. Frequency distributions between the two classes of stream types will be compared to determine whether the distributions differ and whether one class is in poorer condition than the other.

At each five-year interval, these frequency distributions will be compared to assess whether a five-year change is detectable, and the magnitude of detectability. Over time, consistent change (trend) will be tracked. Because the sensitivity of both change detection and trend detection depend on spatial and temporal variation across the Skagit County stream network, they cannot be determined until data have been collected from this network. Research conducted in the EMAP program indicates that 1 – 2% trends in some key habitat features are detectable in 10 - 20 years with 80% likelihood if such trends actually occur.

## DELIVERABLES

Map of all reaches surveyed
Report detailing initial survey effort and associated baseline information
Annual reports to assist with establishing salmon habitat trend analysis and adaptive management considerations pertaining to Skagit County Code 14.24.120, Ongoing Agriculture, as outlined in Skagit County Resolution #R20030210.
Five-year reports detailing trends in habitat conditions in Ag-NRL and RRc-NRL zoned lands under Skagit County jurisdiction and a comparison of those trends, if any, to those zoned lands under Skagit County jurisdiction outside of Ag-NRL and RRc-NRL. The five-year reports will also be used to assist with adaptive management considerations as described above.

# SKAGIT BASIN STREAMS SURVEY DESIGN

Prepared by

Anthony (Tony) R. Olsen
USEPA Western Ecology Division

# Skagit Basin Streams Survey Design

**Contact:**
Derek Koellmann
Salmon Recovery Coordinator
Skagit County Public Works
1800 Continental Place
Mount Vernon, WA  98273
Phone: 360 336 9400
Email: derekk@co.skagit.wa.us

GIS person: Josh Greenberg
Skagit County GIS
124 West Gates St.
Mount Vernon, WA. 98273
Phone: (360) 336-9368  Fax 336-9466
Email: joshg@co.skagit.wa.us

## Description of Sample Design

**Objectives:** Skagit County will conduct a survey of physical channel and in-stream habitat conditions to document, quantify, and track salmon habitat conditions in the Skagit Watershed over time.  To accomplish this end, the County will use Environmental Monitoring and Assessment Program (EMAP) site selection protocols and procedures to select a representative set of sampling locations (stream reaches) where habitat conditions will be surveyed.  The County will also primarily use EMAP survey protocols and procedures to conduct the habitat surveys; however, certain methods have been modified to increase the level of precision associated with this survey and to collect additional data.

The objectives of this effort are to establish a baseline of current general physical habitat conditions in WRIAs 3 & 4, determine whether habitat conditions are stable, improving or degrading over time, and provide a means to differentiate between trends in salmon habitat conditions in Agriculture-NRL & Rural Resource-NRL zoned lands versus other lands under Skagit County jurisdiction. This effort is in response to Skagit County

Resolution #R20030210, which specifies actions the County will take to ensure that Skagit County Code 14.24.120, Ongoing Agriculture, is adequately protecting critical areas on agricultural lands.

Specific objectives are:

- Establish a statistically valid baseline of the current general physical habitat conditions in WRIAs 3 & 4 during the first year of the project.
- Conduct additional habitat conditions monitoring in future years to be used to analyze trends in salmon habitat conditions over time.
- Determine whether habitat conditions are improving, degrading, or remaining static in Ag-NRL and RRc-NRL zoned lands.
- Provide a means to differentiate between trends in salmon habitat conditions in Ag-NRL and RRc-NRL zoned lands versus other lands under Skagit County jurisdiction, as defined by the Skagit County Comprehensive Plan.

**Target Population:** Target population consists of all wadeable streams within Skagit County that are in areas affected by Skagit County Code 14.24.120, Ongoing Agriculture (Ag-NRL and RRc-NRL zoned lands) and those outside of those zoning designations but still under County jurisdiction. These are further restricted to only those streams listed on the SHIAPP database as having salmon or the potential to have salmon. No survey work will occur outside of areas regulated by Skagit County (e.g. no sampling will occur in National Forest lands).

**Sample Frame**: Josh Greenberg, Skagit County GIS, provided the GIS coverage. Attribute INOUT is used to define two subpopulations of interest (those in Ag CAO and those outside those zoning designations). Those stream segments that are not coded as IN or OUT are excluded from the sample frame.

**Survey Design**: A Generalized Random Tessellation Stratified (GRTS) survey design for a linear stream resource was used. The GRTS design includes reverse hierarchical ordering of the selected sites.

**Stratification:** Two strata: those streams that are within the Ag CAO zoning designation and those streams which are outside the Ag CAO Zoning designation. Equal number of sites in each stratum.

**Multi-Density Categories:** None

**Panels:** Six panels. Panels “One” to “Five” will be visited once every five years with panel “One” being visited in year 1, panel “Two” in year 6, panel “Three” in year 11, etc. Panel “Annual” will have annual visits to the sites.

**Sample Size:** 220 stream sites: 40 each in panels “One” to “Five” and 20 in panel

“Annual”. In each case expected number of sites in Ag CAO and outside Ag CAO should be equal.

**Oversample:** 100% over sample.

**Site Use:** The base design has 220 sites allocated to 6 panels. These sites are identified by panel name in the variable “Panel”. If it is necessary for a site in any panel to be replaced, then the lowest ordered SiteID that is part of the oversample of sites (identified by “OverSamp” in variable “Panel”) must be used. Subsequent replacement sites continue to be used in the same way.

## Sample Frame Summary

The total stream length in the GIS coverage is 794.907 km. The total stream length in the sampling frame that is in Skagit County study is 781.539 km with 243.258 km in the Ag CAO zoning designation and 538.281 km outside the Ag CAO zoning designation.

## Site Selection Summary

```
     Annual Panel-1 Panel-2 Panel-3 Panel-4 Panel-5 OverSamp
  IN   10      20      20      20      20      20      110
  OUT  10      20      20      20      20      20      110
```

As noted above under the heading **Panel**, Panels “One” to “Five” will be visited once every five years with panel “One” being visited in year 1, panel “Two” in year 6, panel “Three” in year 11, etc. Panel “Annual” will have annual visits to the sites.

## Description of Sample Design Output:

To achieve an expected sample size of sites in the target population, an appropriate sample size was selected for the study area. A Base set of sites and an Oversample of sites are included in the output. The oversample sites should be added, as needed, in numerical SiteID order. Oversample sites are identified in the “panel” data column as Oversamp. Note that sites may be used in order beginning at the first SiteID number and continuing until desired sample size is reached.

A map of the stream network and the selected sites is given in the associated .pdf file labeled *SkagitDesign*.

The tab-delimited, ASCII file (SkagitSites.tab) has the following variable definitions:

| Variable Name | Description |
|---|---|
| SiteID | Unique site identification (character) |
| arcid | Internal identification number |

| | |
|---|---|
| x | Albers x-coordinate |
| y | Albers y-coordinate |
| LonDD | Longitude, decimal degrees |
| LatDD | Latitude, decimal degrees |
| mdcaty | Multi-density categories used for unequal probability selection |
| weight | Weight (in meters), inverse of inclusion probability, to be used in statistical analyses |
| stratum | Strata used in the survey design |
| panel | Identifies base sample by panel name and Oversample by OverSamp |
| auxiliary variables | Remaining columns are from the sample frame provided |

Albers projection used
Spheroid: Clarke1866
Center longitude (decimal degrees): -96
Origin latitude (decimal degrees): 23
Standard parallel 1 (decimal degrees): 29.5
Standard parallel 2 (decimal degrees): 45.5

For further information about the design, contact
Anthony (Tony) R. Olsen
USEPA NHEERL
Western Ecology Division
200 S.W. 35th Street
Corvallis, OR 97333
Voice: (541) 754-4790
Fax: (541) 754-4716
email: Olsen.Tony@epa.gov

# LIST OF EMAP
# HABITAT VARIABLES

The metric list below is a subset of the EMAP habitat variables and only includes those most often used by EMAP.

