A Field Manual of Scientific Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program

2008 Working Version 1.0

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Section 1: Introduction

Columbia River Basin anadromous salmonids have exhibited precipitous declines over the past 30 years, with several populations now protected under the Endangered Species Act (ESA) (Schaller et al. 1999; McClure et al. 2002). A comprehensive monitoring strategy needs to be implemented to reduce the uncertainties surrounding the declines and the actions required to reverse this trend. Data collected from current and historical monitoring programs are generally not adequate or reliable enough for the purposes of ESA assessments and recovery planning (Tear et al. 1995; Campbell et al. 2002; Morris et al. 2002). In addition, monitoring programs for anadromous salmonids in the Columbia River Basin have typically been initiated to evaluate the effects of specific management actions, such as the demographic effects of hatcheries. As such, data are most appropriately viewed at the scale of the subpopulations and populations for which they were derived. However, the ESA requires assessments of species and their habitat at multiple spatial scales – from specific reaches, to subpopulations, populations, and the ESA management unit of Pacific salmon, the Evolutionary Significant Unit (ESU), which is a distinct population or group of populations that is an important component of the evolutionary legacy of the species.

Current monitoring programs for Pacific salmon did not develop as a cohesive design, thus aggregating existing data from a myriad of independent projects creates challenges in addressing these spatially complex questions. These problems arise because information is often not collected in a randomized fashion (Larsen et al. 2004); sampling techniques and protocols are not standardized across programs; and abundance, distribution, population dynamic, and demographic data for species and their habitat is often not available (Tear et al. 1995; Campbell et al. 2002; McClure et al. 2002). As recovery planning has focused more effort on tributary habitat restoration to mitigate for the mortality resulting from the Federal Columbia River Power System (FCRPS) the limitations of historic and ongoing sampling programs have become increasingly apparent.

The Integrated Status and Effectiveness Monitoring Program (ISEMP – Bonneville Power Administration (BPA) project #2003-0017) was created as a cost effective means of developing protocols and new technologies, novel indicators, sample designs, analytical, data management and communication tools and skills, and restoration experiments. These tools are designed to support the development of a region-wide Research, Monitoring and Evaluation (RME) program to assess the status of anadromous salmonid populations, their tributary habitat, and restoration and management actions.

The ISEMP has been initiated in three subbasins: Wenatchee/Entiat, WA, John Day, OR, and Salmon River, ID, with the intent of designing monitoring programs that can efficiently collect information to address multiple management objectives over a broad range of scales. This includes:

• Evaluating the status of anadromous salmonids and their habitat;

• Identifying opportunities to restore habitat function and fish performance, and

• Evaluating the benefits of the actions to the fish populations across the Columbia River Basin.

The multi-scale nature of this goal requires the standardization of protocols and sampling designs that are statistically valid and powerful, properties that are currently inconsistent across the multiple monitoring programs in the region. The Upper Columbia Monitoring Strategy (UCMS, Hillman 2006) is the guiding document under which the ISEMP develops its monitoring and implementation strategies and protocols. The UCMS outlines a monitoring strategy specific to the Upper Columbia Basin based on monitoring approaches adopted by the Independent Scientific Advisory Board of the Northwest Planning council (ISAB), Action Agencies/NOAA Fisheries, and the Salmon Recovery Funding Board (SRFB). This approach includes monitoring current conditions (status monitoring), monitoring changes over time at the same sites (trend monitoring), and monitoring the effects of restoration actions on fish populations and habitat conditions (effectiveness monitoring).

Although the UCMS identifies the project area as the Wenatchee, Entiat, Methow, and the Okanogan River subbasins, this and other ISEMP protocols have been implemented as pilot projects in the Wenatchee and Entiat River subbasins. Monitoring in the Okanogan River subbasin is conducted by the Colville Tribe under the Okanogan Basin Monitoring and Effectiveness Plan (OBMEP) using protocols similar to, but differing in some areas, ISEMP protocols. A comprehensive and coordinated monitoring plan in the Methow River is under development.

One of the first steps in implementing a scientific study of ecological phenomena is to determine the location and frequency of sampling observations. Processes for selecting appropriate sampling sites must meet the needs of rigorous study designs. The site selection process is functionally separate from collecting data at those sites. This protocol addresses the selection of sites to be sampled using specific ISEMP protocols. Other ISEMP protocols have been developed that more specifically address the frequency and methodologies used to make valid sampling observations. This site selection protocol is a component of the overall ISEMP, and while it stands alone as an important contribution to the management of anadromous salmonids and their habitat, it also plays a key role within ISEMP as it is built on a standardized format following Oakley et al. (2003) that all of the ISEMP protocols adhere to.

