A Field Manual of Scientific Protocols for Habitat Surveys within the Upper Columbia Monitoring Strategy

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Section 1: Introduction

Background and Objectives

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 (Hillman 2006) outlines a monitoring strategy specific to the Upper Columbia Basin that was 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 (Hillman 2006) 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 in the Methow River is under development.

The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. However, because another purpose for this document is to prepare for the development of a final field manual when ISEMP is ready to propose standardized monitoring program elements, this manual also serves as a draft template for future ISEMP field manuals. This habitat 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.

This document was created as an internal guide for field practitioners working within Bonneville Power Administration's Integrated Status and Effectiveness Monitoring Program (ISEMP) in 2006. This draft document has been updated and revised for the 2008 field season. The ISEMP program has taken an experimental approach to the development of scientific monitoring protocols. Hence, this document is best viewed as a working draft that is subject to change as the ISEMP program adds, subtracts, or modifies portions of these methods. Changes to methods are adopted at the beginning of the field season and adhered to until the next year's manual is completed. However, because another purpose for this document is to prepare for the development of a final field manual when ISEMP is ready to propose standardized monitoring program elements, this manual also serves as a draft template for future ISEMP field manuals.

This field manual also incorporates into these procedures knowledge gained from practical field experience and experimentation carried out since the inception of the Upper Columbia Basin Monitoring Strategy (UCBMS). These changes are tracked on the Protocol Revision Log in Appendix D. In 2005, the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) compared methods from different habitat protocols used throughout the region against each other and "truth", which was established through intensive surveys. Data metrics of each protocol were evaluated for comparability between protocols using the signal-to-noise ratio between crews using the same protocol at the same stream, the signal-to-noise ratio of different protocols measuring the same attribute at the same stream, and the ability for the measurements made under each protocol to ascertain the 'truth'. Although changes to this protocol will be likely as a result of this study they cannot be incorporated until specific recommendations from the PNAMP study are made final. Any changes will be tracked in Appendix D.

This manual is designed for quick reference in the field, and is arranged in the order that crews would be generally expected to follow. Detailed descriptions of how to measure indicators have been included to reduce observer variation. It is appropriate to use this manual when performing status/trend monitoring or effectiveness monitoring in the Upper Columbia Basin, although study design requirements for specific effectiveness monitoring projects may require that aspects of these protocols be modified.

Section 2: Sampling Design and Site Selection

This protocol is designed to standardize habitat data collection procedures in the Upper Columbia Basin. The UCMS (Hillman 2006) serves as the primary reference for sampling designs at the basin and subbasin scale, such as the selection of habitat quality parameters to be monitored and site selection. In addition, it may be appropriate to modify these sampling designs in order to address specific questions within any particular subbasin of the Upper Columbia Basin. The habitat methods recommended by the UCMS (Hillman 2006) are intended to measure biological and physical/environmental indicators and have been performed by field practitioners in the Upper Columbia Basin since 2003. This field manual is based primarily upon procedures and modifications of procedures from the EPA (Peck et al. 2001), and the Aquatic and Riparian Effectiveness Monitoring Plan program (AREMP 2005).

Under the ISEMP, habitat, fish abundance, and macroinvertebrate surveys are conducted at the same sites. Habitat status and trend monitoring is intended to characterize stream conditions and trends at the watershed level using randomly selected sites. 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). Habitat surveys are also conducted as a part of effectiveness monitoring, where a Before-After-Impact-Control (BACI) sample design characterizes changes in stream conditions in response to localized restoration activities. Integrating status and trend monitoring with effectiveness monitoring allows comparison of trends at the watershed scale to trends seen at the reach scale, and helps establish the degree to which causal inferences can be made to explain trends resulting from local restoration actions. Details of the site selection process for both status and trend and effectiveness monitoring can be found in the "A Field Manual of Scientific

Protocols for Selecting Sampling Sites used in the Integrated Status and Effectiveness Monitoring Program" (Moberg and Ward 2008).

Section 3: Stream Site Lay Out

References:

Protocol is modified from Peck et al. (2001) and AREMP (2001, 2005).

Equipment:

Applicable maps, metric tape measure, stadia rod, handheld GPS device, digital camera, 3 2-foot long pieces of rebar or orange plastic survey stakes, hammer, engineer flagging, waterproof datasheets and notebook, mechanical pencils and waterproof markers.

Concept:

The biological and physical/environmental indicators identified by the UCBMS (Hillman 2006) require sampling a certain proportion of stream to obtain a representative picture of the ecological conditions in the whole stream network. Probalistically-based random sampling is used to ensure that the results from sampled sites can be generalized to the entire stream network. To ensure that sites are selected without bias, a generalized random tessellation stratified (GRTS) design is used for status/trend monitoring, whereas other designs may be used for effectiveness monitoring depending on specific study needs. The GRTS process generates a sample of "X-sites" located on the stream network. Habitat surveys, conducted over a specified stream reach, are meant to characterize conditions at these X-sites.

Status and trend monitoring is designed to describe current conditions and detect changes to the habitat that occur over time. This is complicated by the fact that changes in stream conditions may result in bankfull widths that are different than when they were first surveyed, or bankfull widths may be the same, but the site lengths may change as a result of a reconnected oxbow or straightening of the channel. Consequently, changes detected in the metrics collected may be the result of a different site length rather than an actual change for that metric. This poses a significant challenge of how to collect data that is comparable to past surveys while at the same time capturing changes to the reach that may have resulted in a different channel length or bankfull widths. Practitioners and strategy designers met in November 2006 and decided trend sites (i.e. annual panel sites) will be laid out according to the site length established at the initial survey and will not change because of changes in bankfull width or changes in channel configuration.

Personnel requirements and training

Each monitoring agency is responsible for training the personnel who will be carrying out the habitat surveys, including water safety courses.

Procedure:

Step 1: Use topographical maps and the GPS unit to find the approximate location of the site from the road, from where crewmembers can access the stream. Use the GPS to navigate to the assigned lat/long. If returning to an "annual panel" site, proceed to step 2. If the site is a "rotating panel" site or "annual panel" site surveyed for the first time use the GPS to find the closest point along the stream that corresponds to the GPS reading. This is the "X-site". Find a suitable area along the X-site above bankfull to place a rebar monument. Record this location on the map. Record the Data Collection Event (DCE) on the Stream Verification Form. The DCE includes the study design number followed by a dash, the site ID followed by a dash, the date followed by a dash, and lastly the time the survey was started using 24 hour time (see example below). Next, take a GPS position; label the GPS point using the DCE. If the GPS unit does not allow entry of the DCE, use an abbreviated code that can be replaced with the DCE at a later time. Include detailed notes of the code on the cover and map datasheet. Proceed with lay out on step 3.

> EXAMPLE: If the study design is WC503432, the site ID is 040619, the date is August 31, 2006, and the start time is 1:30 pm; then the DCE would read WC503432-040619-20060831-1330.

Step 2: When returning to an "annual panel" site locate the X-site and determine what transect the X-site is, usually the F-transect. Locate the A and K transects monuments. Using the site length from the previous survey, determine the distance between transects. Starting at A or K begin laying out the site, marking primary and secondary transects with flagging. If the transects do not align with the permanently monumented transects, make small adjustments to each transect until all transects are equally spaced between transects A and K. If the monuments are missing or cannot be found, relocate the monuments based upon the presence of the found bearing trees or other monuments and the distance between transects, remonument the location following the directions in Step 6. After laying out the "annual panel" site, skip to step 7.

Step 3: When returning to a "rotating panel" site or surveying an "annual panel" site for the first time, establish the bankfull stage. In order to determine bankfull stage, crews should look at several indicators, including stain lines, changes in substrate, slope breaks, tops of point bars, permanent vegetation, and debris lines. Additional details on bankfull identification are included in

Table 1 (Harrelson et al. 1994). Several indicators should be examined to properly determine bankfull height. Indicators should be more distinguishable at non-constrained reaches where, for example, tops of point bars, changes in substrate, and permanent vegetation may be the most reliable indicators. In constrained reaches, especially those with boulders and bedrock substrate, indicators may be difficult, if not impossible, to identify. Under these circumstances, the crew may have to depend on stain lines, or go up or downstream to find reliable indicators and follow these lines back to the transect. Recent large flood events that have exceeded bankfull height may make it difficult to find the correct indicators. If someone on the crew has experience at determining the bankfull level, he/she should consistently determine bankfull height. Find the average bankfull width by measuring the bankfull width at the X-site, and then proceed upstream the distance of the first bankfull width and measure the bankfull width again. Continue upstream the distance of the bankfull width measured at X-site and measure the bankfull width a third time. Take 2 more bankfull measurements downstream from the X-site in the same manner for a total of 5 bankfull measurements. Average the 5 bankfull measurements. Multiply the average bankfull width by 20 to obtain the reach length. Minimum and maximum reach length is 150 m and 500 m, respectively (any average bankfull less than 7.5 m will have a site length of 150 m, and any average bankfull greater than 25 m will have a site length of 500 m). Divide the reach length by 10 to determine the distance between primary transects. Divide the reach length by 20 to determine the distance between primary transects and intermediate transects.

> EXAMPLE: If average bankfull width is 12.6 m, the calculated reach length would be 12.6 * 20 = 252 m. The distance between primary transects would be 25.2 m, and the distance between primary and intermediate transects would be 12.6m.

Step 4: Determine if the site needs to be adjusted to avoid confluences with higher or lower order streams, lakes, reservoirs, waterfalls, or ponds. Do not adjust the reach to avoid man-made obstacles such as bridges, culverts, rip-rap, or channelization. Sample sites can be moved upstream or downstream, however, the X-site should not be moved and must be included within the site and at a primary transect.