| # Variable | Type | Len | Label |
|---|---|---|---|
| 1 SITE ID | Char | 15 | Site ID |
| 2 YEAR | Num | 8 | Year of visit |
| 3 VISIT NO | Num | 8 | Number identifying which visit this is |
| 4 SAMPLED | Char | 30 | Sample status (PHab) |
| 5 XBKA | Num | 8 | Bank Angle--mean (degrees) |
| 6 XUN | Num | 8 | Undercut Distance--Mean (m) |
| 7 XBKF-W | Num | 8 | Bankfull Width--Mean (m) |
| 8 XBKF H | Num | 8 | Bankfull Height-Mean (m) |
| 9 XINC H | Num | 8 | Channel Incision Ht.-Mean (m) |
| 10 XPCM- | Num | 8 | Riparian Canopy & Middle Layer Present (Fraction of reach) |
| 11 XPCMG | Num | 8 | Riparian 3-Layers Present (Fraction of reach) |
| 12 XCL | Num | 8 | Riparian Canopy > 0.3m DBH (Cover) |
| 13 X GB | Num | 8 | Riparian Ground Layer Barren (Cover) |
| 14 XC - | Num | 8 | Riparian Vegetation Canopy cover |
| 15 XG- | Num | 8 | Riparian Vegetation Ground Layer Cover |
| 16 XCMW | Num | 8 | Riparian Vegetation Canopy+Middle Layer (Woody Cover) |
| 17 XCMGW | Num | 8 | Riparian Vegegetation Canopy+Mid+Ground (Woody Cover) |
| 18 PCAN C | Num | 8 | Riparian Canopy Coniferous (Fraction of reach) |
| 19 XCDENBK | Num | 8 | Mean Bank Canopy Density (%) |
| 20 XCDENMID | Num | 8 | Mean Mid-channel Canopy Density (%) |
| 21 XEMBED | Num | 8 | Mean Embeddedness--Channel+Margin (%) |
| 22 XFC ALG | Num | 8 | Fish Cover -Filamentous Algae (Areal Prop) |
| 23 XFC-AQM | Num | 8 | Fish Cover-Aqautic Macrophytes (Areal Prop) |
| 24 XFC-LWD | Num | 8 | Fish Cover-Large Woody Debris (Areal Prop) |
| 25 XFC-BRS | Num | 8 | Fish Cover-Brush & Small Woody Debris |

| # Variable | Type | Len | Label (Areal Prop) |
|---|---|---|---|
| 26 XFC-OHV | Num | 8 | Fish Cover-Overhanging Vegetation (Areal Prop) |
| 27 XFC-UCB | Num | 8 | Fish Cover-Undercut Banks (Areal Prop) |
| 28 XFC-RCK | Num | 8 | Fish Cover-Boulders (Areal Prop) |

|  |  |  |  |  |
|---|---|---|---|---|
| 29 | XFC-HUM | Num | 8 | Fish Cover-Artificial Structures (Areal Prop) |
| 30 | XFC-ALL | Num | 8 | Fish Cover-All Types (Sum Areal Prop) |
| 31 | XFC-NAT | Num | 8 | Fish Cover-Natural Types (Sum Areal Prop) |
| 32 | XFC-BIG | Num | 8 | Fish Cover-Large Woody Debris, Rock, Undercut Banks or Human Structures (Sum Area Prop) |
| 33 | W1-HALL | Num | 8 | Riparian Disturbance--Sum of All Types (Proximity Weighted Presence) |
| 34 | W1-HNOAG | Num | 8 | Riparian Disturbance--Sum of Non-Agricultural Types (Proximity Weighted Presence) |
| 35 | W1 HAG | Num | 8 | Riparian Disturbance--Sum Agricultural Types (Proximity Weighted Presence) |
| 36 | W1H-WALL | Num | 8 | Riparian Disturbance--Wall/Bank Revetment (Proximity Weighted Presence) |
| 37 | W1H PIPE | Num | 8 | Riparian Disturbance--Pipes inflent/effluent (Proximity Weighted Presence) |
| 38 | LSUB DMM | Num | 8 | Substrate-Mean Log l0 (Diameter Class in mm) |
| 39 | LTEST | Num | 8 | Log l0 [Erodible Substrate Diameter (mm)]-Fast estimate |
| 40 | LRBS-TST | Num | 8 | Log l0 [Relative Bed Stability] -Fast estimate |
| 41 | LDMB BW5 | Num | 8 | Log l0 [Erodible Substrate Diameter (mm)]-Est. 2 |
| 42 | LRBS-BW5 | Num | 8 | Log l0 [Relative Bed Stability)-Est. 2 |
| 43 | REACHLEN | Num | 8 | Length of sample reach (m) |
| 44 | X SLOPE | Num | 8 | Channel Slope—field-measured reach mean (%) |
| 45 | X DEPTH | Num | 8 | Thalweg Mean Depth (cm) |
| 46 | RPGT75 | Num | 8 | Residual Pools >75cm deep (number/reach) |
| 47 | RPGT100 | Num | 8 | Residual Pools >100cm deep (number/reach) |
| 48 | RPMXDEP | Num | 8 | Maximum residual depth in reach (cm) |
| 49 | RPXAREA | Num | 8 | Mean vertical profile area of Residual Pools (m2/pool) |
| 50 | RP100 | Num | 8 | Mean Residual Depth (m~/100m) |
| 51 | LSUBD SD | Num | 8 | Substrate-Standard Deviation Log l0 (Diameter Class mm) |
| 52 | PCT-FN | Num | 8 | Substrate Fines --Silt/Clay/Muck (%) |

| # | Variable | Type | Len | Label (Areal Prop) |
|---|---|---|---|---|
| 53 | PCT-SA | Num | 8 | Substrate Sand --.06-2 mm (%) |
| 54 | PCT-HP | Num | 8 | Substrate Hardpan--(%) |
| 55 | PCT-RC | Num | 8 | Substrate Concrete (%) |
| 56 | PCT-SAFN | Num | 8 | Substrate Sand & Fines --<2 mm (%) |
| 57 | PCT-SFGF | Num | 8 | Substrate <= Fine Gravel «=16 mm) (%) |
| 58 | PCT-BIGR | Num | 8 | Substrate >- Coarse Gravel (>l6 mm) (%) |
| 59 | PCT BDRK | Num | 8 | Substrate Bedrock (%) |
| 60 | PCT-ORG | Num | 8 | Substrate Wood or Detritus --(%) |

| | | | |
|---|---|---|---|
| 61 VIW MSQ | Num | 8 | Large Woody Debris Volume in Bankful Channel (m3/m2-all sizes) |
| 62 V4W MSQ | Num | 8 | Large Woody Debris Volume in Bankful Channel (m3/m2-L,X) |
| 63 V1TM100 | Num | 8 | Large Woody Debris Volume in or above Bankful Channel (#/100m-all sizes) |
| 64 V4TM100 | Num | 8 | Large Woody Debris Volume in or above Bankful Channel (#/100m-L,X) |
| 65 SINU | Num | 8 | Channel Sinuosity (m/m) |
| 66 SDDEPTH | Num | 8 | Standard Deviation of Thalweg Depth (cm) |
| 67 XWIDTH | Num | 8 | Wetted Width--Mean (m) |
| 68 XWXD | Num | 8 | Mean Product of Width x Depth (m2) |
| 69 XWD RAT | Num | 8 | Mean Ratio of Width/Depth (m/m) |
| 70 SDWXD | Num | 8 | Standard Deviation of (Width x Depth) (m2) |
| 71 PCT-FA | Num | 8 | Falls (% of reach) |
| 72 PCT-FAST | Num | 8 | Fast Water Habitat (% riffle & faster) |
| 73 PCT=SLOW | Num | 8 | Slow Water Habitat (% Glide & Pool) |
| 74 PCT-POOL | Num | 8 | Pools --All Types (% of reach) |
| 75 PCT-DRS | Num | 8 | Dry Channel or Subsurface Flow (%) |
| 76 PCT-SIDE | Num | 8 | Side channel presence (% of reach) |

# APPENDIX B

## TYPICAL SAMPLING DAY ACTIVITIES

The following is an example of a typical sampling day. Landowners were typically contacted a minimum of 48 hours in advance of an actual survey taking place.

Morning Set-Up

> Prior to heading out to a site, equipment was inventoried to ensure that the crew had all of the equipment necessary to conduct the surveys and that said equipment was in working order.

Drive/hike to site

> The crew traveled to the site. In many instances, due to the location of the sample site, it was necessary for the crew to hike into the sample site. In other cases, the sample site could be accessed by a nearby road.

Make contact with landowners

> All landowners surrounding the sample site were contacted immediately prior to conducting the surveys to make sure they knew that the crew would be accessing their property.

Assess the site

> The site was assessed to ensure that it could be safely surveyed. For example, some sites that were sampleable when originally previewed were determined to not be safe due to a change in flow levels stemming from recent rain events.

Establish X transect

> The X or F transect (center point of the survey reach) was established using GPS coordinates, aerial photos, or other methods. Once the X transect was established, the wetted channel width was measured at that transect. Four additional wetted width measurements were taken in the immediate vicinity of the X transect to establish an averaged wetted width. This average wetted width was used to determine the stream length to be surveyed.

Set transect flags up and downstream of X site

> The entire stream length to be surveyed was divided by 10 to determine the spacing between transects to be surveyed. Once this distance was established, flags designating transects A-K were set at equal intervals.