Many of the criteria listed in Oakley (2003) are contained in the UCMS (Hillman 2006), which can be viewed as a narrative for this and other ISEMP protocols. Questions of monitoring objectives, target populations, attribute selection, sample size, and sample design are all covered by the UCMS (Hillman 2006). However, the UCMS outlines an approach to sampling design that is not always feasible. The adopted sample design approach may differ slightly from the UCMS to reflect “on the ground” conditions and limitations. These differences are described in the “Concept” section within each site selection section. Although this is the first version of this protocol, site selection for habitat, snorkel, and steelhead redd surveys have been carried out in the Wenatchee and Entiat river subbasins since at least 2004 following the same basic procedures documented in this protocol. Past decisions affecting the site selection process within the ISEMP program are documented in the ISEMP Decision Tracking Tool (https://sso.nwfsc.noaa.gov). In the absence of previous versions of this protocol, the tracking tool documents the revision history of the site selection process, and in the future protocols will

be versioned annually. All ISEMP protocols are updated annually and do not change during the field season.

This document was created as a guide for field practitioners, project sponsors and managers, data managers, and analyst working within BPA's ISEMP during the 2008 field season. This version of the Site Selection Protocol guides the site selection process for conducting habitat and snorkel surveys at randomly selected status and trend sites (Section 2.1) and effectiveness sites (Section 2.2); and steelhead redd surveys at randomly selected sites (Section 3.1). Future versions of this protocol will include site selection documentation and procedures for other ISEMP surveys.

Section 2: Site Selection for Habitat, Fish Abundance, and Macroinvertebrate Surveys

Under the ISEMP, habitat, fish abundance, and macroinvertebrate surveys are conducted at the same sites. The process for selecting these survey sites differs between sites used primarily for status/trend monitoring and those used for effectiveness monitoring. Sites used primarily for status/trend are chosen according to the Environmental Protection Agency's generalized random tessellation stratified (GRTS) sample design (Stevens and Olsen 2003; Stevens and Olsen 2004). The GRTS site selection algorithm achieves spatial balance between a simple random sample and a systematic sample within a sampling frame that stratifies the target population by gradient categories and whether the reach is anadromous or resident fish-bearing. The sampling frame excludes non fish-bearing streams and streams with gradients greater than 12%. To determine the status of habitat, fish abundance, and macroinvertebrate metrics, five rotating panels of 25 sites each are selected from the GRTS site list with one panel sampled each year for five years (Urquhart and Kincaid 1999). To determine the trends of habitat, fish abundance, and macroinvertebrate metrics, a single annual panel of 25 sites is selected from the GRTS site list and is sampled each year. After completion of the 5 year pilot program in 2008, power analysis will determine if enough sites are sampled in the annual and rotating panel design to detect trends in various metrics.

Effectiveness monitoring sites are intended to detect change following specific (site-based) restoration actions and are chosen according to criteria that increase the ability to detect changes attributed to restoration actions. This is achieved by using the Before-After-Control-Impact (BACI) study design (Stewart-Oaten et al. 1986, 1992; Smith et al. 1993). Causal inferences from restoration actions are strongest when made from monitoring randomized study sites under the BACI design. However, the statistical power of the BACI design to infer causal relationships is limited by pseudoreplication (where treatments affect control sites and control sites affect treatment sites), the difficulty of selecting appropriate control sites, and the loss of control sites to unanticipated treatments. These issues are partially addressed by stratifying the sites by broad channel type classifications schemes recommended by Rosgen (1996) or Montgomery and Buffington (1993). This increases the number of sites suitable for comparison so that if a control was treated within a channel type there would still remain suitable control(s) for the treatment(s). Effectiveness monitoring using the BACI design is further enhanced by simultaneous sampling of randomized status and trend monitoring sites at the watershed level,

allowing the comparison of site specific trends to watershed-wide trends, thereby increasing the ability to infer causal relationships at effectiveness sites.

2.1 Status and Trend Site Selection

References:

Current versions of the <WENMASTERSample*.xls>, and the <EntiatSiteSelection*.xls> files located on the Oracle Collaboration Website at https://sso.nwfsc.noaa.gov.

Equipment:

GIS map software capable of mapping at the 1:100,000 layer level.

Concept:

The target population for habitat, fish abundance and macroinvertebrates is the Wenatchee stream network with gradient less than 12%. The USGS 1:100,000 National Hydrography Dataset represented the frame for this network. From this target population the GRTS selected 150 sites and 150 oversample sites. Oversample sites are used to replace sites that were rejected during the site selection process. The GRTS algorithm selected sites that were then allocated to strata based on stream order and fish usage (resident or anadromous). Some changes to the allocation of sampling effort were made for the 2005 sampling season since aspects of the GRTS sampling site list developed for the 2004 season (titled WC 503432) were believed to have too few sites within the primary focus area of anadromous habitat (where restoration projects could be anticipated), and too many sites located too far from roads to provide safe working conditions. A new GRTS sampling site list titled WENMASTER was developed for use in 2005 and beyond with a target population that addressed these concerns. The design included an annual panel and five panels on a five year cycle (rotating panel design, see Urquhart and Kincaid 1999).