Step 5: Starting at the X-site, measure downstream along the thalweg a distance of 1 average channel width using a tape measure or stadia rod (if the distance measured is not greater than the rod used to measure it) and mark this point with flagging. If the X-site and the F transect are the same then the next downstream transect is called E-1 (intermediate transect are A-1, B-1, C-1, etc.). Continue measuring 1 channel width downstream and label the next transect E (primary transect are A, B, C, etc.). Continue this until you have measured 10 channel widths from the X-site and are at the beginning of the reach, or transect A (

Figure 1). Return to the X-site and repeat the procedure moving upstream, and ending at transect K. Even if the site was moved and the X-site is not located at transect F, center the reach so that transect F is in the middle. If the site is shifted upstream or downstream and transect F will not be located at the X-site, determine which transect will be positioned at the X-site and label the flagging accordingly, also clearly note on the Verification Form and the map. Monument the X-site separately if it does not correspond with transect A or K.

> Note: Measuring distances along the thalweg can vary between observers in part because these measurements are dependent on the length of the straight-line segments used to measure the sinuous thalweg. A crew that "bends" their tape more frequently to capture zigzags in the thalweg will end up with a site that has a shorter total length than a crew that "cuts corners" by skipping some zigzags. Because we cannot standardize the definitions of zigzags, or the absolute units at which "bending the tape" or "cutting corners" is acceptable, we hope to standardize thalweg measurements in the following manner:
>
> For measuring distances along the thalweg, the increment of measurement (i.e. the straight-line distance between points on a taut tape, or the length at which a stadia rod is

extended) will be standardized as 1/20th of the site length. This measurement increment will be maintained between transects regardless of whether this measurement increment ignores "obvious" zigzags or whether the site is very straight and a larger increment might seem appropriate. A rod should be used only if it is as long as the distances being measured, otherwise, use a tape pulled taut. If rods are used, they should be extended to the increment of measurement. Tapes should be held taut. In general, this increment of measurement will equal the site-averaged bankfull width but can vary depending on maximum and minimum site length criteria discussed in Step 3 of the Site Lay Out procedure.

Because the purpose of this exercise is to measure the thalweg distance, it stands that each end of this straight-line increment will be positioned in the thalweg when the measurement occurs. However, in practice, at larger stream sites it may be easier for the observers to stay closer to the margin of the stream. In such cases, it will be acceptable for the measurement to be made closer to the margin of the stream provided that the standardized increment of measurement is used and that the measuring tape or rod is oriented parallel to the imaginary straight line connecting the two points on the thalweg.

For example, if the average bankfull width is 8.5 m and a tape is used, one surveyor would hold the end of the tape in the thalweg at the X-site and the other surveyor would flag the next transect at the point where the tape stretches tight and intersects the thalweg at 8.5 m. Subsequent transects would be flagged at the same 8.5 m increment. Because most rods do not extend to 8.5 m, a rod would not be used in this case.

Small sites with a bankfull width of less than 7.5 m where the minimum reach length is applied are particularly difficult to lay out since the distance between transects is much greater than the bankfull width. When laying these sites out it is appropriate to make a "break" in the measurement between transects to avoid the rod crossing out of the bankfull channel and cutting the site short. Make as few breaks in the measurement as needed to keep the rod or tautly pulled tape within the active channel when measuring from transect thalweg to transect thalweg. Make breaks at the thalweg only. Be careful to maintain the same total length between transects regardless if breaks are made or not.

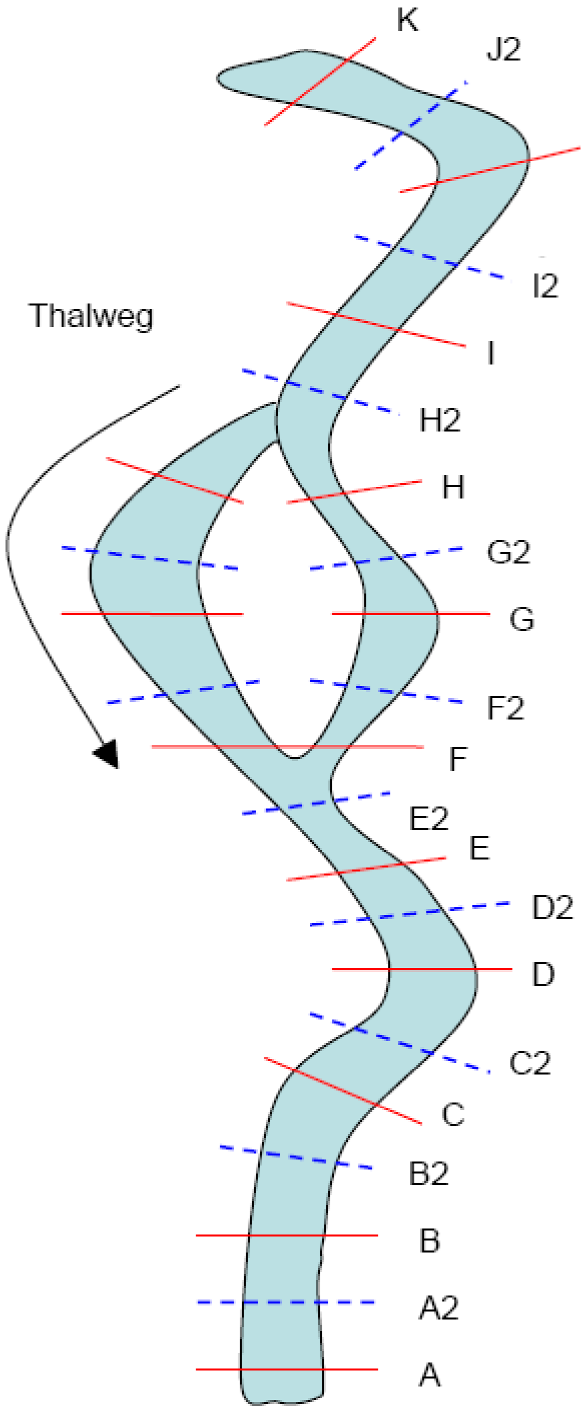
Step 6: While establishing transects A and K and the X-site record the latitude/longitude using the GPS. Also record this on the Stream Verification Form. For status, or "rotating panel", sites permanently monument only the X-site with 2-3 foot sections of rebar driven into the bank above the high water mark. For annual panel sites permanently monument the channel at transects A and K and the X-site with capped rebar. Do not place monuments on private property without permission to do so. This is an important step, as future crews will need to find this monument. If it is not possible to place a rebar as a monument, then lightly chisel "X-site, transect A or transect K" into a large, stable boulder or bedrock above the active channel, or drive a labeled spike into a tree that is in line with the transect (monument tree). When monumenting, establish a bearing tree on one bank, record its size and species, and securely nail a metal plate to the tree with the site ID, creek name, date, collectors, and transect recorded on it. Take a bearing (with the declination set at zero) and measure the horizontal distance from the tree to the monument. Record these on the back side of the Stream Verification Form as part of the site map. Record this information on the metal tag and nail it to the bearing tree. Take GPS coordinates and photos at transects A and K, and the transect representing the X-site. Photos should be taken from the center of the channel and the sequence should begin with the center upstream shot (CU), and then the center left bank (CL), center downstream (CD), and center right bank (CR) shots. In addition, at the X-site photograph the bearing tree with the monument in the photo if possible. Record the photo number, the name of the camera, transect, and the photo orientation on the Stream Verification Form.

> Note: When photos are downloaded they should be named according to the DCE followed by the transect, and lastly the orientation of the photo.
>
> Example: A photo taken at a Chiwawa River (DCE: WC503432-040619-20060831-1330) site from X-site transect looking from the center up would be named: WC503432-040619-20060831-1330_X_CU.

Step 7: After the entire site has been viewed, determine what Rosgen stream type (Rosgen 1996) and Montgomery-Buffington stream class (Montgomery and Buffington 1993) the majority of the reach falls under. If there is an obvious change within the reach then record the dominant stream type first, and record in the notes the thalweg station where the change occurs.

Step 8: Draw a map of the reach on the Stream Verification Form. Include the X-site, channel shape, presence of side channels, permanent monuments, transects, species and size of the bearing tree, a north arrow, and any major terraces and stream features (large pools, log jams, falls, etc.). A good map will shorten the time it takes to find the permanent monuments during resurveys, and allow future surveyors to ascertain if the channel has changed significantly.

Note: Permanent location of sites on private lands will be agreed upon with landowners. Minor modifications to the marking procedure may be necessitated by landowner requirements. Sites located in Wilderness where rules forbid placement of orange stakes will be monumented using discrete ground-level markers accompanied by aluminum flashing nailed into nearby trees.



Data collected at main transects (solid red line):

- Bankfull and wetted width
- Bankfull height at right and left banks
- Depth, substrate, and embeddedness at 11 points
- Bar width (if present)
- Undercut distances at right and left banks (if present)
- Canopy cover measurements (densiometer)
- Visual riparian estimates for right and left banks
- In-channel fish cover assessment
- Human Influence assessment for right and left banks
- Percent unstable banks at right and left banks
- Permanently monument and record latitude/longitude in the GPS for transects A and K, and the X-site at "annual sites".
- Permanently monument and record latitude/longitude in the GPS for the X-site for "rotating panel sites".

Data collected at mid transects (dash blue line):

- Bankfull and wetted width
- Substrate at 11 points
- Bar width (if present)

Data collected along thalweg profile (100 points):

- Thalweg depth
- Presence/absence of bars
- Presence/absence of side channels (regardless of flow)
- Presence/absence of in-channel habitat
- Instream habitat type
- Pool max and pool crest depth (if present)
- What formed the pool (if present)

Data collected in segments between main transects:
- Large woody debris

Data Collected along whole reach
- Slope and bearing
- Macroinvertebrate samples

Figure 1. Reach lay out and data to be collected (modified from AREMP, 2005).

