Field Protocol Manual

Aquatic and Riparian Effectiveness Monitoring Program

Regional Interagency Monitoring for the Northwest Forest Plan

2010 Field Season

Contacts

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Acknowledgements

The Aquatic and Riparian Effectiveness Monitoring Program would like to acknowledge the following people for contributing to the field protocols described here. Nate Dachtler, Kirsten Gallo, and Chris Moyer developed the original protocols and produced the first draft of this document. Erik Moberly and Devin Simmons worked on early details of the original protocols. Kris Fausti worked tirelessly as the lead author on the 2004, 2005, 2006 and 2007 field protocols with the help of Jenni Dykstra, Ted Sedell, Peter Gruendike, and Jake Chambers. Peter Gruendike was the lead author on the 2008 and 2009 field protocols with the help of Heidi Andersen and Hank LaVigne. Heidi Andersen is the lead author for the 2010 protocol. Thanks to all of the field crew members who tested, questioned, and provided feedback over the years.

Introduction

The Northwest Forest Plan, hereafter referred to as “the Plan”, was approved in 1994. The Plan includes an Aquatic Conservation Strategy that requires the protection, rehabilitation, and monitoring of aquatic ecosystems under the Plan’s jurisdiction (USDA-USDI 1994). The Aquatic and Riparian Effectiveness Monitoring Program (AREMP or the monitoring plan) was developed to fulfill these monitoring requirements. The primary purpose of AREMP is to determine the current condition of 6th-field watersheds and track changes in watershed condition over time. A total of 250 watersheds will be monitored under AREMP. One of the most important aspects of the program is the collection of consistent data throughout the Northwest Forest Plan area to provide comparative data used to assess watershed condition.

The field data collected is combined with upslope and riparian information to determine watershed condition. Condition is determined using a decision support model that evaluates individual indicators and then aggregates the evaluation scores. The stream data collected in the field represent about 2/3 of the data included in the decision support model. As natural variance both within and between the watersheds is quite high, it is imperative that errors due to sampling and observer bias are minimized. The data collected will be used as the basis for management decisions throughout the Pacific Northwest. These data comprise one of the largest data sets that exist, both spatially and temporally. Therefore, it is of the utmost importance to make the effort to produce the highest quality data possible. This document is addressed in section 11.1

Standard Operating Procedures of the Quality System Management Plan (Palmer, in prep).

The goal is to efficiently and safely collect the best data possible within a watershed.

Locating and establishing the start of the survey

A topographic map of each watershed will be supplied, marked with potential sample sites. Select sites in numerical order, omitting sites that cannot be sampled. For watershed re-surveys, survey sites will be repeated in numeric order from lowest to highest number. If additional sites need to be added, select sites in numerical order, starting with number 1 (regardless of the numbers of previously surveyed sites).

Note: The Reconnaissance crew will be responsible for establishing whether or not a site is surveyable based on location, condition, and access. A crew leader has the authority at any time to exclude a site if he/she feels it is unsafe for a crew to sample.

Use the topographic map and GPS unit to find the approximate location of the site from the road. Approach the site from downstream, using the "Go To" feature of the GPS unit to guide you toward the Transect A flag. If the Transect A flag cannot be located, use the waypoint to locate the start of the site. If the start point appears to be located on a hill slope, continue up the stream channel, watching both the distance from the site and its location on the hill slope relative to the GPS pointer. The goal is to find the location on the stream that is the smallest possible distance from the GPS waypoint. This will be the start point of the survey.

Selection Criteria

Exclude a watershed if:

1. It is deemed dangerous for a survey crew to be working in the area (i.e., law enforcement personnel identify a watershed as having prevalent drug growing operations). *Safety.*
2. Fire activity blocks or limits road/trail access to the watershed or has potential to spread, endangering the crew while working in the stream. *Safety.*
3. Less than 25% of the total stream length is located on federal land. *Ownership.*
4. A minimum of sampling four sites cannot be completed within six days (the length of time available each sampling trip) due to time constraints, accessibility issues, or site constraints (see below). *Accessibility.*

Exclude a site if:

1. The site is not safely accessible; i.e., it cannot be reached without putting the crew in danger. (A long hike into a steep canyon does not qualify as a dangerous situation for the crew.)
2. The site is not wadeable because of depth or current.
3. Travel time (round trip) from road camp or wilderness camp is over four hours to get to and from the site. The crew should never be in the position of hiking back

to camp or their truck in the dark. If the watershed is large and sites are spread out, a crew will relocate camp to be closer to outlying sites to reduce daily travel time.