This sample design for habitat, fish abundance, and macroinvertebrate surveys was developed to describe current status and to detect trends for a suite of indicators within the target population. While status is best monitored by using as many sites as possible representing the broadest geographical distribution, trends are monitored by repeated sampling of the same sites over time. The trend panel consists of 25 sites that are surveyed annually. The status panel consists of a different rotating panel of 25 sites sampled every year, and revisited every five years (Table 1). Five such rotating panels of 25 sites each is selected from the GRTS site list. This means that GRTS will select a total of 150 sites (6 panels x 25 sites per panel = 150 sites). The annual panel and that year's rotating panel are sampled annually. In the event that some sites may be rejected using the criteria for site rejection described in this protocol, select additional sites from the GRTS oversample list.

Monitoring under the ISEMP program in the Entiat subbasin began in 2005 and is focused primarily on effectiveness monitoring of restoration actions. In the Entiat, 25 GRTS selected sites are sampled every year for five years (panel 1 of Table 1). Sampling GRTS

generated sites in the Entiat subbasin allows trends seen at effectiveness monitoring sites (Section 2.2) to be compared to the greater target population in the watershed.

Table 1. Annual panel and rotating panel design for status/trend monitoring within a given status/trend monitoring zone (e.g., Wenatchee subbasin).

	Year																			
Panel	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	■					■					■					■				
3		■					■					■					■			
4			■					■					■					■		
5				■					■					■					■	
6					■					■					■					■

* Shading indicates the years in which sites within each panel are sampled. For example, sites in panel 1 are visited every year, while sites in panel 2 are visited only in years 1, 6, 11, and 16, assuming a 20-year sampling frame.

Procedure:

Step 1: Annual panel sites that were selected in 2004 for the Wenatchee subbasin and 2005 for the Entiat subbasin were permanently monumented, and will be resampled annually. See the annual panel site lists in the Excel files <WENMASTERSample*.xls> and <EntiatSiteSelection*.xls> for the Wenatchee and Entiat subbasins, respectively located on the Oracle Collaboration Suite website at https://sso.nwfsc.noaa.gov. When reviewing the <WENMASTERSample*.xls> file, note that WC503432 is the 2004 GTRS site list, and WENMASTER is the 2005-2008 site list. Three of the annual panel sites were rejected for resampling in 2005 and replaced with sites from the WENMASTER GRTS site list.

Step 2: For the Wenatchee subbasin status panel, select the next 25 rotating panel sites from the GRTS sampling site list in the current version of <WENMASTERSample*.xls> (found on the Oracle Collaboration Suite at https://sso.nwfsc.noaa.gov). Choose sites across stratums according to Table 2. Some sites may be rejected for the reasons stated below. Replace these sites with the next site for consideration within that stratum according to the steps below.

Table 2. Allocation of sites across stream order and anadromous or resident stream stratums.

Stream Order	Number of sites per panel	
	Anadromous Streams	Resident Streams
1st	2	4
2nd	4	2
3rd	5	1
4th	5	NA
5th	2	NA

Step 3: Use a 1:100,000 layer mapping software to determine if the site is non-target. Reasons to consider a site non-target (NT) are listed below and are based on functional disconnections between the map layer and real life conditions. Record NT (non-target) under the Eval_Status column for sites outside the target population. Explain the reason the site was outside the target population under the "Eval_Status_Comment" column.

1. Site lands in a lake, pond, or reservoir.

2. Site lands in a ditch or a major side channel as seen at the 1:100,000 layer maps. This can only apply if there is an error in the map layer. If it is discovered during a visit to the site, then monument the x-site, or center point, at the nearest point in the main channel and sample.

3. Site lands in a place with no defined channel and would never have flowing surface water during the low flow period.

Do not drop sites if the following apply:

1. Apparent differences in Strahler stream order as seen at the 1:100,000 layer. Record the differences in stream order but still sample the site.

2. Apparent fish use stratum errors (e.g. a site is considered a resident population but actually falls below an anadromous barrier). Record the difference but still sample the site. Document the presence of perceived anadromous barriers when sampling.

3. In 2005 sites from the WENMASTER GRTS site list were rejected from sampling if they were within 200 meters to sites from the WC503432 GRTS site list. However, since 2006 it was decided to no longer allow the proximity to a WC503432 site to be a cause for site rejection.