Table 1. Types of indicators used to determine bankfull stage of a reach (from Harrelson et al.,1994).

Indicator	Description
Top of Pointbars	The point bar consists of channel material deposited on the inside of meander bends. They are a prominent feature of C-type channels but may be absent in other types. Record the top elevation of pointbars as the lowest possible bankfull stage since this is the location where the floodplain is being constructed.
Change in Vegetation	Look for the low limit of perennial vegetation on the bank, or a sharp break in the density or type of vegetation. On surfaces lower than the floodplain, vegetation is either absent or annual. During a series of dry years, perennial plants may invade the formerly active floodplain. Catastrophic flows may likewise alter vegetation patterns. On the floodplain (above bankfull stage) vegetation may be perennial but is generally limited to typical stream side types. Willow, alder, or dogwood often forms lines near bankfull stage. The lower limit of mosses or lichens on rocks or banks, or a break from mosses to other plants, may help identify bankfull stage.
Change in Slope	Changes in slope occur often along the cross-section (e.g., from vertical to sloping, from sloping to vertical, or from vertical or sloping to flat at the floodplain level). The change from a vertical bank to a horizontal surface is the best identifier of the floodplain and bankfull stage, especially in low-gradient meandering streams. Many banks have multiple breaks, so examine banks at several sections of the selected reach for comparison. Slope breaks also mark the extent of stream terraces. Terraces are old floodplains that have been abandoned by a downcutting stream. They will generally have perennial vegetation, definite soil structure, and other features to distinguish them from the active floodplain. Most streams have three distinct terraces at about 2 to 4 feet, 7 to 10 feet, and 20 to 30 feet above the present stream. Avoid confusing the level of the lowers terrace with that of the floodplain; they may be close in elevation.
Change in Bank Materials	Any clear change in particle size may indicate the operation of different processes (e.g., coarse, scoured gravel moving as bed load in the active channel giving way to fine sand or silt deposited by overflow). Look for breaks from coarse, scoured, water-transported particles to a finer matrix that may exhibit some soil structure or movement. Changes in slope may also be associated with a change in particle size. Change need not necessarily be from coarse-to-fine material, but may be from fine-to-coarse.
Bank Undercuts	Look for bank sections where the perennial vegetation forms a dense root mat. Feel up beneath this root mat and estimate the upper extent of the undercut. This is usually slightly below bankfull stage. Bank undercuts are best used as indicators in steep channels lacking floodplains. Where a floodplain exists, the surface of the floodplain is a better indicator of bankfull stage than undercut banks that may also exist.
Stain Lines	Look for frequent inundation water lines on rocks. These may be marked by sediment or lichen. Stain lines are often left by lower, more frequent flows, so bankfull is at or above the highest stain line.

Section 4: Channel Form and Habitat Measurements

Channel cross-section measurements provide insight on the relationships of width and depth, streambed and stream bank shape, and bankfull and flood-prone areas. Several indicators are measured using longitudinal profiles, including gradient, sinuosity, the bankfull width to depth ratio, and pool frequency. These indicators are important attributes of channel condition and measures of the health of aquatic and riparian ecosystems.

I. Slope and Bearing Measurements

References:

Methods taken from Peck et al. (2001); Stack (1989); Robison and Kaufmann (1994); and Kaufmann et al. (1999).

Equipment:

Stadia rod, graduated 1.5 m monopod, Abney hand level, compass, and the Slope and Bearing Form. It is not recommended to use a clinometer or a hand held laser for slope measurements.

Procedure:

Step 1: One crewperson stands at transect K and holds the Abney hand level at a comfortable position against the stadia rod. Note the height at which the hand level is placed on the stadia rod and record it as eye height on the Slope and Bearing Form. Hold the bottom of the stadia rod at the lowest water surface level at the transect, usually at the stream's edge or on a rock placed at the water surface elevation. If it is necessary to place the stadia rod in the water, record the depth on the Slope and Bearing Form under the water depth column.

Note: Do not use the measurement of your eye height while standing; always place the Abney hand level at a recorded height on a stadia rod or other graduated rod..

Step 2*:* The second crewperson positions their stadia rod at the water surface elevation at the next transect or secondary-transect downstream, in this case secondary-transect J-1. It is acceptable to skip secondary transects when measuring slope if the next transect is clearly visible and slope measurements are reliable. Whenever possible, place the stadia rod on a solid substrate at the water surface level; when possible avoid placing it on your boot or holding it at the water surface. If the two crew members are not visible to one another, then the downstream stadia rod should move up to a point where they are visible. When added measurements are needed, be sure to clearly note the extra measurements on the datasheet, and the distance between the points.

Step 3: With the downstream crewperson holding the stadia rod at the water surface level, the upstream crewperson uses the Abney hand level to locate the position on the downstream stadia rod that is level with their eye. It is helpful if the downstream person moves a finger or piece of flagging up the rod to assist the other crewperson in leveling the Abney hand level. Take extra care to make sure the Abney hand level and the stadia rod is in a level position. Record the measurement on the Slope and Bearing Form.

Step 4: Looking downstream from the center of the stream (thalweg) with both shoulders perpendicular to the channel, take a bearing measurement with the compass. Take bearing measurements at all secondary and primary transects. Be sure that the declination of the compass is set to zero, and that there is no electromagnetic interference that may affect the compass dial. The presence of even small pieces of metal near the compass can affect the bearing reading. Check for electromagnetic interference by moving the compass away from you while watching the movement on the dial. It is also possible to have erratic bearing measurements from interferences created by the substrate or old metal in the stream. Record the bearing on the Slope and Bearing Form.

Step 5: The crewperson with the hand level should proceed downstream, to where the other crewperson is holding the stadia rod, in this case transect J-1. Place the hand level rod at the exact position where the stadia rod was, and the crewperson with the stadia rod moves downstream to the next transect, or transect J. Repeat the slope and bearing measurements. Continue this procedure downstream to transect A. Check the data routinely with the transect you are at to confirm that no transect has been skipped or accidentally repeated. Limit the disturbance to the channel as much as possible while moving downstream.

II. Cross-sectional Transects

References:

Methods modified from Kaufmann and Robison (1998), Peck et al. (2001), and AREMP (2005).

Equipment:

Two stadia rods, laser level, 50 m tape, high-tension clips, metric ruler, mechanical pencils, and the Channel/Riparian Cross-section Form.

Procedure:

Cross-sectional data is collected at all primary transects. To maximize efficiency, the surveyor calls out depth, and substrate class size and embeddedness as he/she crosses the channel, while the recorder estimates riparian cover and assesses fish cover and human disturbance. Also, the surveyor should take densiometer readings at the left and right banks and in the center of the channel as he/she moves across the channel collecting data. It may be useful to have the surveyor estimate canopy structure on the bank opposite to the position of the recorder.

Step 1: Begin each cross-sectional survey by determining the bankfull height of the channel on the right or left bank. Measure the bankfull height by placing the stadia rod at the wetted edge. Next, place the laser level or eye level against the stadia rod pointing toward the bankfull level.

Level the laser level or eye level using its bubble indicator. Move the level up and down against the rod to line it up with the major bankfull indicators. With the level aligned with the bankfull indicators and level, record the height of the laser against the stadia rod and move on to Step 2. After the surveyor has reached the opposite bank as part of Step 2, repeat Step 1

> Note: If one bank does not have reliable bankfull indicators leave the bankfull height field for that bank blank and use the other bank as the bankfull height for the transect bankfull height.

Step 2: Beginning at transect A, the surveyor pulls the tape or stadia rod across the channel with the recorder holding the other end and measures the bankfull width and wetted width of the channel. The recorder notes the values and reels in the tape. Also measure the undercut distance of any undercut banks and record it to the nearest 0.01 m. Because of undercuts sometimes the bankfull width will be less than the wetted width. Record the wetted width including mid channel bars; also record the width of mid-channel bars separately in the appropriate box for each transect.

> Note: Mid-channel and point bars are features below the bankfull flow mark, and islands are mid-channel features that are above the bankfull level. Treat a stream separated by an island as a primary channel with a separate side channel. Side channels have between 16% and 49% of the channel flow. Sample the side channel at primary transects only in line with the primary channel transect. Check the box labeled X-tra Side Channel on the Channel/Riparian Cross-section Form and complete the form in the same manner as a regular channel transect. Braided streams have many bars but are considered one channel if none of the bars are above bankfull.

> Note: Measure the wetted width across the entire channel regardless if there is a mid-channel or point bar interrupting the wetted width measurement. Then measure the mid-channel or point bar in the transect and record it. Only measure a point bar distance if the wetted channel at the transect occupies both sides of the point bar. If more than one bar is in the channel make a note in the comments field and indicate any bars in the site map.

Step 3: With the surveyor and recorder still on opposite banks, divide the bankfull channel width into tenths to locate depth and substrate measurement points on the cross-section. In the "DistLB" fields of the Channel/Riparian Cross-section Form, record the distance from the left bank corresponding to 0% (leftbank), 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% (right bank) of the measured bankfull width. Place the stadia rod at the 0% position, measure and record the wetted depth. If a depth point is dry use the laser level and stadia rod to determine the bankfull depth for that location and record under the Bankfull Depth field (leaving the wetted depth field blank). The recorder should pay special attention as to which side of the channel the surveyor is working from and record the data in the appropriate box in the Substrate field of the Channel Cross-section Form.

> Note: Bankfull depth measurements at the left and right banks may be zero if the banks are gradual.