4. The GPS point (used to identify the beginning of a site) is located on private land.
5. The GPS point for a site is located in a lake, wetland or marsh, or on a dam or glacier.
6. The site is an artificial stream or irrigation canal.

Include a site if:

1. All stream channels will be considered, regardless of the presence or absence of flowing water. Use the following criteria to determine whether the site should be sampled;
    a. Active scour must be present in the channel, i.e., fine particles have been removed or pushed to the side and larger substrate is visible. Ephemeral streams that flow over vegetation are not sampled.
    b. There must be **well-defined bankfull indicators** present to sufficiently establish survey transects throughout the length of the site, signifying that it is an active channel. An active channel will have some combination of the following bankfull indicators:
        i. Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the bankfull elevation.
        ii. Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
        iii. A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.
        iv. Locate the elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
        v. Examine the ceiling of undercut banks. This elevation is usually slightly below the bankfull elevation.
        vi. Stream channels actively reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators.
    c. The survey crew must be able to physically work and collect a full set of data within the stream channel. Avoid sites choked with willows (or

similar dense vegetation) that excessively hinder the crew's productivity or restrict mobility while working in the channel.

d. In order to sample for macroinvertebrates the site must have; a minimum wetted width of 1 meter, a minimum depth of 0.1 meter and riffle habitat present.
e. In order to collect water chemistry data there must be flowing water with sufficient depth to completely submerge the YSI meter's probe.

Note: Do not, under any circumstances, walk on private land to access sites. Your presence on private land is considered trespassing, regardless of what you are doing.

Record the site UTM coordinates

GPS points will be taken at the beginning of the survey at or near transect A, and at the end of the survey at or near transect K.

1. Press and hold the ENTER/MARK button for two seconds.
2. On the "Mark Waypoint" screen, toggle to the waypoint number and enter the new waypoint number as follows: a 5 letter watershed code, a 4 number site code, and a Transect location A or K. (Example: ORRCK1003A). If the site is a QA/QC or trend site, place a 9 or a 6 in front of the site number (e.g., ORRCK9003A, ORRCK6003A).
3. Hit the MENU button, scroll to Average Position, then hit ENTER.
4. For the Y&GA location, place the GPS unit at or near Transect A and let the unit log at least 250 measurements (ORRCK1019A).
5. For the Y&GK location, place the GPS unit at or near Transect K and collect at least 40 measurements (ORRCK1019K).
6. Once all the measurements have been recorded, press ENTER, scroll to the DONE box, and press ENTER.
7. Enter the UTM coordinates in the field data recorder.

Monument the site

Site markers are used to monument the site location. The markers will assist others in finding the start of the original site. ***Site markers will not be placed in designated wilderness areas.***

1. Locate a distinct feature near the bottom of the site that will be easily identified by the next survey crew.
    a. Something relatively permanent such as a piece of large wood near the stream (e.g. a large spanner, snag, or tree).
    b. Sometimes riparian zones within the sites are characterized by a continuous patch of vegetation; try to pick something that stands out such as a large clump of sage or one conifer near the start of the site.
2. Attach one of the markers to your chosen spot.
    a. Use an aluminum nail to attach the marker. Make sure the marker is clearly visible and facing the stream.
    b. Place flagging at the top and bottom of the marker. If the tree or log that the marker is attached to is too large to tie flagging around, hang a piece above the marker tying it to the nail or nearby branch.

3. Take a GPS reading of the site marker location and record. If the marker is less than 10 meters from the GPS location of Transect A, use the same GPS coordinates for both.
4. Next, standing at the marker location, take a manual compass bearing from the marker to Transect A Left Bank. Record this bearing in the field data recorder, as well as on the left side of the marker using a permanent pen.
5. Record the following information on the site marker in permanent pen (Figure 1);
    a. Watershed Code (i.e. ORRCK)
    b. Site Number (i.e. 1022)
    c. Compass bearing and direction to Transect A Left Bank (i.e. 345° NNW)
    d. Date (i.e. 22 August 2009)
    e. Surveyor ID (i.e. FNG01)
    f. UTM's for Transect A (i.e.10T 0479344 4934553)
    g. Reach length for the site.

    **Note: When revisiting trend sites that have an existing site marker, add any missing information, then retrace the existing information with permanent pen.*

6. Measure the distance from the marker to bottom of the site and record (this will be done with the laser and prism by taking a point at Left Bank and at the marker and GPS locations).

    The following points will be labeled as Transect Y:
    - First, take a laser shot of the prism pole at the base of the monument (Y&MO).
    - Next, take a shot of the prism pole at the GPS location at Transect A (when getting average waypoint) (Y&GA).
    - Next, take a shot of the prism pole at the left bankfull on Transect A, independent of transect shots (Y&LB).
    - Finally, before traversing back downstream after finishing the survey, take a shot of the GPS location established at or near Transect K (Y&GK).