Step 4: Once a site is determined to be within the target population, reconnoiter the site using maps and prior knowledge, or, in limited cases, by on-the-ground site visits. Determine if the site can be accessed safely and that landowner permission is obtained if on private property. A target site may be rejected for the following reasons listed below. If the site is rejected, record the site as 'target, not sampled' (TN) under the Eval_status column of the appropriate site list. Record any comments associated with the "Eval_Status" determination under the "Eval_Status_Comments".

1. Reject the site if it cannot be safely sampled.

2. Sites that are too remote (i.e. greater than 10 miles from a trailhead and greater than 0.5 miles from a trail) will be considered "physically inaccessible" and will be rejected from sampling.

3. Rejects sites were landowner permission could not be obtained.

Step 5: Record the reason a target site was not sampled under the "Eval_Reason" column. Add comments about the reason a target site was rejected or skipped under the "Eval_Reason_Comment" column. Any other reasons for rejecting a site must be approved by the ISEMP coordinator. Be sure to fill out the columns "full name of editor(s)" and "date(s) this was edited". Rename the file with the current date when changes are made and redistribute to the snorkel/habitat coordinator and the ISEMP coordinator.

Table 3. Description of codons used to track the acceptance or rejection of a target site.

Codon	Name	Meaning
Eval_Status		
TS	Target Sampled	Site is a member of the target population and was sampled
TN	Target, not sampled	Site is a member of the target population but was not sampled
NT	Non-Target	Site is not a member of the target population
NN	Not Needed	Site is not needed
Eval_Reason		
PI	Physically Inaccessible	Site is greater than 10 miles from a trailhead and greater than 0.5 miles from a trail.
NS	Not Safe	Site is not considered safe to sample
LD	Landowner Denial	Access to site was denied by landowner(s)
SS	State Surveys	Site is located within an index reach surveyed by the state.
SK	Site Skipped	Site is not sampled with no pre-approved reason for rejecting.

Step 6: If a site is rejected from sampling due to landowner denial, the next site within the same stratum and the same ownership classification (private or public) should be selected for sampling. A few sites have ownership listed as "both" and these should be treated as "private" and be replaced with the next private site on the list. A few others say "Public Lake" and will likely be rejected due to being a non-target site and should be replaced with the very next site on the list regardless of ownership. Do not select sites out of sequence.

Step 7: Once at a site, follow layout procedures in the ISEMP habitat survey protocol (Moberg 2008). This protocol describes how to adjust the reach boundaries upstream or downstream of the x-site, but still including the x-site, to avoid sampling lakes, reservoirs, ponds, private property where no access permission has been obtained, unsafe areas, and to avoid

changes in stream order within the site. Stream order changes if two streams of the same order merge. Shift the site to avoid sampling above anadromous stream barriers or waterfalls if site was intended to survey anadromous reaches.

Step 8: Select sites for resample. Sample 5 sites of the Wenatchee basin sites with two separate crews. Sample one site from each anadromous stream order stratum. No crew members should sample a site twice during the resample.

2.2 Effectiveness Monitoring Site Selection in the Entiat Subbasin

References:

Entiat River Inventory & Analysis Channel Typing Map (CCCD 1998); List of potential sites prepared by the Entiat Habitat Subcomittee.

Equipment:

50 m tape, stadia rod, flagging, and color copy of Entiat Channel Typing Map

Concept:

Effectiveness monitoring under the ISEMP program in the Upper Columbia has been limited to monitoring restoration actions on the Entiat River and its associated side channels and off channel habitat. Sampling sites for effectiveness monitoring are selected according to a stratified random sampling design (Hillman 2006) that classifies streams or stream segments to be treated with some action(s) according to a level I channel classification or channel type (Rosgen 1996). Alternatively, the Montgomery and Buffington (1993) river classification system may be helpful in determining if channels are similar and therefore appropriate for the BACI study design. Rosgen-based channel types were established for the first 21 river miles using remote sensing tools and ground verification as reported in the Entiat River Inventory and Analysis (CCCD 1998), and are shown in Figure 1.

Control sites are sites with the same channel type that will not receive treatments and are selected in the same manner. Furthermore, in order to take advantage of what can be learned from recent implemented restoration actions, we have identified and selected for sampling some sites that have had restoration actions completed, and termed them pre-existing treatments. The assumption is that as sites are treated certain metric values should move from representing the control sites to representing the preexisting treatment sites over time.