Note: Depth measurements that are out of the wetted channel require special attention. Since there is no water to take a depth measurement it is necessary to measure the bankfull depth at that point by aligning the laser with bankfull indicators against the stadia rod. Be sure to record this measurement under the bankfull depth field. The wetted depth field is left blank. If bankfull indicators are not readily available it may be necessary to measure the elevation difference of the point on the dry channel bed and the water level. To do this place flagging or visible object where depth is to be measured and place the stadia rod at the nearest water level. Point the laser or hand level to the flagging or object and record the difference as a negative value in the wetted depth field. Flag these measurements with a B if bankfull indicators were used to measure the depth at that point, or a W if the difference between that point and the wetted elevation was used. No flag is necessary for depth measurements taken in the wetted channel.

Step 4: Concurrent with the depth measurement, determine the embeddedness of the substrate within a 10 cm circle at the base of the stadia rod. Embeddedness is the fraction of a particle's surface that is surrounded by (embedded in) fine sediments (≤ 2 mm) on the stream bottom. Field crews should visually examine the 10 cm circle and estimate the percentage of particles larger than sand that are buried by fine sediment (≤2 mm). If the circle is occupied entirely by sand and finer substrates, then embeddedness is 100%. If the particle is fine or coarse gravel place or visualize a 10 cm ring around the particle and estimate what percentage of these particle is buried by sand and fines. For cobble first estimate the embeddedness of that particle as it appears in place, then again by carefully picking it up and estimating what percentage of the rock was imbedded by sand and fines. This can be done by 'reading' the stain lines around the particle left by the sand and fines. Use both estimates to best determine the embeddedness of cobble. Do not confuse these stains for stain lines present from algae or water stains. Embeddedness should be estimated for small and large boulders by estimating the percentage of the particle that is embedded by sand and fines without removing them. This requires the measurer to visualize how far the boulders extend below the streambed.

Step 5: As the surveyor removes the rod to estimate embeddedness, they should reach down and, without looking, pick up the first substrate touched under the tip of the stadia rod. Estimate the size of this particle using its intermediate axis (B-axis) (Every substrate has a long A axis, an intermediate B axis, and a short C axis). Using the Substrate Size Class Codes on the Channel/Riparian Cross-section Form, determine which code applies to that particle (Table 2). If a particle is near a size break on the class code chart, and embeddedness has already been estimated, it should be picked up and measured using a tape or stadia rod.

Note: Substrate class and percent embeddedness should be estimated concurrently. Do not remove a particle to estimate size unless embeddedness has already been estimated, or it has been picked up with the intent of determining embeddedness.

Step 6: Repeat Steps 3 through and 5 for the next station located 10%, 20%, 30%, 40%, etc. of the bankfull distance across the channel. While taking cross-section measurements look for the thalweg at the cross-section, and record it under the Bank Measurement box on the Channel/Riparian Cross-section Form.

Note: It is good practice to be in the habit of taking cross-section measurements in the same manner every time. The surveyor and recorder should start on the right bank; the surveyor then crosses the channel to measure bankfull and wetted widths, and takes depths, substrate, embeddedness, and canopy cover measurements as he/she returns to the right bank. The surveyor should also estimate riparian makeup (Section 5) while on the left bank. If the surveyor follows this sequence, the trips across the channel are limited. However, the terrain present may demand that the data be collected in a different order.

Table 2. Substrate type, abbreviations and size class used for pebble counts.

Substrate type	Abbreviation	Size class	Description
Smooth bedrock	RS	>4000 mm	Smooth surface rock bigger than a car
Rough bedrock	RR	>4000 mm	Rough surface rock bigger than a car
Hardpan	HP	>4000 mm	Firm, consolidated fine substrate
Large Boulders	XB	>1000 to 4000 mm	Meter stick to car size
Small Boulders	SB	>250 to 1000 mm	Basketball to meter stick
Cobbles	CB	>64 to 250 mm	Tennis ball to basketball size
Coarse gravel	GC	>16 to 64 mm	Marble to tennis ball size
Fine gravel	GF	>2 to 16 mm	Ladybug to marble size
Sand	SA	>0.06 to 2 mm	Smaller than ladybug size, but visible as particles and gritty between fingers
Silt, clay, muck	FN	< 0.06 mm	Silt, clay, muck and not gritty between fingers
Wood	WD	Regardless of size	Wood and other organic particles
Other	OT	Regardless of size	Concrete, metal, tires, car bodies, etc.

III. Riparian Assessment

References:

Modified protocol from Kaufmann et al. (1999) and Peck et al. (2001)

Equipment:

Convex spherical densiometer, mechanical pencil, and the Channel/Riparian Cross-section Form.

Procedure:

Canopy cover over the stream is determined at each of the 11 primary cross-section transects. A convex spherical densiometer (Model B) is used (Lemmon, 1957). Six measurements are obtained at each cross-section: one on each bank and four from the middle of the channel. Visual estimates of the riparian cover are also made at each transect.

Step 1: While conducting the cross-section transect surveys take densiometer readings at each bank regardless of the wetted edge, and from the middle of the channel looking upstream, to the right bank, to the left bank, and downstream. Use a model B convex spherical densiometer (Lemmon 1957) with only 17 square grid intersections showing (Figure 2).

Hold the densiometer 0.3 m above the surface of the water level with your face reflected just below the apex of the taped “V”. Level the densiometer using the onboard bubble level. In this position, carefully read how many of the grid intersections are shaded, a number between 0 and 17. Record this value in the Canopy Cover Measurements box on the Channel/Riparian Cross-section Form. Repeat this measurement as you cross the channel while taking the cross-section transect measurements.

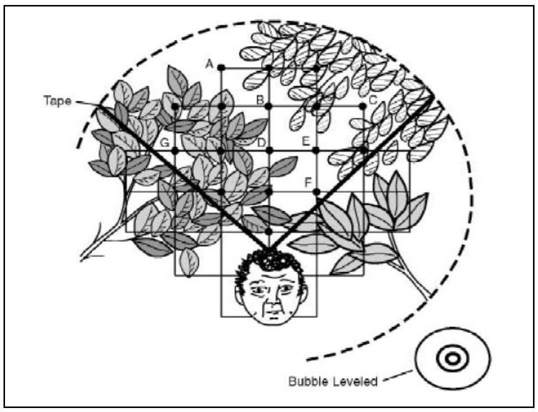


Figure 2. Schematic of modified convex spherical canopy densiometer (from Mulvey et al., 1992) showing 10 of 17 intersections with canopy cover, giving a densiometer reading of 10. Note proper positioning with the bubble leveled and face reflected at the apex of the "V".

Step 2: Visual riparian estimates should be made while taking the cross-section measurements. Facing the bank, estimate a 5 m distance upstream and downstream from the primary transect (10 m total length). Estimate a distance of 10 m back into the riparian vegetation from the bankfull stage. Within this 10 m by 10 m square, visually divide the riparian vegetation into three layers: a canopy layer (>5 m high), an understory (0.5 to 5 m high), and a ground cover layer (<0.5 m high). Within this 10 m by 10 m area, determine the dominant vegetation type for the canopy layer and the understory as either deciduous, coniferous, broadleaf evergreen, mixed, or none. Record the appropriate vegetation type by circling the corresponding letter in the Visual Riparian Estimate field of the Channel/Riparian Cross-section Form.

Note: Consider the layer “mixed” if more than 10% of the aerial coverage is made up of the alternate vegetation type.

Step 3: Examine the canopy cover layer (> 5 m). Determine separately the aerial cover class of 1) large trees (>0.3 m diameter at breast height DBH), and 2) small trees (<0.3 m DBH).

Estimate aerial cover as the amount of shadow that would be cast on the ground below it by a particular layer alone if the sun were directly overhead. Record the cover class by circling the appropriate number on the Visual Riparian Estimate box on the Channel/Riparian Cross-section Form.

Step 4: Examine the understory layer (0.5 m to 5 m high). Determine the aerial cover class separately for 1) woody shrubs and seedlings (including canopy tree stems within the height parameters of this class (<5m to >.5M), and 2) non-woody herbs, forbs, and grasses.

Step 5: Examine the ground cover (ground level to 0.5 m). Determine the aerial cover class separately for 1) woody shrubs and saplings, 2) non-woody herbs/forbs/grasses, or 3) barren, bare dirt, or duff.

Step 6: Repeat Steps 2 through 7 for the opposite bank.

IV. Fish Cover

References:

Peck et al. (2001).

Equipment:

Channel/Riparian Cross-section Form.

Procedure:

Fish cover, algae, and aquatic macrophytes are assessed using a semi-quantitative visual estimate of the channel, extending 5 m upstream and downstream of each primary transect. Features that are visually estimated in this area include filamentous algae, aquatic macrophytes, woody debris (>0.3 m diameter), brush and small woody debris (<0.3 m diameter), overhanging vegetation (< 1 m above the water surface), undercut banks, boulders, and artificial structures. The recorder usually conducts this assessment as the surveyor surveys the cross-section at each transect.

Step 1: Examine the channel 5 m upstream and downstream of the transect. Within that area estimate the percent area of the wetted channel where each attribute provides cover for fish (i.e. where a fish could hide from a predator) as listed and defined in Table 3. Fish cover is not assessed for dry channels.

Step 2: Circle the number in the Fish Cover Table representing the area covered in the wetted channel for each attribute (Table 4).

Table 3. Definitions of elements that provide fish habitat and cover in the wetted channel.