7. Take a picture of the marker location and surrounding distinctive features. This will include a <u>minimum</u> of three pictures; 1) facing Transect A Left Bank standing at the monument 2) facing the monument standing at Transect A Left Bank and 3) a view of the monument from the route a crew will take to approach the site.

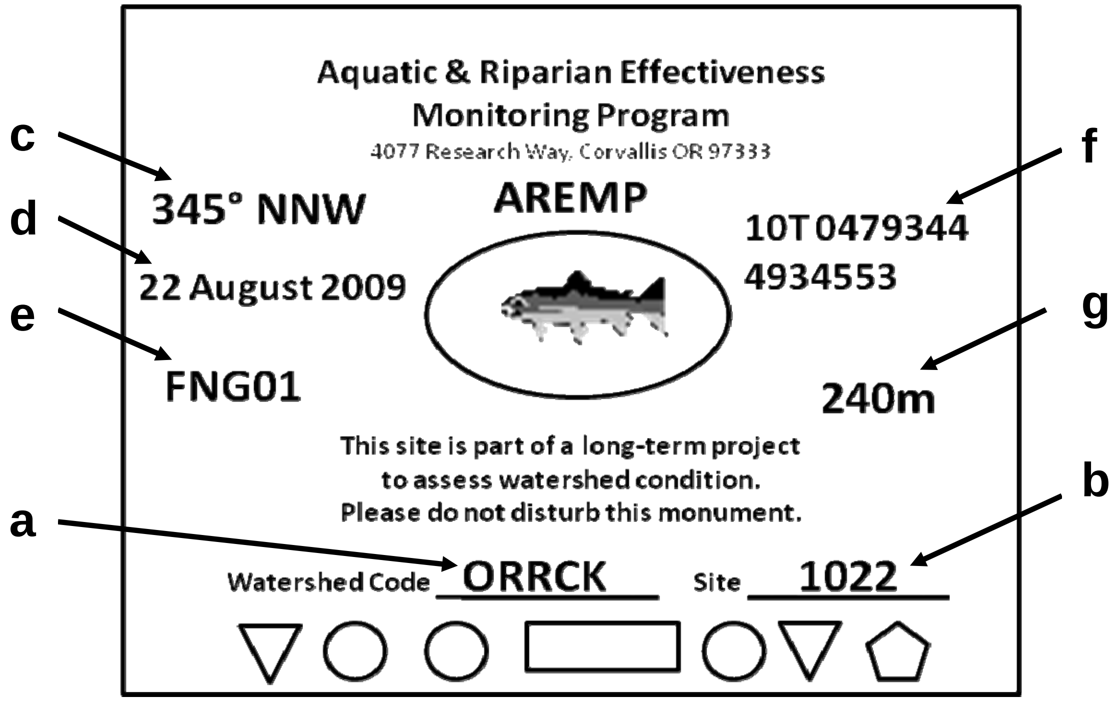


Figure 1. Schematic of site marker with required information filled out.

Photo Documentation

Information about each site will be documented in photographs and in the field data recorders. Four photos (1 left bank, 1 downstream, 1 right bank, 1 upstream) will be taken at Transect A of each site. In addition, photographs should be taken of rare or unique features in the site including culverts, logjams, beaver dams, or vertebrates that are difficult to identify.

The digital photos collected in the field prove invaluable when relating individual sites to watershed condition. These photos bring to life much of the data collected in the field and allow this information to be relayed to the public in a way that can be more readily understood. AREMP will use these photos in several different ways. They will be linked to GIS, which will allow for more meaningful interpretation of the field data. These photos will be retaken at 5-year intervals, which will provide a means to discern changes in the area over time.

The crews will be responsible for taking photos in the field, including the photos taken at Transect A and photos of the monument site. It is possible that due to the position of satellites or the depth of the canyon you are in, you will not be able to get GPS coverage. In this case, walk around the area where you will be taking pictures in an attempt to obtain satellites.