The UCMS calls for monitoring restoration actions randomly; however, in the Entiat subbasin there have been too few restoration actions to date and there will be too few anticipated restoration actions in the future to select samples randomly. The number and location of sites selected depends on the available funding, effect size, variability, power, significance levels, and the number of anticipated restoration actions. Since monitoring is based upon restoration actions, site selection is ultimately based upon how many, and where, restoration actions will be implemented. The BACI study design requires pre-project data to be collected and practitioners anticipate the locations of future restoration actions to obtain at a minimum of one year of pre-

project data. This requires frequent communication with the entities managing restoration actions and is not always possible[1]. The site selection process is further limited by available funding for monitoring and implementing restoration actions in the Entiat River.

Effectiveness monitoring sites are selected by the Entiat Watershed Planning Unit Habitat technical subcommittee before the annual field season begins using this protocol. Six new sites are to be selected by the committee for the 2008 field season. Given the limited number of new restoration actions funded and underway, site selection is driven primarily by knowledge of restoration needs that should also guide future project site selection. Once future restoration actions have been identified, suitable control sites are also identified for monitoring. It is recognized that selecting only six new sites for monitoring in 2008 using all the criteria for site selection identified by Hillman (2006) may not be possible; therefore, it is best to view the entire panel of sites (newly selected sites plus old sites) being surveyed for 2008 when considering the balance of the site selection process (Table 4).

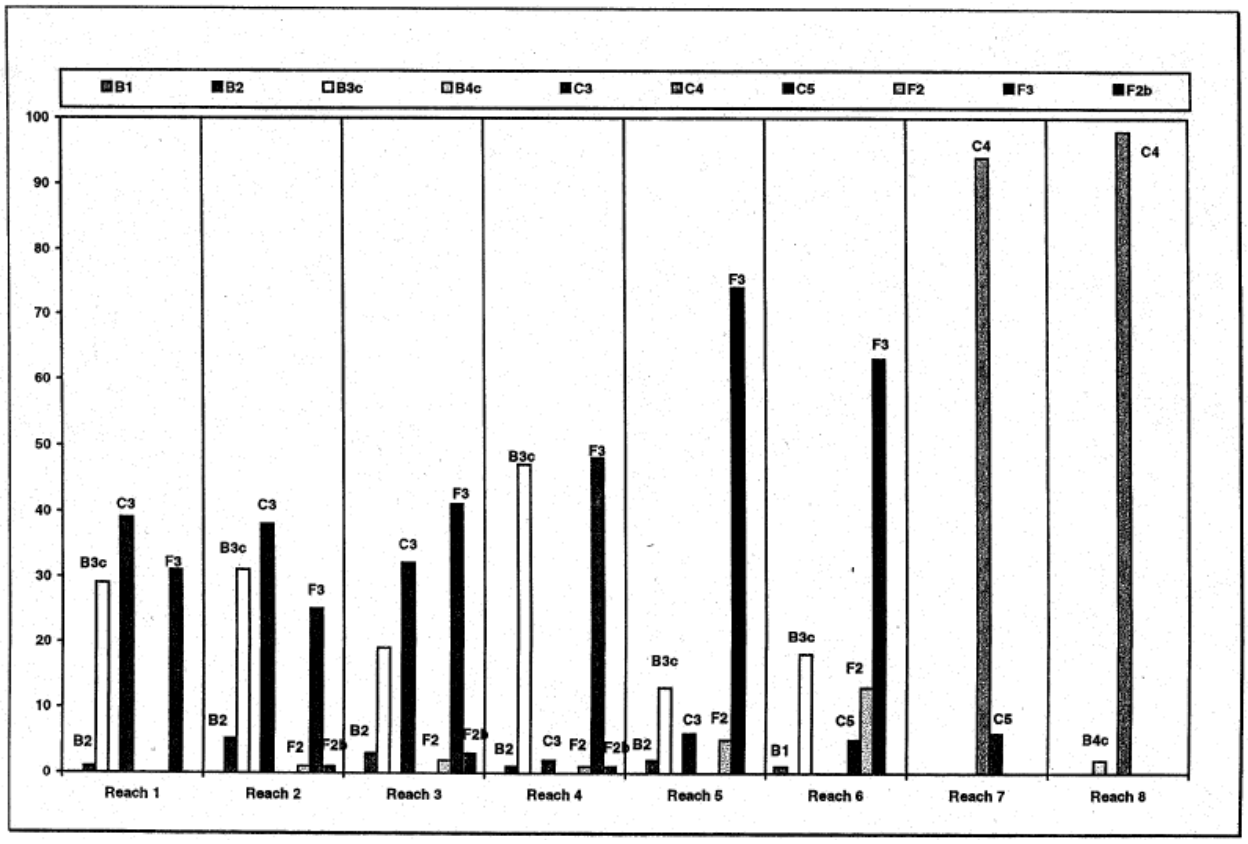

Figure 1. Frequency of occurrence of Rosgen (1996) geomorphic stream type by reach in the Entiat River. Note the absence of any A, D, E, and G type streams. Taken from the Entiat River Inventory and Analysis (CCCD 1998).