Data was recorded:

At each transect:

- a. Wetted width
- b. Bankfull width
- c. Bankfull height

Substrate Cross Sections at set intervals

  - i. Distance from bank
  - ii. Depths
  - iii. Substrate size class
  - iv. Embeddedness
- h. Canopy cover measurements (6 total)
- i. Fish cover
- j. Riparian Vegetation Cover
- k. Anthropogenic Influences

Between transects:

- Thalweg profile
  - i. 10-15 equally spaced measurements including:
    1. Depth
    2. Presence of soft/small sediment
    3. Channel unit code (pool, glide, riffle, rapid, etc.)
    4. If channel unit code was a pool, then a pool form code (way by which the pool was created) was recorded (wood, boulder, etc.)
    5. Presence/absence of a side channel
    6. Presence/absence of back water
  - ii. At midpoint of profile a Substrate Cross Sections was taken
  - iii. Each piece Large Woody Debris (LWD) with a minimal large end of 0.1 meters and a minimum length of 1.5 meters was categorized into one of 24 categories.
- Riparian legacy tree
- Presence of invasive species
- Slope
- Bearing
- Bank shape
- Bank stability
- Bank cover

For the entire site:

- Location of sample site
- Width used to define the reach to be sampled
- Total reach length surveyed

Stream discharge
Evidence of torrents
Temperature (one time reading)
Channel constraints
A general stream assessment including

  i. Watershed activities and disturbances observed
  ii. Site characteristics within a 200 meter radius
  iii. Weather
  iv. General written assessment of the site

Depending on the survey crew size, tasks were divided up as follows:

l. Two person survey crew
  i. Transects were completed first
  ii. Slope and bearing next
  iii. Crew broke up:

The entire stream length to be surveyed was divided by 10 to determine the spacing between transects to be surveyed. Once this distance was established, flags designating transects A-K were set at equal intervals.

Data was recorded:

At each transect:

a. Wetted width
b. Bankfull width
c. Bankfull height
d. Incised height
e. Bar width (if applicable)
f. Bank angles
g. Substrate Cross Sections at set intervals
  i. Distance from bank
  ii. Depths
  iii. Substrate size class
  iv. Embeddedness
h. Canopy cover measurements (6 total)
i. Fish cover
j. Riparian Vegetation Cover
k. Anthropogenic Influences

Between transects:

Thalweg profile
  i. 10-15 equally spaced measurements including:
    1. Depth
    2. Presence of soft/small sediment

3. Channel unit code (pool, glide, riffle, rapid, etc.)
4. If channel unit code was a pool, then a pool form code (way by which the pool was created) was recorded (wood, boulder, etc.)
5. Presence/absence of a side channel
6. Presence/absence of back water

ii. At midpoint of profile a Substrate Cross Sections was taken
iii. Each piece Large Woody Debris (LWD) with a minimal large end of 0.1 meters and a minimum length of 1.5 meters was categorized into one of 24 categories.

Riparian legacy tree
Presence of invasive species
Slope
Bearing
Bank shape
Bank stability
Bank cover

For the entire site:

Location of sample site
Width used to define the reach to be sampled
Total reach length surveyed
Stream discharge
Evidence of torrents
Temperature (one time reading)
Channel constraints
A general stream assessment including

i. Watershed activities and disturbances observed
ii. Site characteristics within a 200 meter radius
iii. Weather
iv. General written assessment of the site

Depending on the survey crew size, tasks were divided up as follows:

l. Two person survey crew

i. Transects were completed first
ii. Slope and bearing next
iii. Crew broke up:

1. One completed legacy tree, bank stability, site verification, debris and torrent evidence, and channel constraint forms.
2. Other completed flow measurements and forms.

m. Three person survey crew

i. Crew broke into one pair and one individual

1. Pair completed transects
2. Individual completed legacy tree, bank stability, site verification, debris and torrent evidence, channel constraint, and flow measurements.

        ii. Crew re-grouped to complete slope and bearing

- n. Four person survey crew
    - i. Crew broke out into two pairs
        1. F site was established
        2. First pair would set flags downstream to transect A and then work upstream on the transects.
        3. Second pair would set flags upstream to transect K and then take slope and bearing measurements downstream to transect A
        4. Second pair would then split up
            - a. One completed legacy tree, bank stability, site verification, debris and torrent evidence, and channel constraint forms.
            - b. Other completed flow measurements and forms.
        5. When second pair had completed individual tasks, they would find the first pair. Then the remaining transects were divided between the two pairs. The second pair would typically start at the mid-point of the remaining transects (e.g. first pair has completed the G transect and is completing the thalweg profile between transects G & H. Thus transects H, I, J, and K still need to be surveyed. Second pair would begin surveying transect J and work through K while first pair works through transects H & I).

Crew leader verifies that all information on the forms is complete and makes sense.

Crew leader reviews all forms and initials ones that are complete. Any missing information is collected.

Flags are taken down and removed from site.

Site is left as it was found.

Crew heads back to the office.

# APPENDIX C

EQUIPMENT USED FOR THE SALMON HABITAT MONITORING PROGRAM

1- 50 meter tape
2- Clipboards
1- Top-setting wading rod
3- Stadia rods
1- Pigmy head
1- Flow meter
1- Utility tool
2- Vests
3- Pairs of gloves
2- Backpacks
2- Boxes of flagging
2- Clinometers
2- Densitometers
2- Compasses
6- Pairs of wading boots
6- Pairs of waders
2- Machetes and case
1- List of GPS locations
1- Crescent wrench
1- Vise grips
1- Screw driver
1- Roll duct tape
1- Tube of wader repair stuff
1- Stop watch
1- Hand pump
1- Salmon Habitat Monitoring Plan
1- Flow meter manual
1- EMAP protocols
1- Procedure manual for flow meter
1- GPS manual
2- Thermometers
1- First aid kit
1- Calculator
1- Camera manual
6- Pencils
3- Sharpies
Misc:  extra forms
1- Computer
1- GPS unit w/ case
1- Camera with case
1- Cell phone

2- Hand-held Radios
4- Rechargeable batteries with charger
1- 30 meters clear tubing (3/8” interior diameter)
1- 16 meters clear tubing (3/8” interior diameter)
1- Neutrally buoyant object

# APPENDIX D

FORMS USED FOR THE SALMON HABITAT MONITORING PROGRAM:

Reviewed by (initial): ______

# STREAM VERIFICATION FORM - STREAMS/RIVERS

**SITE NAME:** ____________________ **DATE:** __ __ / __ __ / __ __ __ __ **VISIT:** 0 1 2 3

**SITE ID:** ____________________ Don't forget to record Reach Length on back. **TEAM:**

## STREAM/RIVER VERIFICATION INFORMATION

Stream/River Verified by (X all that apply): GPS Local Contact Signs Roads Topo. Map

Other (Describe Here): Not Verified (Explain in Comments)

| Coordinates | | Latitude North | Longitude West | Type of GPS Fix | Are GPS Coordinates w/i 10 Sec. of map? |
|---|---|---|---|---|---|
| MAP | Degrees, Minutes, and Seconds<br>OR<br>Decimal Degrees | . | . | 2D<br>3D | Yes<br>No |
| GPS | Degrees, Minutes, and Seconds<br>OR<br>Decimal Degrees | . | . | | |

## DID YOU SAMPLE THIS SITE?

| **YES** If YES, check one below | **NO** If NO, check one below |
|---|---|
| **SAMPLEABLE** (Choose method used) | **NON-SAMPLEABLE-PERMANENT** |

**YES** If YES, check one below

**SAMPLEABLE** (Choose method used)

- Wadeable - Continuous water, greater than 50% wadeable
- Boatable
- Partial - Sampled by wading (Explain in comments)
- Partial - Sampled by boat (Explain in comments)
- Wadeable Interrupted - Not continuous water along reach
- Boatable Interrupted - Not continuous water along reach
- Altered - Stream/River Present but not as on Map

**NO** If NO, check one below

**NON-SAMPLEABLE-PERMANENT**

- Dry - Visited
- Dry - Not visited
- Wetland (No Definable Channel)
- Map Error - No evidence channel/waterbody ever present
- Impounded (Underneath Lake or Pond)
- Other (explain in comments)

**NON-SAMPLEABLE-TEMPORARY**

- Not boatable - Need a different crew
- Not wadeable - Need a different crew
- Other (Explain in comments)

**NO ACCESS**

- Access Permission Denied
- Permanently Inaccessible (Unable/Unsafe to Reach Site)
- Temporarily Inaccessible-Fire, etc. (Explain in comments)

## GENERAL COMMENTS:

## DIRECTIONS TO STREAM/RIVER SITE:

56029

Record information used to define length of reach, and sketch general features of reach on reverse side.