Filamentous algae: Area of the channel effectively covered by long, streaming filaments of microscopic algal cells that often occur in slow moving, nutrient rich water with little riparian shading. Not to be confused with macrophytes and flowering aquatic plants that can look very much like algae when flower are not present.
Marcrophytes: Floating, submerged, or emergent water loving plants, including mosses and wetland grasses that could provide cover for fish or macroinvertebrates.
Large Woody debris (>0.3 m diameter): Larger pieces of wood that can influence cover and stream morphology.
Brush/small woody debris (<0.3 m diameter): Smaller wood that primarily affects cover but not morphology.
Live trees or roots: Area of the channel effectively covered by parts of trees, including roots that are in the active channel and are alive.
Overhanging vegetation: Area of the channel effectively covered by vegetation within 1 m of the surface water.
Undercut banks: Area of the wetted channel effectively covered by undercut banks. A channel is rarely covered more than 10% by undercut banks.
Boulders: Area of the channel covered by boulders between 25 cm and 4 m (b-axis).
Artificial structures: Area of the channel covered by artificial structures including those placed in the channel for fish restoration, structures discarded in stream (tires, old cars, etc.), or those placed in the stream for diversions, impoundments, channel stabilization, or other purposes.

Table 4. Percent of channel area covered by fish cover.

Fish cover descriptor	Fish cover class	Percent of channel covered
Absent	0	0
Sparse	1	<10
Moderate	2	10-40
Heavy	3	40-75
Very Heavy	4	>75

V. Human Influences

References:

Protocol modified from Peck et al. (2001)

Equipment:

No special equipment needed.

Procedure:

Step 1: Evaluate and record the presence and proximity of human influences on the Human Influence Box in the Channel/Riparian Cross-section Form. Human influence observations are confined to 5 m upstream and 5 m downstream of each primary transect (Figure 3). The proximity of human influences is distinguished according to whether the activity is at the bank, close to the bank (within 10 m), or far from the bank (10 to 30 m from the bank). Assess human influence conditions 5 m upstream and 5 m downstream of the transect. There are 11 categories used to determine human influences at the transects:

- Buildings
- Landfull/trash
- Logging operations
- Mining activity (present and historical)
- Park/lawn
- Pasture/range/hay field
- Paved road/railroad/trail
- Pavement/cleared lot
- Pipes (inlet/outlet)
- Row crops
- Unpaved road/railroad/trail
- Wall/dikes/revetments

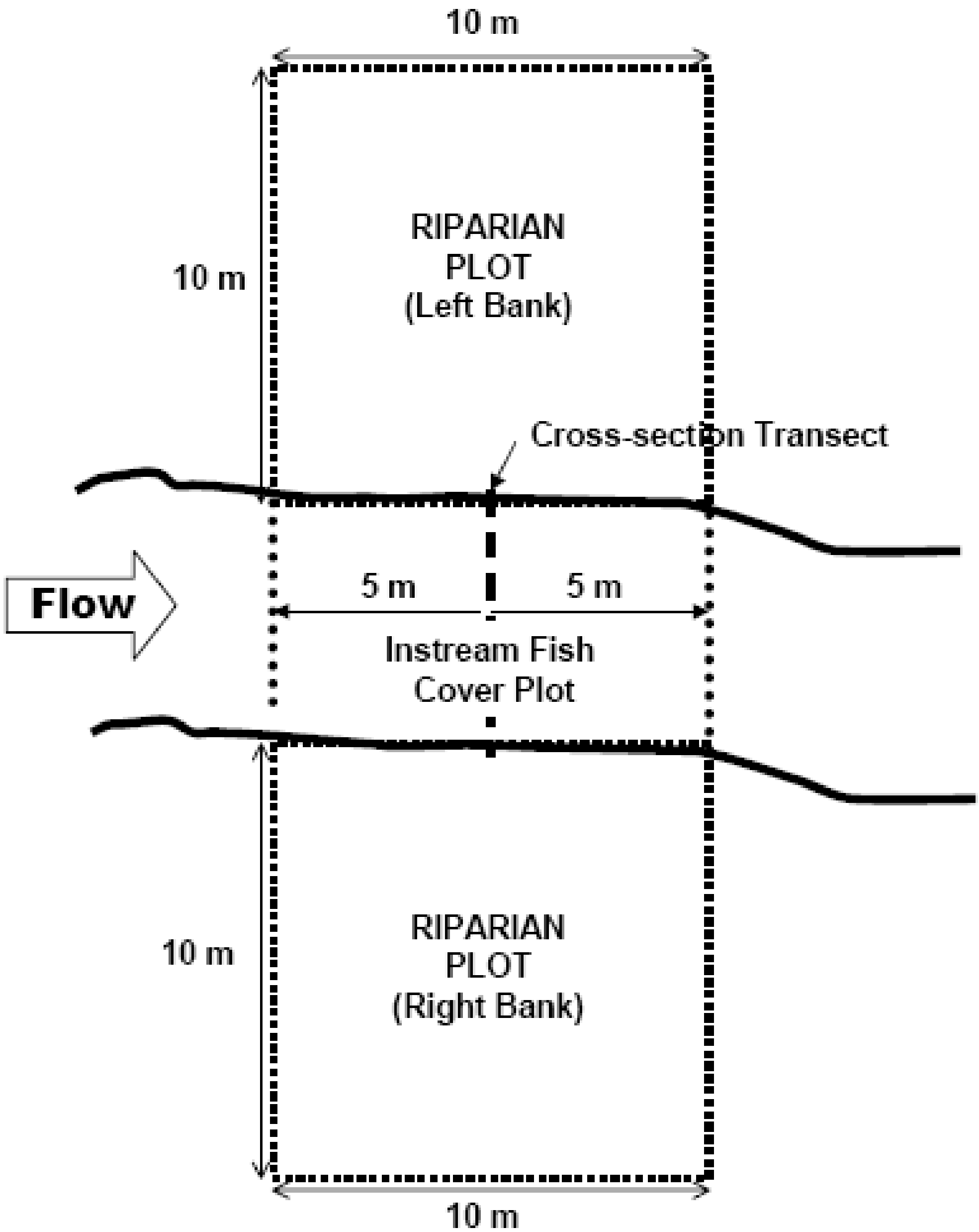


Figure 3. Boundaries for visual estimation of riparian vegetation, instream fish cover, and human influences (plan view). From Peck et al. (2001).

Step 2: Circle or record if the human influence is at the bank (B), within 10 m of the bank (C), or more than 10 m from the bank (Pn) for the right and left banks at each primary transect.

Step 3: Next, estimate the percent of the bank that is unstable 5 m upstream and 5 m downstream of the transect. Active erosion is defined as recently eroding or collapsing banks and may have the following characteristics: exposed soils and inorganic material, evidence of tension cracks, active sloughing, or superficial vegetation that does not contribute to bank stability. Limit your observations of bank stability to the portion of the bank at and below the bankfull level. Record the percentage of the bank that is unstable for the right and left bank in the Human Influences box of the Channel/Riparian Cross-section Form.

Note: Unstable banks have breakdown, slumping, cracking or bare or steep surfaces.

Step 4: Repeat Steps 1 through 3 at each primary transect.

Section 5: Longitudinal (Thalweg) Profile &Woody Debris

I. Longitudinal Profile

References:

Protocol modified from Peck et al. (2001), and AREMP (2001 and 2005).

Equipment:

Stadia rod, 50 m tape, laser level, and Thalweg Profile and Woody Debris Form.

Procedure:

Longitudinal profiles are performed between each transect by following the thalweg of the main channel at 100 equally spaced stations. Habitat type, pool maximum depth and crested depth, presence of side channels, and in-active channel habitats (backwater or side pool) are assessed at each longitudinal point. Beginning in 2007, ISEMP adopted the NWIFC definition of secondary habitat units- units that are less than 50% of the wetted width. Secondary units occur in conjunction with a primary unit (habitat unit greater than 50% of the wetted width). For maximum efficiency the recorder should count the large woody debris (LWD, see below) while the surveyor moves up the longitudinal profile between transects. For streams with an abundance of LWD, it may be more efficient for the surveyor to call out the LWD totals to the recorder. Substrate is measured for size class at the secondary transects as part of the longitudinal profile.

Step 1: Determine the interval distance between thalweg measurements by dividing the total reach length into 100 stations based on the bankfull width used to determine the length of the sampling reach. The recorder should transfer the thalweg depth recorded under the Bank Measurements box on the Channel/Riparian Cross-section Form to the zero station box on the Longitudinal/Thalweg form.

Step 2: The surveyor moves upstream the distance of the thalweg interval calculated in Step 1 and calls out a depth measurement in the thalweg of the channel to the recorder.

Step 3: At the thalweg station examine the stream to the right and left for the presence of side channels. Measure and record to the nearest 0.5 m the length of any side channels present. Record the entire length of the side channel in the Side Channel Length box. Number the side channels and continue to record their presence at each longitudinal point. In the case of multiple side channels be sure to clearly draw and record the length of side channels on the map.

> Note: If a side channel is present and contains between 16% and 49% of the total flow, establish a secondary cross-section transects as necessary. Establish side channel transects in line with the main channel transects but perpendicular to the side channel flow. Use separate field datasheets to record data for the side channel. Flag side channel transects with an "X" (e.g. XA, XB, etc.). If more than one distinct side channel is encountered number the side channels as they are encountered moving upstream. Clearly identify and label all main channel and side channel transects in the map on the Verification Form. Side channel data collection is limited to the Channel/Riparian Cross-section Form with no longitudinal data collected on the side channels. Do not rely on the increment length of the main channel to calculate the side channel lengths. It is better to take measurements and record all side channel lengths.