1. Turn on your camera and do the following:
    a. Verify the image quality is set on “SUPERFINE”. Hold down the Func. Button.
    b. Verify the image size is set on “L”. Hold down the Func. Button.
    c. Verify that the date and time on the camera are correct. Press Menu then press the right arrow to bring up the settings menu.
2. At the beginning of each day, open the screen on the GPS unit that displays the time and take a photo of it with the digital camera. This photo serves as a backup in case the digital camera clock varies.
    a. On the GPS unit Section Menu, select *Status*
    b. On the Sub-section Menu, select *UTC Time*. This is Greenwich Mean Time, for Pacific Daylight time **subtract** 7 hours.
    c. You should now be viewing a screen showing time and date.
    d. Take a picture of this screen, attempting to minimize glare. Look at the picture on the viewfinder to ensure that the numbers on the GPS unit can be read.
3. Take a series of photos standing in the middle of the **bankfull channel** (midway between left bank and right bank, regardless of wetted channel) at Transect A. The first photo taken should be of the white board, which will then be placed on the left bank. Take the second picture of the left bank (where the white board is); rotate the camera clockwise 90^o to take the next photo, which will be of the downstream view. Repeat 2 more 90^0 rotations to capture the right bank and the upstream view. Ask all other crew members to stay out of the photos. Gear in the photos is OK as long as it does not move between pictures. Keep gear bundled up to avoid the “yard sale” look.
4. The **white board** should contain the following information:
    a. Location (i.e., Watershed code name and site number): For Site 3 on Wadeable Creek in Oregon, you would put “ORWAD1003” or ORWAD9003 (6003) for QAQC and trend
    b. Date (Day Month Year): “3 July 2003”
    c. View: “LB Transect A.”

Additional photos to take

Take photos that will help give people who may never visit the area an idea of what it looks like. These photos should help show the condition of the areas sampled, species captured at each site, land disturbances, etc. Take pictures of the following:

- Features such as logjams, waterfalls, deep pools, and beaver dams.
- Land disturbances such as fires, landslides, extensive blow downs, etc.
- Unusual species and species that are difficult to identify; this info should also be entered into the photo log and incidental spreadsheets along with the photo number (see the photographs of Biota).
- If possible, take a picture of the overall watershed (from a road/clearing).
- Scenic shots and photos of people working are good as well.

The Photo Log data form

In the field data recorder, enter the appropriate information detailing the site ID (ORWAD1003), the UTM coordinate, the date, the photographer, and the photo number. In the comments section, describe the subject of the photo (e.g., transect photo, unidentified salamander) the habitat or other distinguishing features of the biota. Enter each picture taken at a site into the photo log.

Order of events for photographs

1. GPS screen showing date and time.
2. Close-up of white board with site information.
3. Transect A left bank with whiteboard.
4. Downstream from Transect A.
5. Transect A right bank.
6. Upstream from Transect A.
7. Transect A left bank from monument.
8. Monument from Transect A left bank.
9. Approach to monument.
10. Any other additional photos needed to capture distinctive features.