[1] Efforts to explore the feasibility of a more comprehensive approach to restoration project implementation and monitoring are being conducted by ISEMP (*cite* Monahan, J.T. and W.S. Wright. 2007. Feasibility Scoping for the Integrated Status and Effectiveness Monitoring Program: Entiat IMW. GeoEngineers, Bellingham, WA. 48 pp.)

Treatment sites are selected and located to capture as much of the restoration actions within the site as is possible. If the site cannot capture the entire restoration action, then locate the site at the downstream end of the action to best detect restoration-effected changes. If the restoration action is at a single point, such as a pool-forming cross-vane, locate the restoration action in the center of the monitoring site. When choosing effectiveness monitoring sites, do not locate the reach across two Rosgen channel types or Montgomery and Buffington channel types. Changes in channel type types are evident by changes in width:depth ratio, entrenchement, sinuosity, and significant changes in channel slope.

Table 4. Monitoring sites organized by channel type and treatment/control type.

Channel Type		**Treatment**	**Control**	**Pre-existing Treatment**
Rosgen	**Montgomery/ Buffington**			
C	Pool riffle	Sego Yurt CDLT Stormy	City Limits Main. CDLT Moriane Lower Stormy	Deskin-Wortz Jon Small
B	Plane-bed	Harrison Main Whitehall Main Stanton-Love	Knapp-Wham Main Keystone Wilson Main (may be a C channel)	
F	Plane-bed	Above Hatchery Milne		Dinkleman
Side channels	NA	Moen Lower Harrison Wilson Side Harrison Pond PUD Canal Hanna Detweiler	City Limits Side Knapp Wham Ditch	

Procedure:

Step 1: Identify potential site specific restoration activities in the Entiat River or use knowledge of restoration needs to predict where restoration activities are likely to occur. Include the type of restoration activity that is expected and the timeline that implementation is expected to follow.

Step 2: Identify existing monitoring sites, including if the site is a treatment or control, and what type of restoration is associated with the sites.

Step 3: Of the potential restoration sites identified in step 1, identify sites that best meet the following criteria:

1. The restoration activity is likely to be implemented.

2. There is opportunity to collect pre-project data.

3. Monitoring sites are representative of the overall restoration actions being taken in the Entiat River.

4. Monitoring sites are representative of different channel types identified for restoration actions.

5. Treatment and control sites are balanced within types of restoration actions and channel type.

Step 4: Visit the identified sites to determine if they are appropriate for monitoring. Plan to visit more sites than are needed in anticipation that some sites may not be appropriate for monitoring. When evaluating sites consider the following:

1. Is the reach the expected channel type?

2. If a control site, is the site complimentary in channel dimensions, slope, and aspect to the treatment sites?

3. If a treatment site, can the exact location of the treatment action be determined and, if not, can it be sufficiently predicted to fall within a study site with reasonable certainty?

Step 5: Establish the middle of the reach (the X-site) and monument and survey the site according to the ISEMP habitat protocol (Moberg 2008).

Section 3: Site Selection for Steelhead Redd Surveys

Steelhead redd (*O. mykiss*) surveys in the Wenatchee subbasin are designed to determine the status and trends in steelhead redd abundance and distribution. Sampling randomly selected sites allows the status of steelhead redd abundance and distribution to be determined for the entire subbasin. Trend monitoring is accomplished through the continuation of annually sampled index reaches. In the Entiat subbasin, status and trends in steelhead redd distribution and abundance is detected by a combination of sampling index reaches in the Mad River and Roaring Creek, and a total count of steelhead redds in the mainstem Entiat River.

Prior to the inception of the ISEMP program, the Washington Department of Fish and Wildlife (WDFW) and United States Forest Service (USFS) has conducted steelhead redd surveys at index reaches in the Wenatchee and Entiat subbasins, respectively. Since 2004 these surveys have been funded in part by the ISEMP program and the index reaches have not changed since then. Contracted under the ISEMP program in 2004, the United States Fish and Wildlife Service (USFWS) began conducting a total count of steelhead redds in the Entiat River. The USFWS determined that a total count was as cost effective as counting redds in index reaches and better enabled detection of changes in redd distributions and abundance in the Entiat River (Nelle, R.D., U.S. Fish and Wildlife Service, pers. Comm..).

3.1 GRTS-based random steelhead redd survey site selection (Wenatchee Basin)

References:

<WenatcheeSteelheadSiteList*.xls>

Equipment:

GIS map software capable of mapping at the 1:100,000 layer level, 50m tape, flagging, and GPS.