Step 4: Examine the channel at the thalweg and identify the appropriate habitat units that are present (see Table 5). Habitat units are broken into three types: Turbulent, non-turbulent, and pools. Turbulent habitat tends to have broken, white-capped waves and is noisy. Non-turbulent habitat tends to not have whitecaps and is less noisy. Pools are slow water habitat that forms a depression in the stream. Pools are further identified as scour (S), plunge (P), or dammed (D). Scour pools are generally created by fluvial processes and occur in a predictable manner along the stream where the power of the stream scours the stream bed into a pool. Plunge pools are formed by the water flowing over an object and scouring a depression in the stream as the water falls over that object. Dammed pools are formed when an object (usually wood) backs up the stream and forms a pool. Pools are further identified by the process or objects that created them (see Table 5). Determine the appropriate channel habitat unit code and pool forming element code (if applicable) for the station and circle the appropriate letter representing the habitat unit (Table 5). Determine and record if the habitat unit is a primary or secondary unit. Primary units occupy more than half the wetted width, and secondary units occupy less than half the wetted width and occur in conjunction with a primary unit. It may be possible, although extremely rare, to have two secondary units and a primary unit. Indicate dry stations by flagging the station as "dry" in the comments field. If the habitat unit is a pool, measure and record the pools maximum depth and crested depth. For scour and plunge pools measure the crested depth at the tail of the pool. Dammed pools crested depth should be measured at the head and the tail of the pool. Peck et al. (2001) and the 2006 version of this protocol measured crested depth at the head of dammed pools[1]. Beginning in 2007 both the head and tail crested depths will be measured at dammed pools. Examine the channel at the thalweg for the presence of backwater areas and side pools. Backwater habitats are areas of standing or slow moving water partially isolated from the flow of the main channel (Armantrout 1998). Side pools are deep, concave shaped areas that do not meet the definition of a primary pool and are adjacent to the stream channels and remain

[1] Data collected in the Entiat Basin in 2006 measured dammed pools crested depth at the head and tail of the pool, and the tail crested depths was entered into the ISEMP database with the head crest added in the comment field.

connected to the channel (Nickelson et al. 1992). Record the presence of backwater areas or side pools by sequentially numbering on the In-Channel Habitat box on the Thalweg Profile & Woody Debris form. During the 2005 and 2006 season alcoves and side pools were counted separately. Alcoves have not been adequately defined in the literature; however, Nickelson et al. (1992) describes alcoves and side pools similarly, differing only in where in the active channel they occur. Beginning in 2007, alcoves are considered as side pools regardless of where they occur in the channel.

> Note: If a dammed pool flows over a log measure the tail crested depth at the deepest flow. If there is no overflow (i.e. some beaver dam) then the tail crested depth is 0.

> Note: It has been found that variance between crews using the same protocol to identify and measure habitat units in the same reach can be quite high (Roper and Scarnecchia 1995, Roper et al. 2002). To limit the variance between crews, crewpersons must be well trained, with the most experienced crewmember identifying habitats.

Table 5. Habitat types, definitions, and codes, and pool formation types and codes.

Habitat Type	Habitat Code	Pool Formed by	Pool Formation Code
Plunge Pool	P	Fluvial Processes	F
Scour Pool	S	Boulder or Bedrock	B
Dammed Pool	D	Rootwad	R
Turbulent Fast Water	T	Wood	W
Non-turbulent Fast Water	N	Not a Pool	N
		Beaver	V

Step 5: If a mid-channel bar is present, mark a “Y” for yes under the Bar Width box.

Step 6: Use the stadia rod to measure the next thalweg point and repeat Steps 2 through 5. If the stream is split, follow the channel with the most flow.

> Note: Every 5^{th} measurement should end at the next flagged secondary-transect (A1, B1, C1… etc.). It may be necessary to make minor adjustments to align station 5.

Step 7: When the surveyor has reached station 5, take a wetted width and bankfull width measurement across the channel. If present, measure and record the bar width at station 5.

Step 8: Conduct a substrate pebble count at the secondary transects in the same manner as used at the primary transects; however, do not estimate embeddedness or take depth measurements at the secondary transects. Record secondary-transect substrate on the Thalweg Profile and Woody Debris Form.

Step 9: Continue taking thalweg measurements upstream until station 9 is reached, one longitudinal increment below the next primary transect (A, B, C, etc.). Again, it may be necessary to make minor adjustments to the longitudinal station spacing so that station 9 is one increment short of the next transect. Complete the Channel/Riparian Cross-section Form for the next transect before beginning the next thalweg profile.

Note: Longitudinal profile measurements and LWD debris tallies are carried out concurrently.

Table 6. Criteria used to define pools.

Primary pool units must be wider than half of wetted width.
Secondary pools are less than half of wetted width.
Primary pool units must include the thalweg.
All pool units (except plunge) must be longer than wide.
All pools must have a max. depth is ≥ 1.5X the crested depth.
Crested depth is measured at the tail of pools except dammed pools where crest is measured at the tail and head.
Plunge pools are not required to be as long as wide

II. Large Woody Debris Assessment

<u>References:</u>

Methods modified from Peck et al. (2001).

<u>Equipment:</u>

Measuring tape, meter stick, and Thalweg Profile & Woody Debris Form.

<u>Procedure:</u>

These methods are used to tally LWD within the bankfull channel for the 10 segments of stream located between the 11 primary transects (A, B, C, etc.). Large woody debris tallies are separated into size length and diameter classes. The data recorder counts LWD as the surveyor measures thalweg depths between transects.

Step 1: Scan the stream segment between transects A and B.

Step 2: Tally all LWD pieces that are at least partially within the bankfull channel. LWD must have a large end diameter of at least 10 cm and a length of at least 1 m.

Step 3: For each piece of LWD, determine which of the nine classes it falls into based on the diameter of the large end and length of the piece (Table 7).

Note: If a piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with a circular cross-section that would have the same volume.

Note: Wood that is imbedded within the stream bank is counted if the exposed portion meets the length and width requirements. Do not count a piece if only the roots (but not the stem/bole) extend within the active channel.

Step 4: Place a tally mark in the appropriate diameter and length class on the LWD box.

Step 5: After the LWD has been tallied for the transect segment, write the total number of pieces for each diameter and length class in the small box at the lower right hand corner of each tally box.

Step 6: Repeat Steps 1 through 6 for the next stream segment.

Table 7. Size classes used to categorize large woody debris.

Diameter classes	Length classes
•□ 10 cm to 15 cm	• 1 m to 3 m
• >15 cm to 30 cm	• > 3 m to 6 m
•> 30 cm	• > 6 m

Section 6: Data Management

Data management framework

The ISEMP Data Management effort is designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins located in the Wenatchee and Entiat subbasins, WA, John Day, OR, and Salmon River, ID. Beginning in 2004, a pilot project has been under development aimed at integrating four primary data management tools: Automated Template Modules (ATMs), the Status Trend and Effectiveness Monitoring Databank (STEM databank), Protocol Editor (PE), and the Aquatic Resources Schema (ARS). The STEM Databank is the central data repository for the ISEMP project. It was developed by the Scientific Data Management Team at NOAA-Fisheries to: (1) accommodate large volumes of data from multiple agencies and projects; (2) summarize data based on how, when, and where data were collected; (3) support a range of analytical methods; (4) develop a web-based data query and retrieval system, and (5) adapt to changing requirements. This fully-normalized database structure allows the incorporation of new attributes or removal of obsolete attributes without modification of the database structure. Data can be summarized in a variety of formats to meet most reporting and analytical requirements.

Successful data management systems require a user interface that is intuitive to the user and that increase the efficiency of the user's workflow. The Automated Template Modules (ATMs) are a collection of forms that allow users to enter and view data in a format that is familiar to biologists. Each ATM has forms for entering new data, reviewing existing data, and updating existing data. Additionally, each ATM has a switchboard to help guide the user to the correct forms.

Data entry forms perform the critical function of validating data at the time of data entry. For categorical attributes, users are only allowed to select from acceptable categories as defined by the protocol. Similarly, values entered for continuous attributes are checked to ensure values are within the expected range. Data entry forms are "protocol aware". The database includes tabular data that specifies details about the protocol. All categorical fields on data entry forms have pull-down lists that limit the values a user can enter for the field. The pull-down lists reference the protocol documentation tables and only display values that are defined for the active protocol. Similarly, for continuous values, the forms check the expected range as defined in the protocol and warn the user if the entered value falls outside of the expected range. Users can choose to modify the value or accept the value as it was entered. The use of "soft" bounds on continuous values is an effective validation strategy for ecological data, where data often follows a normal distribution with long tails as opposite to a discrete distribution common to financial data.

Protocol Editor is a data dictionary, user-friendly tool for describing the list of all attributes collected by a given protocol that includes a description of the data type, units of measure, number of characters or digits, number of decimal places, and list of acceptable values for all attributes collected by a protocol. Protocol Editor allows the ATM to be calibrated to a given protocol and allows the ATM to ensure consistency between the protocol and the data entered for that protocol. Protocol Editor follows the same rules established by Protocol Manager (a protocol documenting tool being developed by USBOR). A protocol is defined as a collection of methods, where each method consists of the list of attributes to be recorded by the data collector. The name of attributes is restricted to attributes defined by the ARS; however, users are allowed to create an alias name for the attributes. Metadata entered into Protocol Editor can easy be exported in a tabular format for importing into Protocol Manager.

The ARS is the collection of database tables that store data entered into the ATM forms. The ARS was developed to support agencies within the Columbia River Basin manage, document, and analyze aquatic resources data. The ARS aims to define a standardized data structure for storing and processing water quality, fish abundance, and stream habitat data. The ARS is robust against variations between data collection protocols, supports procedures for increasing data integrity at the time of data entry, and supports proper analysis and summarization of aquatic resources data.

Data handling

The field practitioners should be careful to avoid transposing errors when writing and entering data, and should be sure that all data is clearly legible. Practitioners should be in the practice of making photocopies of data sheets, and designating a copy as the Master Copy. The

Master Copy can be edited by reviewers using red ink who should initialize and date any edits. Future copies of the Master Copy should either be made in color or clearly show these post-survey edits.