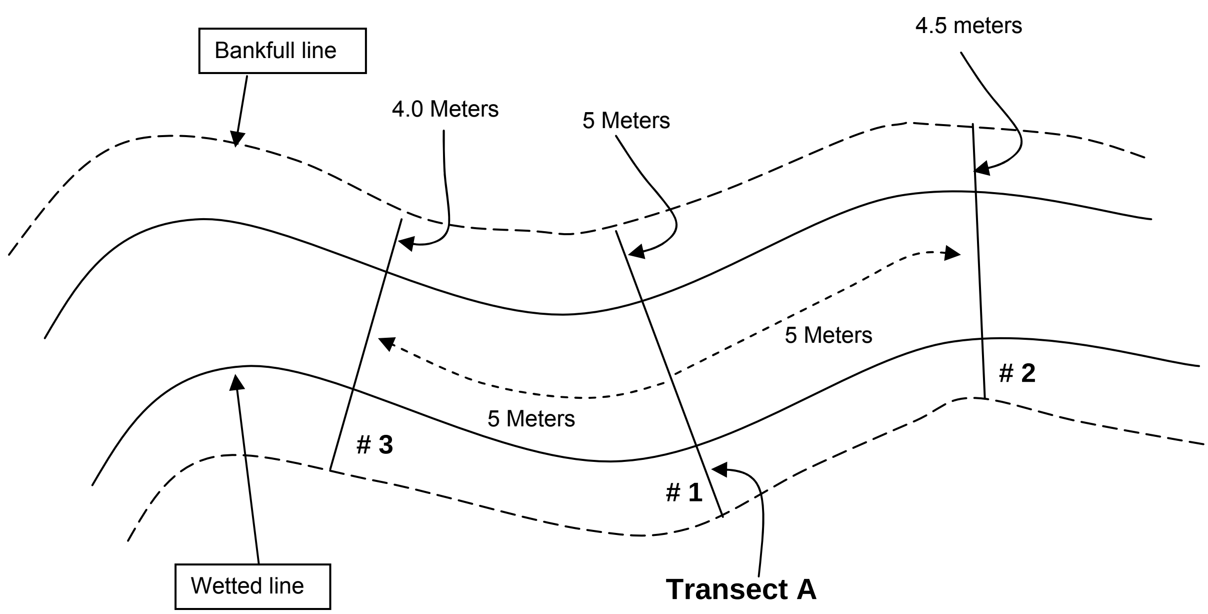
Site Layout

1. Examine the bankfull indicators (described below) throughout the site to identify the bankfull elevation. Recognize that all six indicators are rarely present at an individual site.
    - Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the current water level.
    - Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
    - A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.
    - Define an elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
    - Examine the ceiling of undercut banks. This elevation is usually slightly below the bankfull elevation.
    - Stream channels actively attempt to reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators.

2. Measure the bankfull width **perpendicular to the channel** at Transect A. Round the bankfull width to the nearest 0.1 meter. This number will be used to determine the location of additional bankfull width measurements.
3. Two additional bankfull widths will be measured, one upstream and one downstream (Figure 2). For example, the initial bankfull width was 5.3 m, go upstream 5.3 m and take a bankfull width measurement. Repeat this procedure going downstream from the initial bankfull width location to get one more bankfull width measurement. If the situation arises where a bankfull cannot be measured on the downstream end of Transect A, take the additional measurement above Transect A.

    Note: If a qualifying side channel is encountered while acquiring the 3 bankfull widths, measure the bankfull width of the side channel and add it to the bankfull width of the main channel.

Record the three bankfull widths and calculate the average. Use the average to determine the width category from Table 1 below (this information will also be provided in the field data recorders). The site length is defined for each width category and is equal to 20 times the bankfull width.



Measurement 1	5.0M
Measurement 2	4.5M
Measurement 3	4.0M
Add the 3 measurements and divide by 3	13.5/3=4.5
Take the average number and find the site length in Table1	160M

Figure 2. Schematic of the three bankfull measurements taken to determine site length and an example of how to calculate site length.

Table 1. Average bankfull width categories with corresponding site length.

Average Bankfull Width in meters	Width Category	Site Length in meters
1 to 8	8	160
8.1 to 10	10	200
10.1 to 12	12	240
12.1 to 14	14	280
14.1 to 16	16	320
16.1 to 18	18	360
18.1 to 20	20	400
20.1 to 22	22	440
≥22.1	24	480

Transect layout

In all sites, 11 transects will be laid out and should be labeled A-K. In addition to the 11 major transects, 10 intermediate transects will be flagged with **orange** flagging and used for pebble counts and thalweg locations (Figures 3 and 4). Side channels and pools will also be identified and marked with **blue** flagging. Transect A will be marked with **biodegradable** orange flagging. Site information should be documented in both of the field data recorders.

Determine the site length as described in the previous section and divide the site length by 20 to obtain the increment between each transect.

For example, the distance between transects in a 160m reach is 160/20=8m (Table 1).

Following the thalweg (defined as the deepest path of flowing water in the main channel), measure the distance between transects using a meter tape. The meter tape should be laid on the surface of the water at the thalweg while measuring. Place an orange flag in an obvious area near eye level at each transect location. Label the flags with the corresponding transect name (A, B, C…K). Label the intermediate flags with the letter of the preceding transect and the number 2 (A2, B2, C2…J2).

***If a sharp bend in the channel is encountered while measuring between transects, split the measurement at the apex of the bend in order to accurately capture the channel length.*

***Remove all flagging from the site (except for the Transect A flag) after the survey is completed. The flagging will be kept and reused for following surveys.**