Reviewed by (initial):

# STREAM VERIFICATION FORM - STREAMS/RIVERS (cont.)

/ /

**SITE ID:** ______________________ **TEAM:**

## STREAM/RIVER REACH DETERMINATION

| Channel Width Used to Define Reach (m) | DISTANCE (m) FROM X-SITE REACH | | DETERMINATION Total Reach Length Intended (m) | Comment |
|---|---|---|---|---|
| | Upstream Length | Downstream Length | | |
| | | | | |
| | | | | |

## SKETCH MAP - Arrow Indicates North

## PERSONNEL

| NAME | DUTIES Biomorph | Geomorph | Forms |
|---|---|---|---|
| ______________________ | ☐ | ☐ | ☐ |
| ______________________ | ☐ | ☐ | ☐ |
| ______________________ | ☐ | ☐ | ☐ |
| ______________________ | ☐ | ☐ | ☐ |
| ______________________ | ☐ | ☐ | ☐ |

# PHab: CHANNEL/RIPARIAN CROSS-SECTION FORM - STREAMS

Reviewed by (Initials): ____________

SITE ID: ______________ DATE: ___/___/______ TRANSECT: ☐ A ☐ B ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I ☐ J ☐ K X-tra Side Channel ☐

## SUBSTRATE CROSS-SECTIONAL INFORMATION

| | Dist LB XX.XX m | Depth XXX cm | Size Class Code | Embed. 0-100% | Flag |
|---|---|---|---|---|---|
| Left | | | | | |
| LCtr | | | | | |
| Ctr | | | | | |
| RCtr | | | | | |
| Right | | | | | |

| SUBSTRATE SIZE CLASS CODES | Embed. (%) |
|---|---|
| RS = Bedrock (Smooth) - (Larger than a car) | 0 |
| RR = Bedrock ( Rough) - (Larger than a car) | 0 |
| RC = Concrete/Asphalt | |
| XB = Large Boulder (1000 to 4000 mm) - (Meterstick to car) | |
| SB = Small Boulder (250 to 1000 mm) - (Basketball to meterstick) | |
| CB = Cobble (64 to 250 mm) - (Tennis ball to Basketball) | |
| GC = Coarse Gravel (16 to 64 mm) - (Marble to Tennis ball) | |
| GF = Fine Gravel (2 to 16 mm) - (Ladybug to marble) | |
| SA = Sand (0.06 to 2 mm) - (Gritty - up to Ladybug size) | 100 |
| FN = Silt / Clay / Muck - (Not Gritty) | 100 |
| HP = Hardpan - (Firm, Consolidated Fine Substrate) | 0 |
| WD = Wood - (Any Size) | |
| OT = Other (Write comment below) | |

## FISH COVER/ OTHER

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)
(circle one)

| | Cover in Channel | Flag |
|---|---|---|
| Filamentous Algae | 0 1 2 3 4 | |
| Macrophytes | 0 1 2 3 4 | |
| Woody Debris >0.3 m (BIG) | 0 1 2 3 4 | |
| Brush/Woody Debris <0.3 m (SMALL) | 0 1 2 3 4 | |
| Live Trees or Roots | 0 1 2 3 4 | |
| Overhanging Veg. =<1 m of Surface | 0 1 2 3 4 | |
| Undercut Banks | 0 1 2 3 4 | |
| Boulders | 0 1 2 3 4 | |
| Artificial Structures | 0 1 2 3 4 | |

## VISUAL RIPARIAN ESTIMATES

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

D = Deciduous
C = Coniferous
E = Broadleaf Evergreen
M = Mixed
N = None

| RIPARIAN VEGETATION COVER | Left Bank | Right Bank | Flag |
|---|---|---|---|
| **Canopy (>5 m high)** | | | |
| Vegetation Type | D C E M N | D C E M N | |
| BIG Trees (Trunk >0.3 m DBH) | 0 1 2 3 4 | 0 1 2 3 4 | |
| SMALL Trees (Trunk <0.3 m DBH) | 0 1 2 3 4 | 0 1 2 3 4 | |
| **Understory (0.5 to 5 m high)** | | | |
| Vegetation Type | D C E M N | D C E M N | |
| Woody Shrubs & Saplings | 0 1 2 3 4 | 0 1 2 3 4 | |
| Non-Woody Herbs, Grasses, & Forbs | 0 1 2 3 4 | 0 1 2 3 4 | |
| **Ground Cover (<0.5 m high)** | | | |
| Woody Shrubs & Saplings | 0 1 2 3 4 | 0 1 2 3 4 | |
| Non-Woody Herbs, Grasses and Forbs | 0 1 2 3 4 | 0 1 2 3 4 | |
| Barren, Bare Dirt or Duff | 0 1 2 3 4 | 0 1 2 3 4 | |

0 = Not Present P = >10 m C = Within 10 m B = On Bank

| HUMAN INFLUENCE | Left Bank | Right Bank | Flag |
|---|---|---|---|
| Wall/Dike/Revetment /Riprap/Dam | 0 P C B | 0 P C B | |
| Buildings | 0 P C B | 0 P C B | |
| Pavement/Cleared Lot | 0 P C B | 0 P C B | |
| Road/Railroad | 0 P C B | 0 P C B | |
| Pipes (Inlet/Outlet) | 0 P C B | 0 P C B | |
| Landfill/Trash | 0 P C B | 0 P C B | |
| Park/Lawn | 0 P C B | 0 P C B | |
| Row Crops | 0 P C B | 0 P C B | |
| Pasture/Range/Hay Field | 0 P C B | 0 P C B | |
| Logging Operations | 0 P C B | 0 P C B | |
| Mining Activity | 0 P C B | 0 P C B | |

## BANK MEASUREMENTS

| | Bank Angle 0 - 360 | Undercut Dist. (m) | Flag |
|---|---|---|---|
| Left | | | |
| Right | | | |

| | | |
|---|---|---|
| Wetted Width XXX.X m | | |
| Bar Width XX.X m | | |
| Bankfull Width XXX.X m | | |
| Bankfull Height XX.X m | | |
| Incised Height XX.X m | | |

## CANOPY COVER MEASUREMENTS

DENSIOMETER (0-17Max)

| | | Flag | | | Flag |
|---|---|---|---|---|---|
| CenUp | | | CenR | | |
| CenL | | | Left | | |
| CenDwn | | | Right | | |

Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, etc. = misc. flag assigned by field crew. Explain all flags in comment sections.

| Flag | Comments |
|---|---|
| | |
| | |
| | |

27657

# PHAB: THALWEG PROFILE & WOODY DEBRIS FORM STREAMS

Reviewed by (initial):________

SITE ID: ______________________ DATE: ____ / ____ / ________

TRANSECT: ☐ A-B ☐ B-C ☐ C-D ☐ D-E ☐ E-F ☐ F-G ☐ G-H ☐ H-I ☐ I-J ☐ J-K

| THALWEG PROFILE | | | | | | For Transect A-B ONLY: | | | Increment (m) X.X: | | Total Reach Length (m): |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STA-TION | THALWEG DEPTH (cm) (XXX) | WETTED WIDTH (m) (XXX.X) | BAR WIDTH 1 Present | BAR WIDTH 1 XX.X | SOFT /SMALL SEDI-MENT | CHANNEL UNIT CODE | POOL FORM CODE | SIDE CHANNEL | BACK WATER | FLAG | COMMENTS |
| 0 | | | Y N | | Y N | | | Y N | Y N | | |
| 1 | | | Y N | | Y N | | | Y N | Y N | | |
| 2 | | | Y N | | Y N | | | Y N | Y N | | |
| 3 | | | Y N | | Y N | | | Y N | Y N | | |
| 4 | | | Y N | | Y N | | | Y N | Y N | | |
| *5 | | | Y N | | Y N | | | Y N | Y N | | |
| 6 | | | Y N | | Y N | | | Y N | Y N | | |
| *7 | | | Y N | | Y N | | | Y N | Y N | | |
| 8 | | | Y N | | Y N | | | Y N | Y N | | |
| 9 | | | Y N | | Y N | | | Y N | Y N | | |
| 10 | | | Y N | | Y N | | | Y N | Y N | | |
| 11 | | | Y N | | Y N | | | Y N | Y N | | |
| 12 | | | Y N | | Y N | | | Y N | Y N | | |
| 13 | | | Y N | | Y N | | | Y N | Y N | | |
| 14 | | | Y N | | Y N | | | Y N | Y N | | |

| SUBSTRATE | Station (5 or 7) | LFT | LCTR | CTR | RCTR | RGT | FLAG |
|---|---|---|---|---|---|---|---|
| | * | | | | | | |