Concept:

Steelhead redd sampling site selection procedures have undergone changes since ISEMP was initiated in 2004. The process was originally founded on the site selection design for habitat/fish abundance/macroinvertebrate sample sites. The 2004 sites were selected from the same GRTS sampling site list used in the Habitat/Fish Abundance/Macroinvertebrate sampling in 2004, but excluded non-anadromous sites. However, the two designs evolved apart prior to the implementation of steelhead redd surveys in 2005. The design overlap was largely confined to decisions made before January 11, 2005 (see Decision Tracking Tool, ISEMP 2008). After that date, decisions made regarding site selection were made specifically in the context of either habitat/snorkel or steelhead redds unless otherwise noted.

Sample sites are selected from a target population of points along the stream network shown by the USGS 1:100,000 National Hydrography Dataset. The target population includes all anadromous streams with gradients less than 12%. Anadromous reaches were determined by information about which areas are accessible to adult steelhead for spawning that was contemporary as of February 18th, 2005. From this target population the GRTS selects 150 sites and 150 oversample sites. Oversample sites are used to replace sites that were rejected during the site selection process. The GRTS site list is stratified by gradient classes as shown in Table 5, where gradients 0-2% was divided by stream order giving 90% of the 0-2% gradient class to 1st through 4th order streams. The proportion of gradient classes in will be represented only if no sites were rejected and replaced. Rejecting and replacing sites from the oversample will skew what percentage of gradient classes is represented by the sample.

This sample design for steelhead redd surveys was developed to describe current status within the target population. The status panel consists of a rotating panel of 25 sites sampled every year, and revisited every five years (Table 1). Five such rotating panels of 25 sites each is selected from the GRTS site list over five years. A single panel of 25 sites sampled annually to detect trends (annual panel) in spawning was not selected from the GRTS in lieu of intensive sampling at already established index reaches in the Wenatchee subbasin by the WDFW.

Table 5. Stratification of the GRTS site list by gradient classes for steelhead redd surveys.

Gradient Category	1st through 4th Order 0 - 2%	5th Order 0 – 2%	2 – 4%	4 – 8%	8 – 12%
Sample Size %	0.9* 45%	0.1*45%	25%	20%	10%

Procedures:

Step 1: Select 25 sites from the GRTS sampling site list used contained in <WenatcheeSteelheadSiteList*.xls> located on the Oracle Collaboration Suite at https://sso.nwfsc.noaa.gov.

Step 2: Use 1:100,000 layer mapping software to determine if the site is target or non-target. Reasons to consider a site target or non-target are listed below and are based on functional disconnections between the map layer and real life conditions. Use the codons from Table 3 that applies to the site and record under the Eval_Status column in appropriate site list file.

1. The x-site is within a lake, pond, or reservoir.

2. The x-site lands in an irrigation ditch or a major side channel as seen at the 1:100,000 layer maps. This can only apply if there is an error in the map layer. If it is discovered during a visit to the site, then monument the x-site, or center point, at the nearest point in the main channel and proceed to sample the site.

3. The x-site lands in a place with no defined channel and would never have surface water flow during the low flow period.

Sites may not be dropped for the following reasons:

1. The stream is dry or has low flow.

2. Apparent fish use stratum errors (e.g., a site is considered an anadromous population but appears to be above a perceived anadromous barrier). In this case, record the presence of perceived anadromous barriers, and proceed to sample the site.

Step 3: Once a site is determined to be a target site, reconnoiter the site using maps and prior knowledge, or, in limited cases, by on-the-ground site visits. Determine if the site can be accessed safely and that landowner permission is obtained if on private property. A target site may be rejected for the following reasons listed below. Record the site as 'target, not sampled' (TN) under the Eval_status column of the appropriate site.

1. If it cannot be safely sampled.

2. Sites that are too remote (i.e. greater than 10 miles from a trailhead and greater than 0.5 miles from a trail) will be considered "physically inaccessible."

3. Landowner permission could not be obtained.

Step 4: Record reasons for rejecting a site under the columns “Eval_Reason” using the codons in Table 3. Add comments about the reason the site was rejected or skipped under the “Eval_Reason_comments” column. Any other reasons for rejecting a site must be approved by the ISEMP coordinator. Be sure to fill out the columns “full name of editor(s)” and “date(s) this was edited”. Rename the file with the current date at the end of the file name (yyyymmdd) when changes are made and upload to the Oracle Collaboration Suite website at https://sso.nwfsc.noaa.gov and notify the ISEMP coordinator and relevant contractors.

Step 5: If a site is rejected from sampling due to landowner denial, the next site with the same ownership classification (private or public) should be selected for sampling. A few sites have ownership listed as "both" and these should be treated as "private" and be replaced with the next private site on the list. A few others say "Public Lake" and will likely be rejected due to being non-target and should be replaced with the very next site on the list regardless of ownership. Do not select sites out of sequence.