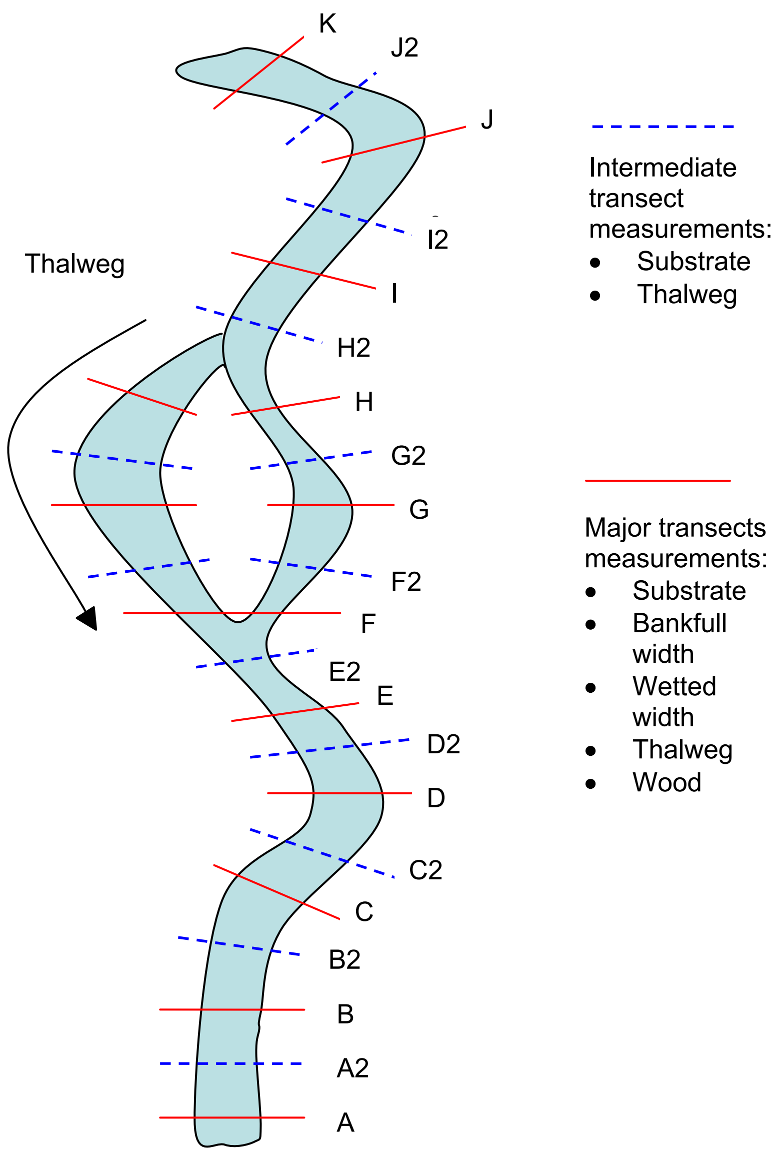


Figure 3. Site layout and tasks performed at major and intermediate transects.