| FLAG | COMMENTS (for SUBSTRATE and LWD) |
|---|---|
| | |
| | |

**LARGE WOODY DEBRIS** (≥10 cm small end diameter; ≥ 1.5 m length)

CHECK IF UNMARKED BOXES ARE ZERO ☐ FLAG ____

| DIAMETER LARGE END | PIECES ALL/PART IN BANKFULL CHANNEL Length 1.5-5m | 5-15m | >15m | PIECES BRIDGE ABOVE BANKFULL CHANNEL Length 1.5-5m | 5-15m | >15m |
|---|---|---|---|---|---|---|
| 0.1-<0.3 m | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 0.3-0.6 m | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 0.6-0.8 m | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| >0.8 m | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| SUBSTRATE SIZE CLASS CODES | POOL FORM CODES | CHANNEL UNIT CODES |
|---|---|---|
| RS = BEDROCK (SMOOTH) - (LARGER THAN A CAR)<br>RR = BEDROCK ( ROUGH) - (LARGER THAN A CAR)<br>RC = CONCRETE/ASPHALT<br>XB = LG. BOULDER (1000 TO 4000 mm) - METERSTICK TO CAR)<br>SB = SM. BOULDER (250 TO 1000 mm) - BASKETBALL TO METERSTICK)<br>CB = COBBLE (64 TO 250 mm) - (TENNIS BALL TO BASKETBALL)<br>GC = COARSE GRAVEL (16 TO 64 mm) - (MARBLE TO TENNIS BALL)<br>GF = FINE GRAVEL (2 TO 16 mm) - (LADYBUG TO MARBLE)<br>SA = SAND (0.06 TO 2 mm) - (GRITTY - UP TO LADYBUG SIZE)<br>FN = SILT/ CLAY / MUCK - (NOT GRITTY)<br>HP = HARDPAN - (FIRM, CONSOLIDATED FINE SUBSTRATE)<br>WD = WOOD - (ANY SIZE)<br>OT = OTHER (COMMENT ON OTHER SIDE) | N = Not a pool<br>W = Large Woody Debris<br>R = Rootwad<br>B = Boulder or Bedrock<br>F = Unknown, fluvial<br>COMBINATIONS:<br>eg. WR, BR, WRB | PP = Pool, Plunge<br>PT = Pool, Trench<br>PL = Pool, Lateral Scour<br>PB = Pool, Backwater<br>PD = Pool, Impoundment<br>GL = Glide<br>RI = Riffle<br>RA = Rapid<br>CA = Cascade<br>FA = Falls<br>DR = Dry Channel |

17021

Flag Codes: K = no measurement made; U = suspect measurement; F1, F2, ect. = flags assigned by each field crew; G1, G2, etc. for flags not specific to one station. Explain all flags in comments. 1 = Measure Bar Width at Station 0 and Mid-Station (5 or 7).

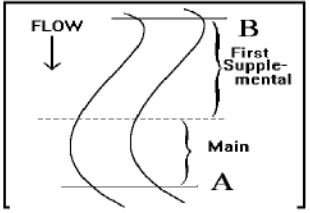
# PHab: SLOPE AND BEARING FORM - STREAMS

Reviewed by (initial): ______

SITE ID: ____________________ DATE: ___ / ___ / ______

| MAIN (always used) | | | | FIRST SUPPLEMENTAL | | | SECOND SUPPLEMENTAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **TRANSECT & METHOD**<br>Mark method for every Transect | **Slope(%) or Elev. Diff. (cm)**<br>Mark Units for every Transect | **BEARING 0 - 359** | **PROPOR-TION %** | **Slope(%) or Elev. Diff. (cm)** | **BEARING 0 - 359** | **PROPOR-TION %** | **Slope(%) or Elev. Diff. (cm)** | **BEARING 0 - 359** | **PROPOR-TION %** | **FLAG** |
| **A < B** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **B < C** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **C < D** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **D < E** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **E < F** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **F < G** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **G < H** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **H < I** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **I < J** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |
| **J < K** ☐ CL ☐ TR<br>☐ HL ☐ WT<br>☐ LA ☐ Other | .<br>☐ % ☐ cm | | | . | | | . | | | |

| FLAG | COMMENT |
|---|---|
| | |
| | |
| | |



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Flag codes: K = Sample not collected; U = Suspect sample; F1, F2, M (M = Method - used for method comment only) = flag assigned by field crew. Explain all flags in comment sections

03/20/2003 2003 Phab Slope CL=Clinometer; HL=Hand Level; LA=Laser rangefinder with electronic clinometer; TR=Transit, surveyors level or total station; WT=Water Tubing.

# RIPARIAN "LEGACY" TREES AND INVASIVE ALIEN PLANTS

Reviewed by (initial): ______

22977

SITE ID: ______________________

DATE: ___ / ___ / _____

| Tran | LARGEST POTENTIAL LEGACY TREE VISIBLE FROM THIS STATION | | | | | | ALIEN PLANT SPECIES PRESENT IN LEFT AND RIGHT RIPARIAN PLOTS | |
|---|---|---|---|---|---|---|---|---|
| | Trees not Visible | DBH (m) | Height (m) | Dist. from wetted margin (m) | Type | Taxonomic Category | Check all that are present | |
| A | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐<br>NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| B | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐<br>NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| C | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐<br>NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |

## INSTRUCTIONS

**Potential Legacy trees** are defined as the largest tree within your search area, which is as far as you can see, but within maximum limits as follows:

Wadeable Streams: Confine search to no more than 50 m from left and right bank and extending upstream to next transect (for 'K' look upstream 4 channel widths)

Non-wadeable Rivers: Confine search to no more than 100 m from left and right bank and extending both upstream and downstream as far as you can see confidently.

**Alien Plants**: Confine search to riparian plots on left and right bank

Wadeable Streams: 10 m x 10 m

Non-wadeable Rivers: 10 m x 20 m

Not all aliens are to be identified in all states. See Field Manual and Plant Identification Guide.

## TAXONOMIC CATEGORIES

Acacia/Mesquite
Alder/Birch
Ash
Maple/Boxelder
Oak
Poplar/Cottonwood
Sycamore
Willow
Unknown or Other Deciduous

Cedar/Cypress/Sequoia
Fir (including Douglas fir and hemlock)
Juniper
Pine
Spruce
Unknown or Other Conifer

Unknown or Other Broadleaf Evergreen

Snag (Dead tree of any species)

## ALIEN SPECIES

| | | |
|---|---|---|
| RC Grass | Reed canarygrass | *Phalaris arundinacea* |
| Engl Ivy | English ivy | *Hedera helix* |
| ChGrass | Cheat grass | *Bromus tectorum* |
| Salt Ced | Salt Cedar | *Tamarix spp.* |
| Can This | Canada thistle | *Cirsium arvense* |
| M This | Musk thistle | *Carduus nutans* |
| Hblack | Himalayan blackberry | *Rubus discolor* |
| Teasel | Teasel | *Dipsacus fullonum* |
| Spurge | Leafy spurge | *Euphorbia esula* |
| G Reed | Giant reed | *Arundo donax* |
| C Burd | Common burdock | *Arctim minus* |
| Rus Ol | Russian-olive | *Elaeagnus angustifolia* |

## COMMENTS

**Transects D to K continued on other side**

# RIPARIAN "LEGACY" TREES AND INVASIVE ALIEN PLANTS

Reviewed by (initial): ______

22977

**SITE ID:** ____________________ **DATE:** ___/___/_____

| Tran | LARGEST POTENTIAL LEGACY TREE VISIBLE FROM THIS STATION | | | | | | ALIEN PLANT SPECIES PRESENT IN LEFT AND RIGHT RIPARIAN PLOTS | |
|---|---|---|---|---|---|---|---|---|
| | Trees not Visible | DBH (m) | Height (m) | Dist. from wetted margin (m) | Type | Taxonomic Category | Check all that are present | |
| D | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| E | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| F | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| G | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| H | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| I | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| J | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |
| K | ☐ | ☐ 0-0.1 ☐ .75-2<br>☐ .1-.3 ☐ >2<br>☐ .3-.75 | ☐ <5<br>☐ 5–15<br>☐ 15–30<br>☐ >30 | ______ | ☐ Deciduous<br>☐ Coniferous<br>☐ Broadleaf Evergreen | ______ | ☐ NONE | ☐ RC Grass ☐ Salt Ced ☐ Hblack ☐ G Reed<br>☐ Engl Ivy ☐ CanThis ☐ Teasel ☐ C Burd<br>☐ Ch Grass ☐ M This ☐ Spurge ☐ Rus Ol |

# CHANNEL CONSTRAINT AND FIELD CHEMISTRY - STREAMS/RIVERS

Reviewed by (initial): ________

**SITE ID:** ______________________________ **DATE:** ___/___/_____

| **IN SITU MEASUREMENTS** | **Station ID:** **(Assume X-site unless marked)** |
|---|---|
| | **Comments** |
| **STREAM/RIVER DO mg/l:**<br>**(optional)** . | |
| **STREAM RIVER TEMP. (C):** . | |
| **TIME OF DAY:** : | |

## CHANNEL CONSTRAINT

**CHANNEL PATTERN (Check One)**

**One channel**

**Anastomosing (complex) channel -** (Relatively long major and minor channels branching and rejoining.)

**Braided channel -** (Multiple short channels branching and rejoining - mainly one channel broken up by numerous mid-channel bars.)