Step 6: Use a GPS to determine the x-site and the site boundaries. Site boundaries are ½ mile upstream and downstream of the x-site. Monument and record the GPS point of the downstream and upstream boundaries of the site as well as the x-site. Record monument information and GPS points according to the Steelhead Redd Protocol (Nelle 2008).

Step 7: Adjust the reach boundaries upstream or downstream of the x-site, while still including the x-site within the sampling reach, to avoid sampling lakes, reservoirs, ponds, private property where no access permission has been obtained, unsafe sampling conditions, and anadromous barriers upstream of the x-site. DO NOT shift the reach boundaries to avoid perceived anadromous barriers below the x-site (see example). If for any of these reasons a 1 mile reach cannot be fitted, then truncate the site to match the available space. If truncating the site results in a site less than ¾ mile in length, then reject the site as a NonTarget (NT) site. If a ¾ mile site cannot be established when avoiding non-permitted private property, then reject the site due to Landowner Denial (LD). Record how the site was shifted or truncated, and the conditions that required shifting or truncating the reach.

Example: In the case of a site falling just downstream of an anadromous barrier that is identified on the hydrography/barrier layer used in sample-site design, the site would be adjusted to begin at the falls and extend the appropriate distance downstream.

Step 8: If a site is unsafe to sample at the beginning of the sampling period, but would be safe later in the sampling period, then the site should be rejected from sampling based upon the Not Safe (NS) rule. Likewise, if a site is physically inaccessible at the beginning of the sampling period but would be accessible later, then reject the site as Physically Inaccessible (PI).

Step 9: If a sampling reach lands entirely within an already established index reach, then note that data for this site will be collected by the WDFW index reach survey crews, monument and record the GPS location of the reach boundaries, and add an additional site to be surveyed. If a sampling reach falls partially within a WDFW index reach, then sample the site even if there is some duplicated effort.

Step 10: If two randomized sites overlap then both sites should be sampled provided the sample events are spaced out in time to avoid redd disturbance, or the sampling events occur concurrently but data is able to be assigned to each of the x-sites. For example, if redds are encountered within the overlap zone, then those redds are counted for each site. However, do not record GPS twice and record the extent of the overlap in site notes.

Step 11: If habitat conditions at a site, as observed during the first sampling visit, are such that there is 100% certainty that no steelhead will spawn at this site during this season, then repeat sampling visits can be skipped provided that the specific habitat conditions (e.g. gradient, width, depth, substrate type, and habitat type) that rule out steelhead spawning are noted in field data. However, the site would still be included in the sample design and the data for the site would reflect zero spawning. Great caution should be used when skipping repeat sampling due to a perception that there is inadequate spawning habitat at a site because part of the intention of these surveys is to document unanticipated locations where steelhead may spawn. The decision to skip repeat sampling should best be done by several experienced professionals (including the crew leader) and, if there is any doubt that steelhead spawning cannot be ruled out at a particular site, then repeat sampling should still be performed.

Section 4: References

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APPENDIX A: ATTRIBUTE TABLE

Attribute Name	Attribute Description
GRTS panel name	Sampling sites generated by EPA GRTS
Site Stratum	Stratum site belongs to
Site name	Unique name of site
Site ownership	Ownership of site (public or private)
Site AKA	Name of site used by associated agencies
Site Latitude	Latitude in decimal degrees
Site Longitude	Longitude in decimal degrees
Stream Name	Stream name as defined in National Hydrography Dataset or in USGS Geographic Names Information System
Barrier location Latitude	Latitude in decimal degrees
Barreir location longitude	Longitude in decimal degrees
Site above or below barrier	
Gradient Category (GRADCAT)	Gradient category of site from GRST
Fish population group	Fish population of site from GRST
Strahler stream order (new)	
Strahler stream order (old)	
Selected sample	Site selected to sample
Site sampled	Site has been sampled
Site panel	Panel site belongs to
Recon decision	Explanation of recon decision
Rejection notes	Notes as to why a site was rejected
Site Selection File	Name of file used to select sites
Date site selection file edited	

EvalStatus	Evaluation status of site from table in site selection protocol
EvalReason	Explanation of EvalStatus
Editor	Name of editor
EditDate	Date edited
Site Panel	Panel site belongs to
Site Oversample	Site selected from GRTS oversample
Recon Notes	Notes from site recon
Site Landowner Permission	Permission to access site is granted
Site truncated	Site was shortened to avoid rejecting site
Site Resample	Site was selected for resample
Site type	Site is control, treatment, or preexisting treatment
Site channel type	Channel type according to Entiat Inventory and Analysis
Site original sample year	Year site was first sampled