Data should be entered into the ATM provided by ISEMP on a regular basis by the data collectors and should undergo AQ/QC before being sent to the ISEMP coordinator, and the Upper Columbia Data Steward for uploading into the STEM Databank.

Data Analysis

This section is under development by the ISEMP data analysis team and will be included in the next revision of the working draft.

Data reporting

Terraqua Inc. is responsible for preparing an annual report that will follow the outline below covering the habitat data collection period:

1. Brief abstract (limit 600 words).

2. Standard introduction provided by ISEMP plus brief description of specific project(s) covered in report.

3. Concise description of project area/map.

4. Description of methods and materials used to perform tasks.

5. Summary of results and brief discussion of results by task (problems encountered, suggestions for future work).

6. If necessary, supplemental electronic copies of summarized field data in spreadsheet or GIS format.

The annual report shall be submitted to the BPA Project Manager/COTR and the ISEMP coordinator. Guidelines for preparing the report can be found at http://www.efw.bpa.gov/Integrated_Fish_and_Wildlife_Program/ReportingGuidelines.pdf. The Upper Columbia Data Steward is responsible for generating an annual report to the Watershed Action Teams, Project Sponsors and monitoring agencies that will include a summary of the macroinvertebrate data.

Section 7: References

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Tear, T. H., J. M. Scott, P. H. Hayward, and B. Griffith. 1995. Recovery plans and the endangered species act: are criticisms supported by data? Conservation Biology 9: 182-195.

Appendix A: Attribute Table

This section is under development and will be included in the document in the next revision of the working version.

Appendix B: Dataforms

1. Longitude
2. Transects
3. Slope
4. Verification
5. Map
6. Cheat Sheet

Thalweg Profile & LWD **ISEMP 2008 Habitat Data Form** **DCE:**

Trans	Thalweg Depth (cm)	Bar Present	Back water	Side Pool	Dry	Side Ch. Present	Side Ch. Length	HabUnit #	Wet Width (m)	BF width (m)	HU Wetted Width (m)*	Bar Width (m)	LB UC (m)	RB UC (m)	Secondary Trans. Subst.		LWD		Flag
															LB			# of pieces	
1															0.1		SS		
2															0.2		SM		
3															0.3		SL		
4															0.4		MS		
5															0.5		MM		
6															0.6		ML		
7															0.7		LS		
8															0.8		LM		
9															0.9		LL		
															RB				

Trans	Thalweg Depth (cm)	Bar Present	Back water	Side Pool	Dry	Side Ch. Present	Side Ch. Length	HabUnit #	Wet Width (m)	BF width (m)	HU Wetted Width (m)*	Bar Width (m)	LB UC (m)	RB UC (m)	Secondary Trans. Subst.		LWD		Flag
															LB			# of pieces	
1															0.1		SS		
2															0.2		SM		
3															0.3		SL		
4															0.4		MS		
5															0.5		MM		
6															0.6		ML		
7															0.7		LS		
8															0.8		LM		
9															0.9		LL		
															RB				

Habitat Units *= Subtract bar width from HU widths.

Unit #	Habitat Unit Type (THU)	(P)rimary/ (S)econdary	Pool Forming Code	Pool Type	Max. Depth (cm)	Tail crest (cm)	Head crest (cm)	HU Length (m)	Supplement* HU Width 1 (m)	Supplement* HU Width 2 (m)	Supplement* HU Width 3 (m)	Supplement* HU Width 4 (m)	Supplement* HU Width 5 (m)	Notes:

Thalweg Notes:

Transectional Data Form ISEMP 2008 Habitat Data Form Side Ch. Trans: DCE:

Trans.	WW (m)	BFW (m)	Bar W (m)	L_BFH (cm)	R_BFH (cm)	Ave_BFH (cm)	LB % Instab*	RB % Instab*	L_UC (m)	R_UC (m)	TransectNotes:

Subtrate and Depth						Human Influence 0 = NP, 1 = 10-20 m, 2 = 0-10 m, 3 = at bank				Rip. Vis. Est. 0 = Absent, 1 = < 10%, 2 = 10-40%, 3 = 40-75%, 4 = > 75%				Fish Cover Vis. Est. (0-4)			Densiometer (0-17)		
Station	WetDepth (cm)	BFDepth (cm)	Subst.	% Embed	Flag	LB	InfluenceType	RB	Flag	LB	Rip. Est.	RB	flag	Cover Type	%Cover	flag	Dir.	Values	flag
Left Bank							Buildings			Canopy > 5 m high				Artificial Structures			Center UP		
0.1							Landfill/Trash				Veg. Type D C E M N			Boulders > 25 cm			Center Left		
0.2							Logging Operations				Big trees > 30cm			Brush Woody Debris <30 cm			Center Down		
0.3							Mining Activity				Sm. Trees < 30cm			Bryophytes			Center Right		
0.4							Park/Lawn			Under story 0.5 to 5 m high				Filamentous Algae			LB		
0.5							Pasture/Range/Hay Field				Veg. Type D C E M N			Large Woody Debris > 30 cm			RB		
0.6							Paved Road/Railroad/Trail				Woody Shrubs & saplings			Live Trees or Roots			Notes:		
0.7							Pavement / Cleared Lot				Non-woody herbs forbs grasses			Macrophytes					
0.8							Pipes (Inlet/Outlet)			Grnd Cover < 0.5 m high				Overhanging Veg. 1m from water					
0.9							Row Crops				Woody Shrubs & saplings			Undercut Banks					
Right Bank							Unpaved Road/Railroad/Trail				Non-woody herbs forbs grasses			Notes:					
Notes:							Walls/Dikes/Revetments				Barren bare dirt or duff								
										Notes:									

Trans.	WW (m)	BFW (m)	Bar W (m)	L_BFH (cm)	R_BFH (cm)	Ave_BFH (cm)	LB % Instab*	RB % Instab*	L_UC (m)	R_UC (m)	TransectNotes:

Subtrate and Depth						Human Influence 0 = NP, 1 = 10-20 m, 2 = 0-10 m, 3 = at bank				Rip. Vis. Est. 0 = Absent, 1 = < 10%, 2 = 10-40%, 3 = 40-75%, 4 = > 75%				Fish Cover Vis. Est. (0-4)			Densiometer (0-17)		
Station	WetDepth (cm)	BFDepth (cm)	Subst.	% Embed	Flag	LB	InfluenceType	RB	Flag	LB	Rip. Est.	RB	flag	Cover Type	%Cover	flag	Dir.	Values	flag
Left Bank							Buildings			Canopy > 5 m high				Artificial Structures			Center UP		
0.1							Landfill/Trash				Veg. Type D C E M N			Boulders > 25 cm			Center Left		
0.2							Logging Operations				Big trees > 30cm			Brush Woody Debris <30 cm			Center Down		
0.3							Mining Activity				Sm. Trees < 30cm			Bryophytes			Center Right		
0.4							Park/Lawn			Under story 0.5 to 5 m high				Filamentous Algae			LB		
0.5							Pasture/Range/Hay Field				Veg. Type D C E M N			Large Woody Debris > 30 cm			RB		
0.6							Paved Road/Railroad/Trail				Woody Shrubs & saplings			Live Trees or Roots			Notes:		
0.7							Pavement / Cleared Lot				Non-woody herbs forbs grasses			Macrophytes					
0.8							Pipes (Inlet/Outlet)			Grnd Cover < 0.5 m high				Overhanging Veg. 1m from water					
0.9							Row Crops				Woody Shrubs & saplings			Undercut Banks					
Right Bank							Unpaved Road/Railroad/Trail				Non-woody herbs forbs grasses			Notes:					
Notes:							Walls/Dikes/Revetments				Barren bare dirt or duff								
						Notes:				Notes:									

Slope & Bearing Form					ISEMP 2008 Habitat Data Form						DCE:
Trans	Level WetDepth (cm)	Level EyeHeight (cm)	Rod WetDepth (cm)	Level Height on Rod (cm)	Bearing (0-360) ° declination	Levels US Trans.	Levels Dist. From US trans (m)	Rods US trans.	Rod Dist. From US trans (m)	Flag	SlopeNotes
K											
J-mid											
J											
I-mid											
I											
H-mid											
H											
G-mid											
G											
F-mid											
F											
E-mid											
E											
D-mid											
D											
C-mid											
C											
B-mid											
B											
A-mid											
Notes:											

Stream Verification & Monument Form				ISEMP 2008		DCE	
SiteName			X-Site Monument		A Transect Monument		K Transect Monument
SiteAKA		Transect		Transect		Transect	
StreamName		Actual Lat.DD		Actual Lat.DD		Actual Lat.DD	
StartDateTime		Actual Long.DD		Actual Long.DD		Actual Long.DD	
EndTime		EPE		EPE		EPE	
Predicted Lat. DD		Bank		Bank		Bank	
Predicted Long. DD		DistFrombank		DistFrombank		DistFrombank	
Reach Length		TreeDistance		TreeDistance		TreeDistance	
Ave. BFWidth		TreeBearing		TreeBearing		TreeBearing	
RosgenType		TreeSpecies		TreeSpecies		TreeSpecies	
BedformType		TreeDBH		TreeDBH		TreeDBH	
CrewInitials	Role	Monument Type		Monument Type		Monument Type	
		Monument photo		Monument photo		Monument photo	
		CUPhoto		CUPhoto		CUPhoto	
		CLPhoto		CLPhoto		CLPhoto	
		CDPhoto		CDPhoto		CDPhoto	
		CRPhoto		CRPhoto		CRPhoto	
		LBPhoto		LBPhoto		LBPhoto	
Sampled	Yes / No	RBPhoto		RBPhoto		RBPhoto	
ReasonNotSampled:		Notes		Notes		Notes	
GeneralNotes							