**CHANNEL CONSTRAINT (Check One)**

**Channel very constrained in V-shaped valley (i.e.** it is very unlikely to spread out over valley or erode a new channel during flood)

**Channel is in Broad Valley** but channel movement by erosion during floods is **constrained by Incision** (Flood flows do not commonly spread over valley floor or into multiple channels.)

**Channel is in Narrow Valley but is not very constrained,** but limited in movement by relatively narrow valley floor (< ~10 x ban kfull width)

**Channel is Unconstrained in Broad Valley (i.e.** during flood it can fill off-channel areas and side channels, spread out over flood plain, or easily cut new channels by erosion)

**CONSTRAINING FEATURES (Check One)**

**Bedrock (i.e.** channel is a bedrock-dominated gorge)

**Hillslope (i.e.** channel constrained in narrow V-shaped valley)

**Terrace (i.e.** channel is constrained by its own incision into river/stream gravel/soil deposits)

**Human Bank Alterations (i.e.** constrained by rip-rap, landfill, dike, road, etc.)

**No constraining features**

Percent of channel length with margin in feature: **%** **--->**

contact with constraining

Bankfull width: (m)

Valley width (Visual Estimated Average): (m)

Note: Be sure to include distances between both sides of valley border for valley width.

**If you cannot see the valley borders, record the distance you can see and mark this box.**

| **Percent** | **of** | | **M** | **Examples** |
|---|---|---|---|---|
| 100% | | | | 100% |
| | 50 % | | | 50% |

**Comments**

Reviewed by (Initials):

# TORRENT EVIDENCE ASSESSMENT FORM - STREAMS

**SITE ID:** ______________________ **DATE:** ___/___/______

## TORRENT EVIDENCE

**Please X any of the following that are evident.**

### EVIDENCE OF TORRENT SCOURING:

| | |
|---|---|
| | 01 - Stream channel has a recently devegetated corridor two or more times the width of the low flow channel. This corridor lacks riparian vegetation with possible exception of fireweed, even-aged alder or cottonwood seedlings, grasses, or other herbaceous plants. |
| | 02 - Stream substrate cobbles or large gravel particles are NOT IMBRICATED. (Imbricated means that they lie with flat sides horizontal and that they are stacked like roof shingles -- imagine the upstream direction as the top of the "roof.") In a torrent scour or deposition channel, the stones are laying in unorganized patterns, lying "every which way." In addition many of the substrate particles are angular (not "water-worn.") |
| | 03 - Channel has little evidence of pool-riffle structure. (For example, could you ride a mountain bike down the channel?) |
| | 04 - The stream channel is scoured down to bedrock for substantial portion of reach. |
| | 05 - There are gravel or cobble berms (little levees) above bankfull level. |
| | 06 - Downstream of the scoured reach (possibly several miles), there are massive deposits of sediment, logs, and other debris. |
| | 07 - Riparian trees have fresh bark scars at many points along the stream at seemingly unbelievable heights above the channel bed. |
| | 08 - Riparian trees have fallen into the channel as a result of scouring near their roots. |

### EVIDENCE OF TORRENT DEPOSITS:

| | |
|---|---|
| | 09 - There are massive deposits of sediment, logs, and other debris in the reach. They may contain wood and boulders that, in your judgement, could not have been moved by the stream at even extreme flood stage. |
| | 10 - If the stream has begun to erode newly laid deposits, it is evident that these deposits are "MATRIX SUPPORTED." This means that the large particles, like boulders and cobbles, are often not touching each other, but have silt, sand, and other fine particles between them (their weight is supported by these fine particles -- in contrast to a normal stream deposit, where fines, if present, normally "fill-in" the interstices between coarser particles.) |

### NO EVIDENCE:

| | |
|---|---|
| | 11 - No evidence of torrent scouring or torrent deposits. |

## COMMENTS

# STREAM DISCHARGE FORM

Reviewed by (Initials): ______

**SITE ID:** ______________________________

**DATE:** ___ / ___ / ______

## Velocity Area

| Distance Units | | Depth Units | Velocity Units |
|---|---|---|---|
| ft cm | | ft cm | ft/s XX.X m/s X.XX |

(Final measurement should be left bank.)

| | Dist. from Bank | Depth | Velocity | Flag |
|---|---|---|---|---|
| 1 | 0 | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |
| 11 | | | | |
| 12 | | | | |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |
| 16 | | | | |
| 17 | | | | |
| 18 | | | | |
| 19 | | | | |
| 20 | | | | |

## ☐ Timed Filling

| Repeat | Volume (L) | Time (s) | Flag |
|---|---|---|---|
| 1 | ___ . __ | ___ . __ | ___ |
| 2 | ___ . __ | ___ . __ | ___ |
| 3 | ___ . __ | ___ . __ | ___ |
| 4 | ___ . __ | ___ . __ | ___ |
| 5 | ___ . __ | ___ . __ | ___ |

## Neutral Bouyant Object

| | Float 1 | Float 2 | Float 3 |
|---|---|---|---|
| Float Dist. ft m | | | |
| Float Time (s) | | | |
| Flag | | | |

### Cross Sections on Float Reach

| | Upper Section | Middle Section | Lower Section |
|---|---|---|---|
| Width ft m | . | . | . |
| Depth 1 ft cm | | | |
| Depth 2 | | | |
| Depth 3 | | | |
| Depth 4 | | | |
| Depth 5 | | | |

## Q Value

If discharge is determined directly

$^3$FLAG

| Flag | Comments |
|---|---|
| ___ | |
| ___ | |
| ___ | |

Flag Codes: K = No measurement or observation made; U = Suspect measurement or observation; Q = Unacceptable QC check associated with measurement; Z = Last station measured (if not Station 20); F1, F2, etc. = Miscellaneous flags assigned by each field crew. Explain all flags in comments section.

# STREAM ASSESSMENT FORM - STREAMS/RIVERS

Reviewed by (initial): ______

**SITE ID:** ______________________ **DATE:** ___/___/______

## WATERSHED ACTIVITIES AND DISTURBANCES OBSERVED

(Intensity: Blank=Not observed, L=Low, M=Moderate, H=Heavy)

| Residential | Recreational | Agricultural | I | Stream Management |
|---|---|---|---|---|
| L M H Residences | L M H Hiking Trails | L M H Cropland | L M H Industrial Plants | L M H Liming |
| L M H Maintained Lawns | L M H Parks, Campgrounds | L M H Pasture | L M H Mines/Quarries | L M H Chemical Treatment |
| L M H Construction | L M H Primitive Parks, Camping | L M H Livestock Use | L M H Oil/Gas Wells | L M H Angling Pressure |
| L M H Pipes, Drains | L M H Trash/Litter | L M H Orchards | L M H Power Plants | L M H Dredging |
| L M H Dumping | L M H Surface Films | L M H Poultry | L M H Logging | L M H Channelization |
| L M H Roads | | L M H Irrigation Equip. | L M H Evidence of Fire | L M H Water Level Fluctuations |
| L M H Bridge/Culverts | | L M H Water Withdrawal | L M H Odors | L M H Fish Stocking |
| L M H Sewage Treatment | | | L M H Commercial | L M H Dams |

## SITE CHARACTERISTICS (200 m radius)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Waterbody Character** | Pristine<br>Appealing | 5<br>5 | 4<br>4 | 3<br>3 | 2<br>2 | 1<br>1 | Highly Disturbed<br>Unappealing |
| **Beaver** | Beaver Signs:<br>Beaver Flow Modifications: | Absent<br>None | | Rare<br>Minor | | Common<br>Major | |
| **Dominant Land Use** | Dominant Land Use 'X' Around<br>Class | Forest | | Agriculture<br>25 - 75 yrs. | Range<br>> 75 yrs. | Urban | Suburban/Town |