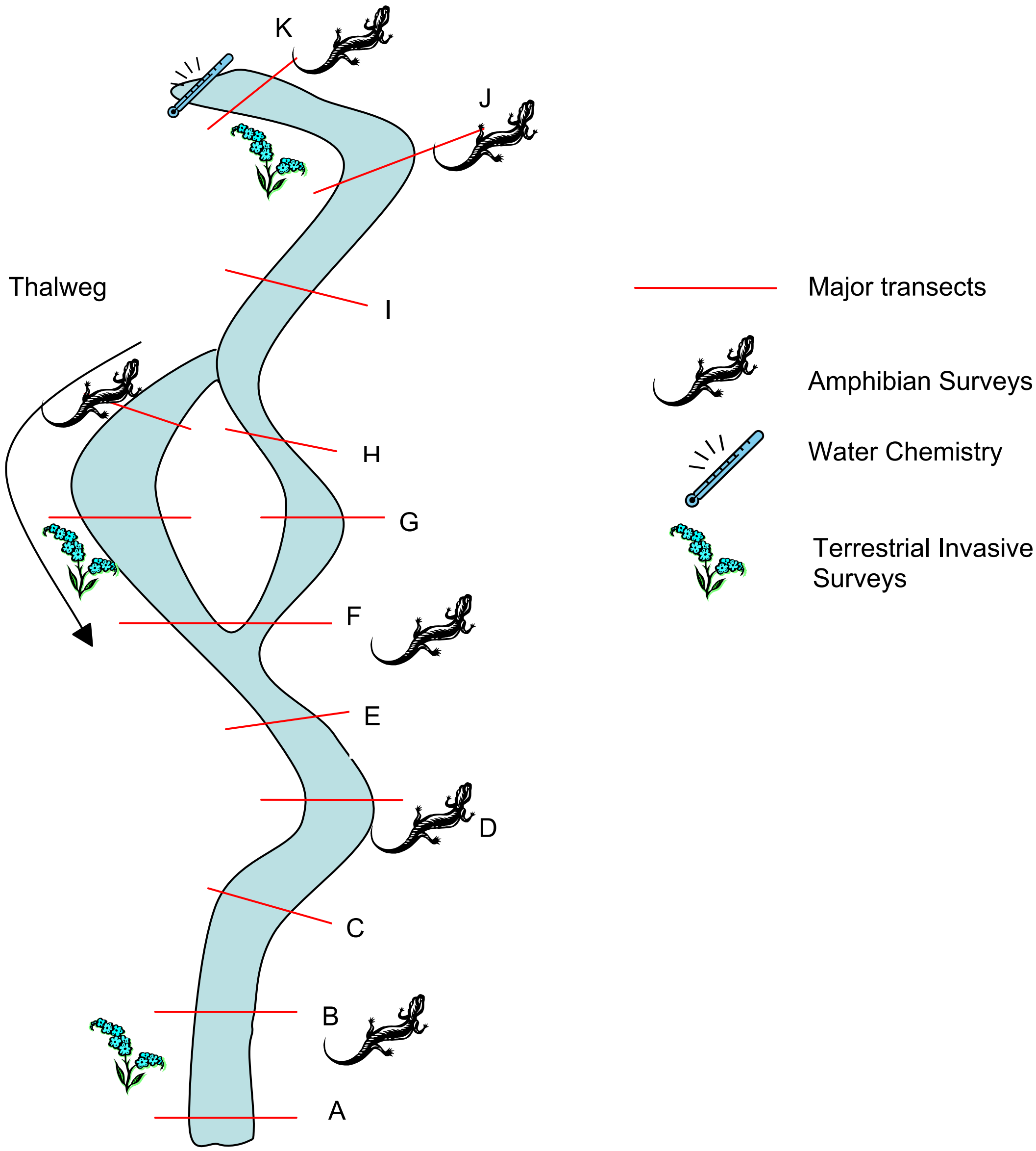


Figure 4. Location of biological surveys performed in a site.

Site Maps

A site description map will be drawn on a template located on the back of the AREMP Description and Comment data form (Figure 5).The focus should be to capture any special features of a site and to aid in monument description, so it is important to keep the maps simple and concise. There will be an additional template for sites containing side channels (Figure 6).Examples of features to capture: large log jams, culverts, monument location, waterfalls, roads.

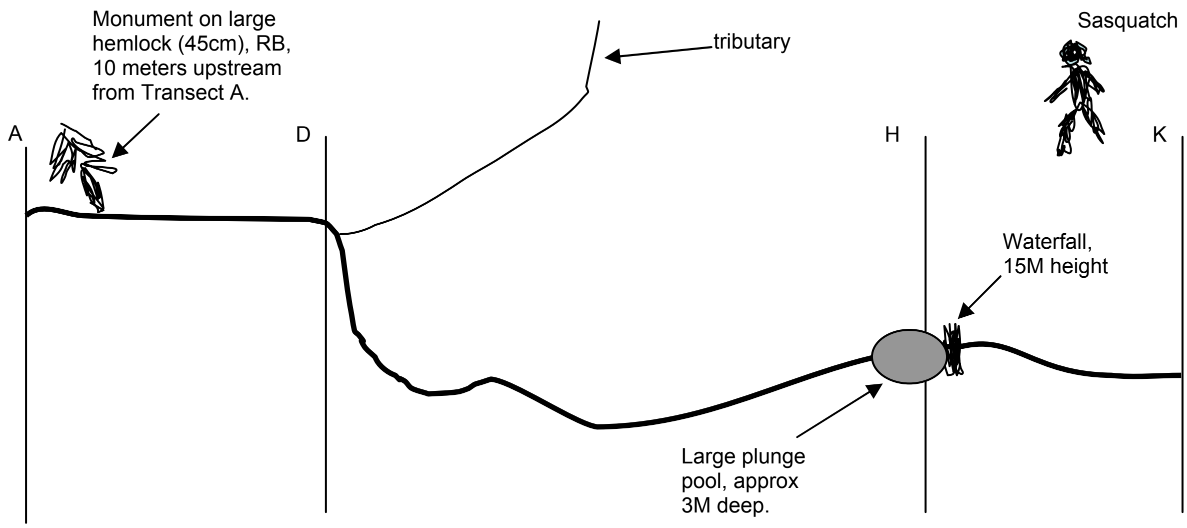


Figure 5. Example of site map in a site **without** qualifying side channels.