Map Drawing Form **ISEMP 2008 Habitat Data Form**

DCE:

Site name		Diagram notes	
Diagram artist			
Date drawn			

Monument written description:

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) - tennisball to basketball	
GC	Course gravel (16 to 64 mm) - marble to tennisball	
GF	Fine gravel (2 to 16 mm) - ladybug to marble	
SA	Sand (0.06 to 2 mm) - gritty to ladybug	100
FN	Silt, clay, muck (non gritty)	100
HP	Hardpan - hardened soil cemented together	0
HS	Hardsand - sand not cemented, but still hard and consolidated	0
WD	Wood - any size	
OT	Other (describe in comments)	

Habitat Type Codes	Veg. Type Codes
Slow P = plunge pool	D = deciduous
S = scour pool	C = Coniferous
D = dammed pool	E = Evergreen Broadleaf
	M = mixed (at least 10% of any type)
Fast T = turbulent	N = None
N = nonturbulent	

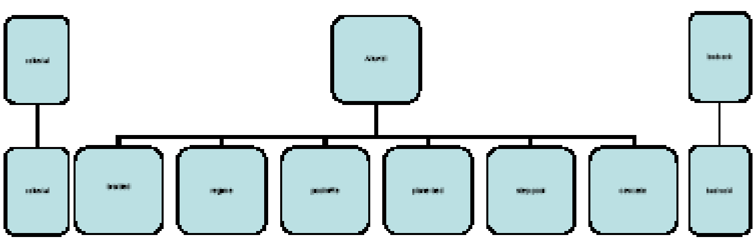
Flag Codes	Pool forming Codes
K = unable to collect data	W = Large Woody Debris
U = Suspect measurment or sample	R = Rootwad
F1, F2, etc. =flags assigned by field crew	B = Boulder or Bedrock
neg. 999 for all non values	F = Fluvial

Pool Criteria

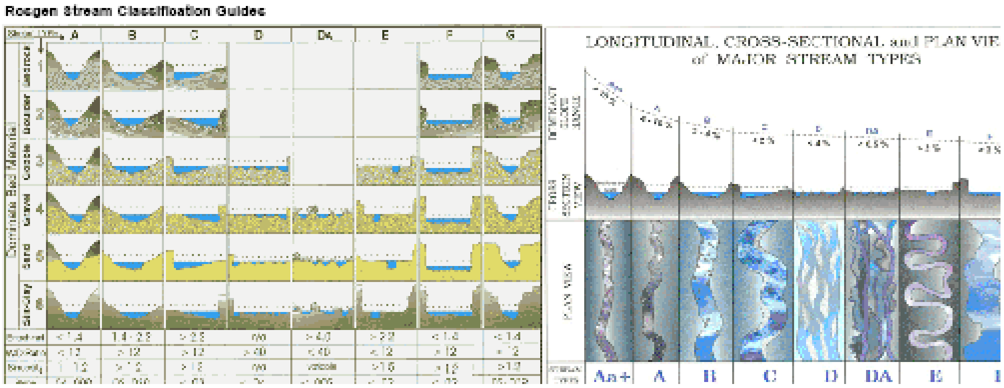
Primary pools are greater than half the wetted width
Secondary pools are less than half the wetted width, still meet the other criteria
Pools are longer than wide
Pools must have max. depth ≥ 1.5X crest depth at tail
Measure head crest depth for dammed pools

LWD Classes		
SS= 10-15 cm X 1-3 m	SM= 10-15 cm X >3-6 m	SL= 10-15 cm X >6 m
MS= >15-30 cm X 1-3 m	MM= >15-30 cm X >3-6 m	ML= >15-30 cm X > 6 m
LS= >30 cm X 1-3 m	LM= >30 cm X 3-6 m	LL= >30 cm X >6 m

Montgomery Buffington Channel Bedform Type Classification



Rosgen Stream Classification Guides



Appendix C: Field Gear List

1. GPS unit with extra batteries
2. Appropriate maps including USGS 7.5 min.
3. Digital camera with extra batteries and memory
4. Two known working compass
5. Waterproof metal clipboard
6. Appropriate waterproof forms and field note books
7. Extra waterproof data forms
8. At least 3- two foot long ½ inch dia. rebar with caps
9. At least 3 metal bearing tree site ID tags
10. Sledge hammer and handful of 3” nails
11. Two 50 m tapes
12. Two 5 m or 7.5 m stadia rods
13. Clip on centimeter ruler
14. Abney hand level and case
15. Orange and pink flagging
16. A bunch of sharpies and mechanical pencils
17. Laser level with extra batteries
18. Hip waters and felt boots
19. Emergency first aid kit
20. D-frame 500 micron kick net
21. Plastic bottles and ethanol for invertebrate samples
22. Scrub brush
23. Stop watch
24. Random number table
25. A couple of carbineer
26. A pack lunch and plenty of water
27. Polarized sunglasses
28. Sun blocker lotion
29. Sun hat
30. Good hiking boots and socks
31. Matches and firestarter
32. A copy of this protocol
33. A good back pack for all this stuff

Appendix D: Protocol Revision Log

As new information becomes available and habitat monitoring efforts are refined, the protocol will be revised. Effectively tracking past and current protocol versions are important for data summaries and analyses that utilize data collected under different protocol versions. Protocol Editor will house previous and current protocol versions and the dates of their implementation. Reviews will be performed for all proposed changes to the protocol and the Upper Columbia Data Steward notified so the version number can be recorded in the project metadata and any necessary changes can be made to database structure (Peitz et al. 2002). Consistent with the recommendations of Oakley et al. (2003) this protocol includes a log of its revision history. The revision history log (adapted from Peitz et al. 2002) will track the protocol version number, revision dates, changes made, the rationale for the changes, and the author that made the changes. Revisions or additions to existing methods will be reviewed by ISEMP staff prior to implementation. Major revisions such as a complete change in methods will necessitate a broader review by outside technical experts. When the protocol warrants significant changes the protocol version and date on the title page should be updated to reflect the new version. Version numbers should increase incrementally by hundreths (e.g., Version 1.01, 1.02 etc.) for minor changes and by the next whole number (e.g., version 2.0, 3.0 etc.) for major changes (Peitz et al. 2002).

Protocol Revision History Log

Previous Version #	New Version #	Revision Date	Author	Changes made	Reason
	1.0	June 7, 2006	Moberg, J	Protocol written	New effort needed to provide field level direction to the UCMS for habitat survey crews
	1.0	2006	Moberg, J	Measurements of flood prone width used to calculate entrenchment ratios were dropped	Based on PNAMP's preliminary results from 2005 study indicating the inability of any protocol tested to satisfactorily calculate entrenchment ratios.
1.0	2.0	June 15, 2007	Moberg, J	Extensive	Incorporating learning from first year
1.0	2.0	2007	Moberg, J	Secondary pools, or pools less than 50% of the wetted width, were counted	Preliminary results from the PNAMP study showed that pools were best represented by the Northwest Indian Fisheries Commission (NWIFC) protocol derived from Pleus et al. (1999), which limited pools to those that meet a minimum pool area and residual depth based on the stream's bankfull width. The NWIFC also divided pools into primary pools that are greater than 50% of the wetted width and secondary pools that are less than 50% of the wetted width. Pools will continue to be counted by ISEMP in 2008 in the same manner as in previous years to allow between year comparisons of untreated pool data. Minimum pool criteria used by the NWIFC for primary and secondary pools can be applied to ISEMP data during the analysis phase if a between protocol comparison is desired.
1.0	2.0	2007	Moberg, J	Embeddedness samples were increased from five per transect (Peck et al. 2006) to 11 per transect for the 2006 field season.	Sennatt et al. 2006 compared ability of 5 different protocols to detect embeddedness in the dam-controlled Ompompanoosuc River and found that the Peck et al. (2001) method (referred to in the

					study as the EPA method) adopted by ISEMP most effectively captures the expected impact of flow regulation on embeddedness in the Ompompanoosuc River. Additionally, it was the only method able to detect the translation of the region of low embeddedness downstream of the dam during the study period.
1.0	2.0	2007	Moberg, J	Addition of data management section	To ensure data collected by this protocol meets the objectives of the ISEMP Data Management effort designed to develop standardized tools and procedures for the organization, reduction, and communication of monitoring data and methods within ISEMP pilot basins.
1.0	2.0	2007	Moberg, J	Habitat/Fish Abundance Section added	To give direction on how best to work with fish surveying crews to ensure that data from the habitat collections and fish abundance counts can be reliably integrated to assess fish densities at these sites.
1.0	2.0	2007	Moberg, J	Data forms were redesigned to reflect the structure of the ARS and the PM (Appendix B).	
1.0	2.0	2007	Moberg, J	Detailed description of how to 'follow the thalweg' when laying out sites. Separate monumenting methods were developed for status and trend sites, with status sites monumented only at the X-site, and trend sites monumented at the X-site, and transects A and K.	
1.0	2.0	2007	Moberg, J	Side pools were redefined to include alcoves, which were previously not well defined and difficult to identify in the field.	
1.0	2.0	2007	Moberg, J	Macroinvertebrate Sampling section was expanded	To meet criteria established by PNAMP (2006)
2.0	3.0	2008	Moberg, J	Macroinvertebrate Section	Formed Macroinvertebrate

				removed	sampling Protocol
2.0	3.0	2008	Moberg, J	Beaver added to Table 5 as source of pool formation	Increased beaver activity

(adapted from Peitz et al. 2002)