**WEATHER** ______________________

## GENERAL ASSESSMENT (Biotic integrity, Vegetation diversity, Local anecdotal information)

## STREAM ASSESSMENT FORM - STREAM/RIVERS (cont.)

Reviewed by (initial): ____

**SITE ID:** **DATE:** / /

### GENERAL ASSESSMENT (continued)

## Phab: Bank Stability - Streams

Site ID:____________________

Date:____________ 2004

Transect: ☐ A→B ☐ B→C ☐ C→D ☐ D→E ☐ E→F
☐ F→G ☐ G→H ☐ H→I ☐ I→J ☐ J→K

| | Shape | | | | | | Stabilty | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRANSECT | Undercut | | Steep (>30%) | | Gradual (<30%) | | CS | | CU | | US | | UU | |
| | L | R | L | R | L | R | L | R | L | R | L | R | L | R |
| A→B | | | | | | | | | | | | | | |
| B→C | | | | | | | | | | | | | | |
| C→D | | | | | | | | | | | | | | |
| D→E | | | | | | | | | | | | | | |
| E→F | | | | | | | | | | | | | | |
| F→G | | | | | | | | | | | | | | |
| G→H | | | | | | | | | | | | | | |
| H→I | | | | | | | | | | | | | | |
| I→J | | | | | | | | | | | | | | |
| J→K | | | | | | | | | | | | | | |

| | Cover | | | | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TRANSECT | Conifer | | Deciduous | | Shrub | | Grass/Fern | | Other (lawn, boulder, bare) | | |
| | L | R | L | R | L | R | L | R | L | R | |
| A→B | | | | | | | | | | | |
| B→C | | | | | | | | | | | |
| C→D | | | | | | | | | | | |
| D→E | | | | | | | | | | | |
| E→F | | | | | | | | | | | |
| F→G | | | | | | | | | | | |
| G→H | | | | | | | | | | | |
| H→I | | | | | | | | | | | |
| I→J | | | | | | | | | | | |
| J→K | | | | | | | | | | | |

KEY:

**Evergreens**
H = Hemlock
S = Sitka Spruce
R = Red Cedar
D = Douglas Fir

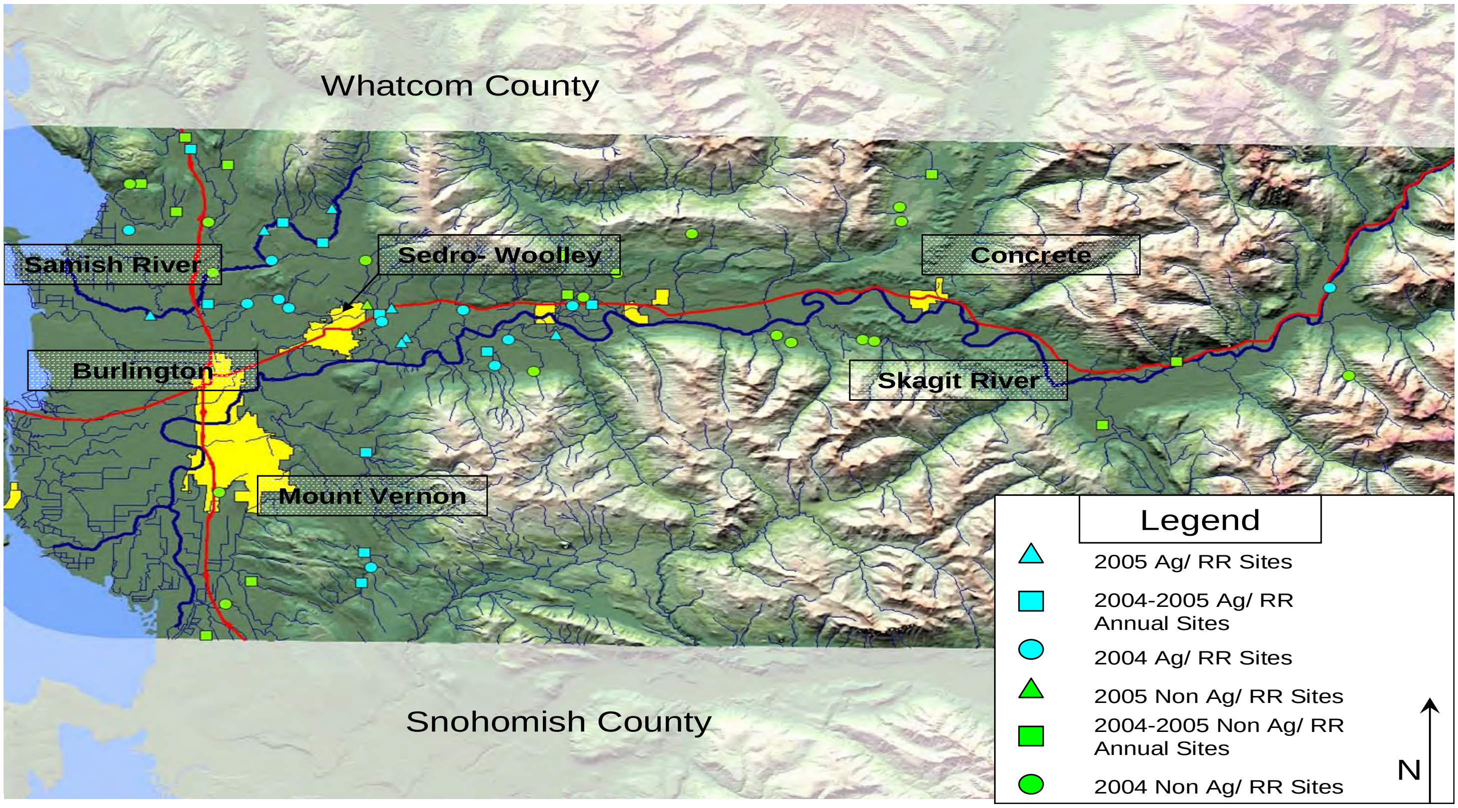
**Deciduous**
A = Alder
W = Willow
C = Cottonwood

**Invasives**
C = Canary Grass
B = Blackberry
J = Japanese Knotweed

# APPENDIX E

## MAP OF SAMPLE SITES

### Salmon Habitat Monitoring Program: 2004/ 2005 Survey Sites



# APPENDIX F

## List of Sample Sites Ag/RR-NRL Zoning

| Site Number | Stratum | Panel | Zoning | Active Ag | Sample Date | Quad Coordinates | Latitude | Longitude | Stream Name | WRIA ID | Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Ag | Annual | A | No | 8/19/2004 | T35 R05 S17 | 48.52084 | -122.1974 | Hansen Creek | 3.0267 | Skagit |
| 6 | Ag | Annual | A | Yes | 8/3/2004 | T35 R04 S18 | 48.52601 | -122.33811 | Thomas Creek | 3.0010 | Samish |
| 9 | Ag | Annual | A | No | 9/1/2005 | T35 R04 S36 | 48.569066 | -122.24621 | Samish River | 3.0005 | Samish |
| 15 | Ag | Year 1 | A | Yes | 8/12/2005 | T35 R03 S14 | 48.518187 | -122.36611 | Samish River | 3.0005 | Samish |
| 17 | Ag | Year 1 | RR | No | 6/30/2004 | T35 R11 S06 | 48.54579 | -121.42115 | Taylor Channel | N/A | Skagit |
| 18 | Ag | Year 1 | A | Yes | 8/4/2004 | T35 R04 S10 | 48.53014 | -122.28037 | Thomas Creek | 3.0010 | Samish |
| 21 | Ag | Year 1 | A | Yes | 8/26/2004 | T35 R05 S14 | 48.52468 | -122.12909 | Wiseman Creek | 3.0280 | Skagit |
| 28 | Ag | Year 1 | RR | Yes | 9/1/2004 | T36 R03 S27 | 48.57571 | -122.40418 | Colony Creek | 1.0648 | Samish |
| 111 | Ag | Over sample | RR | No | 8/10/2004 | T33 R05 S17 | 48.34854 | -122.20037 | Lake Creek | 3.0258 | Skagit |
| 119 | Ag | Over sample | A | Yes | 8/18/2004 | T35 R04 S16 | 48.5271 | -122.30573 | Thomas Creek | 3.0010 | Samish |
| 124 | Ag | Over sample | A | No | 8/6/2004 | T35 R06 S16 | 48.52853 | -122.03953 | Mannser Creek | 3.0339 | Skagit |
| 125 | Ag | Over sample | A | Yes | 8/23/2004 | T35 R15 S17 | 48.51604 | -122.19596 | Hansen Creek | 3.0267 | Skagit |
| 127 | Ag | Over sample | A | No | 8/24/2005 | T36 R04 S28 | 48.577096 | -122.29537 | Samish River | 3.0005 | Samish |
| 128 | Ag | Over sample | A | Yes | 6/21/2005 | T36 R05 S21 | 48.505224 | -122.17662 | Un-named Trib to Black's Slough | N/A | Skagit |
| 131 | Ag | Over sample | A | No | 9/13/2005 | T36 R05 S21 | 48.501822 | -122.18032 | Skiyou Slough | 3.0278 | Skagit |
| 133 | Ag | Over sample | A | No | 9/27/2004 | T35 R06 S15 | 48.5295 | -122.02406 | Red Cabin Creek | 3.0343 | Skagit |
| 135 | Ag | Over sample | A | Yes | 6/8/2005 | T36 R05 S17 | 48.52551 | -122.18917 | Tributary to Red Creek | 3.0268 | Skagit |
| 139 | Ag | Over sample | RR | No | 9/10/2004 | T33 R05 S19 | 48.33812 | -122.20718 | Lake Creek | 3.0258 | Skagit |
| 141 | Ag | Over sample | A | No | 8/1/2005 | T36 R06 S20 | 48.508633 | -122.05401 | Day Creek | 3.0299 | Skagit |
| 142 | Ag | Over Sample | A | Yes | 7/20/2005 | T35 R05 S07 | 48.358406 | -122.20704 | Lake Creek | 3.0258 | Skagit |
| 144 | Ag | Over sample | RR/ SF | No | 9/22/2004 | T35 R05 S36 | 48.48719 | -122.10281 | Sorenson Creek | 3.0291 | Skagit |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 149 | Ag | Over sample | A | No | 8/7/2005 | T35 R05 S25 | 48.496598 | -122.10976 | Sorenson Creek | 3.0291 | Skagit |
| 150 | Ag | Over sample | A | No | 9/13/2004 | T35 R04 S03 | 48.55672 | -122.28675 | Trib to the Samish | 3.0053 | Samish |
| 153 | Ag | Over sample | A | No | 9/28/2004 | T35 R16 S19 | 48.50518 | -122.09191 | Morgan Creek | 3.0293 | Skagit |
| 159 | Ag | Over sample | A | Yes | 6/16/2005 | T36 R04 S24 | 48.592575 | -122.239 | Vernon Creek | 3.0062 | Skagit |
| 164 | Ag | Over sample | A | Yes | 7/15/2005 | T36 R04 S06 | 48.631418 | -122.35617 | Friday Creek | 3.0017 | Samish |
| 165 | Ag | Over sample | A/ RRc | No | 8/11/2005 | T36 R04 S27 | 48.582167 | -122.27977 | Samish River | 3.0050 | Samish |
| 169 | Ag | Over sample | RRc | No | 9/28/2005 | T33 R05 S19 | 48.426665 | -122.20745 | Mundt Creek | 3.0235 | Skagit |
| 231 | Ag | Over sample | A | Yes | 9/7/2004 | T35 R04 S15 | 48.52465 | -122.27208 | Wollard Creek | 1.0648 | Samish |

**Appendix F:** List of sites under Agriculture or Rural Resource zoning that were surveyed during the 2004-2005 sampling period.

# APPENDIX G

## List of Sample Sites under Non-Ag Zoning

| Site Number | Stratum | Panel | Zoning | Active Ag | Sample Date | Quad Coordinates | Latitude | Longitude | Stream Name | WRIA ID | Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 221 | Non-Ag | Annual | RRv | No | 9/15/2005 | T36 R04 S8 | 48.62098 | -122.325 | Trib to Butler | 3.0019 | Samish |
| 222 | Non-Ag | Annual | RRV | No | 9/2/2004 | T35 R10 S29 | 48.49475 | -121.546 | Sutter Creek | 4.1345 | Skagit |
| 223 | Non-Ag | Annual | SF | No | 6/24/2004 | T34 R09 S11 | 48.45074 | -121.606 | Un-named trib to the Sauk | 4.0683 | Sauk/ Skagit |
| 225 | Non-Ag | Annual | RRV | No | 7/12/2004 | T33 R04 S32 | 48.3007 | -122.333 | Kennel Creek | 3.2952 | Skagit |
| 226 | Non-Ag | Annual | RRV | No | 8/5/2004 | T36 R03 S01 | 48.63915 | -122.36 | Friday Creek | 3.0017 | Samish |
| 228 | Non-Ag | Annual | SF/ RRV | No | 8/8/2005 | T36 R06 S09 | 48.536085 | -122.045 | Jones Creek | 3.0332 | Skagit |
| 230 | Non-Ag | Annual | IF | No | 6/17/2004 | T36 R03 S14 | 48.60721 | -122.395 | Whitehall Creek | N/A | Independent |
| 232 | Non-Ag | Year 1 | IF | No | 7/20/2004 | T35 R11 S29 | 48.48593 | -121.405 | Jordan Creek | 4.1412 | Cascade/ Skagit |
| 233 | Non-Ag | Year 1 | RRV | No | 6/28/2004 | T35 R04 S06 | 48.54783 | -122.335 | Samish River | 3.0005 | Samish |
| 235 | Non-Ag | Year 1 | IF | No | 6/21/2004 | T36 R03 S15 | 48.60734 | -122.405 | Whitehall Creek | N/A | Independent |
| 236 | Non-Ag | Year 1 | IF | No | 6/23/2004 | T36 R 08 S28 | 48.57491 | -121.775 | Grandy Creek | 4.0377 | Skagit |
| 238 | Non-Ag | Year 1 | IF | No | 8/12/2004 | T36 R07 S30 | 48.57852 | -121.944 | Trib to Alder Creek | 3.0362 | Skagit |
| 242 | Non-Ag | Year 1 | IF | No | 6/22/2004 | T35 R08 S20 | 48.50805 | -121.802 | Lower Finney Creek | 4.0392 | Skagit |
| 245 | Non-Ag | Year 1 | RRV | No | 8/9/2004 | T35 R05 S06 | 48.55758 | -122.21 | Hansen Creek | 3.0267 | Skagit |
| 246 | Non-Ag | Year 1 | SF | No | 7/13/2004 | T35 R07 S23 | 48.51019 | -121.873 | No Name (Savage Creek) | 4.0384 | Skagit |
| 247 | Non-Ag | Year 1 | SF | No | 9/3/2004 | T35 R06 S09 | 48.53466 | -122.032 | Mannser Creek | 3.0339 | Skagit |
| 335 | Non-Ag | Over Sample | IF | No | 8/11/2004 | T35 R08 S20 | 48.50684 | -121.793 | Finney Creek | 4.0392 | Skagit |
| 336 | Non-Ag | Over Sample | IF | No | 10/26/2004 | T34 R10 S8 | 48.44339 | -121.545 | Hilt Creek | 4.0678 | Sauk/ Skagit |
| 337 | Non-Ag | Over Sample | RRV | No | 7/23/2004 | T36 R04 S30 | 48.58206 | -122.34 | Friday Creek | 3.0017 | Samish |
| 339 | Non-Ag | Over Sample | UGA | Yes | 7/22/2004 | T34 R04 S32 | 48.39839 | -122.326 | Maddox Creek | 3.297 | Skagit |
| 340 | Non-Ag | Over Sample | IF | No | 7/29/2004 | T35 R07 S23 | 48.50564 | -121.861 | Trib to Savage Creek | 4.0384 | Skagit |
| 341 | Non-Ag | Over Sample | IF | No | 8/27/2004 | T35 R 06 S02 | 48.55132 | -122.004 | Trib to Red Cabin Creek | 3.0347 | Skagit |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 342 | Non-Ag | Over Sample | IF | No | 9/8/2004 | T35 R06 S31 | 48.48373 | -122.071 | Trib to Morgan Creek | 3.293 | Skagit |
| 343 | Non-Ag | Over Sample | IF | No | 8/17/2004 | T36 R08 S21 | 48.59864 | -121.774 | No Name | 4.0475 | Independent |
| 345 | Non-Ag | Over Sample | RRV | No | 8/24/2004 | T33 R04 S29 | 48.3221 | -122.318 | Fisher Creek | 3.0181 | Skagit |
| 347 | Non-Ag | Over Sample | RI | No | 9/19/2005 | T33 R04 S21 | 48.337417 | -122.298 | Bulson Creek | 3.198 | Skagit |
| 354 | Non-Ag | Over Sample | IF | No | 9/21/2004 | T36 R06 S32 | 48.563 | -122.049 | Jones Creek | 3.0332 | Skagit |
| 355 | Non-Ag | Over Sample | RRV | No | 8/31/2005 | T36 R03 S24 | 48.588341 | -122.367 | Colony Creek | 1.0648 | Independent |
| 359 | Non-Ag | Over Sample | IF | No | 9/5/2005 | T36 R07 S10 | 48.620314 | -122.749 | Bear Creek | 3.0470 | Baker/ Skagit |
| 365 | Non-Ag | Over Sample | UGA/ URP-OS | No | 6/15/2005 | T35 R05 S18 | 48.528398 | -122.209 | Northern State (Brickyard Creek Trib) | 3.0266 | Skagit |

**Appendix G:** List of sites under other zonings (Non-Ag or RR) that were surveyed during the 2004-2005 sampling period.