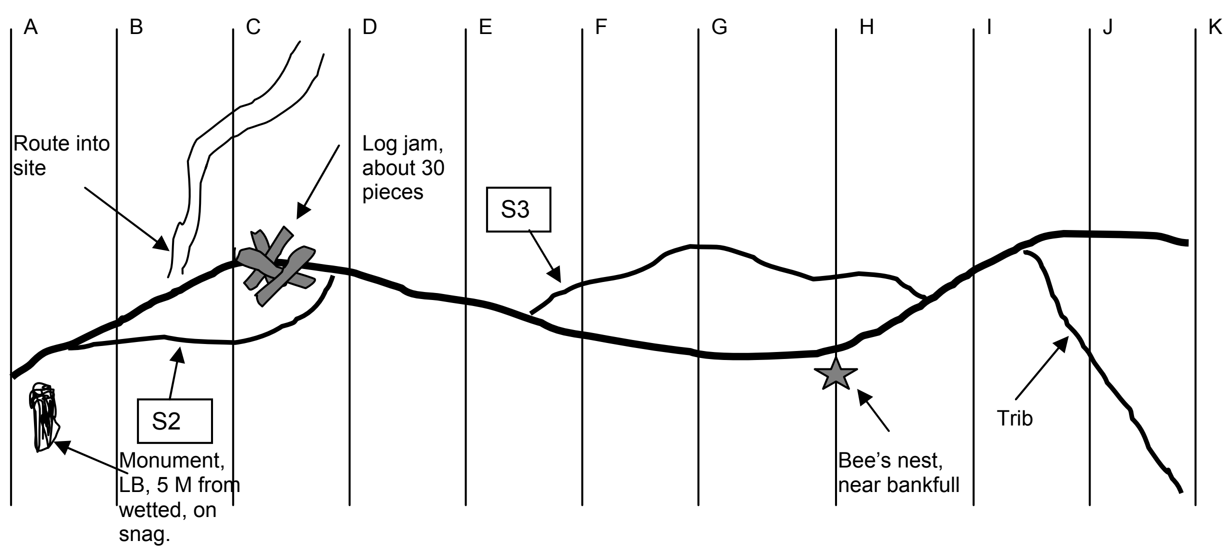


Figure 6. Example of site map for a site containing side channels.

Unusual situations

Since stream channels come in a variety of sizes and shapes, situations will frequently arise that are not addressed in this protocol. In this case, the crew leader should make the best logical decision and document the situation in the notes section of the Stream Data Form on the field data recorder. Unusual situations include the following; details are presented in Table 2:

Obstructions at the waypoint
If the waypoint is located on or close to an obstruction (large culvert or log jam), move the start of the site upstream to the nearest surveyable location.

Impassible barriers
If you encounter an impassible barrier (waterfall, lake or glacier) or private land ***during site layout***, establish the end point of the survey at the barrier (Transect K). Using the transect distances established from the 3 initial bankfull measurements, layout the site traveling downstream to Transect A.

Overlapping sites
Always survey the lowest numbered site first. Transect K of the first site will be flagged as Transect A for the second site. Drop the second site if the first site will overlap more than 50% of the second site's length (In order to determine this you will have to measure the 3 initial bankfull widths for the second site). Overlap is measured from the site's original GPS coordinate.

Small Obstructions
Occasionally logjams or other obstructions cover the stream channel making it impossible to measure transects and capture bankfull. If the obstruction is small and blocks only one transect, move the transect to the nearest suitable location and make a comment in the Stream Data Form. Avoid moving the transect more than 2 meters up or downstream. If the obstruction is large and would block numerous transects, it should be excluded from the survey. Use a stop/start survey in this situation.

Culverts
If a culvert is located within a site and it does not interfere with data collection (a transect does not fall on the culvert), take a point at the bottom of the culvert then move to the other side and take a point at the top. Label these points as "CV" in the field data recorder. Under no circumstance should you ever pick up and move the laser without shooting a new origin (AKA "Traverse").

Stop and Start of Survey
Stop and start is a technique intended for large obstructions (i.e. passable waterfall or large/long culverts) encountered in the site that interfere with data collection or compromise crew safety.

If there is an unsurveyable obstruction within the site, such as a large log jam, passable waterfall, large/long culvert, stop the survey at the obstruction and restart the survey upstream of it. Capture points with the laser at both the bottom and top of the obstruction and label them with the longitude they occur in, as well as “Stop Survey” (SP) or “Start Survey” (SS). Enter a comment of (Waterfall = WF, Culvert = CV, Log Jam = LJ) in the field data recorder for these points. Steps to deal with this situation if encountered are as followed;

1. Begin site layout as previously described.
2. When the obstruction is encountered, measure the distance to the beginning of the obstruction. Place flagging labeled “STOP SURVEY”.
3. Go to the upstream end of the obstruction and, at the first surveyable location, hang a flag labeled “START SURVEY.” Continue measuring up to the next transect location.
4. Measure the distance between the “STOP SURVEY” and “START SURVEY” flagging and record on the Description and Comment Data form.
5. Make sure a note has been entered into the Recon, the laser notebook and in the stream data form.

Table 2. Unusual situations and appropriate actions.

Situation	Action
Culverts “CV”	
Less than 4 times Bankfull width category in length	If it **does not** interfere with data collection (a major transect does not fall on the culvert) refer to the note on culverts in the “Unusual Situations” section. If it **does** interfere with data collection, perform a Stop and Start. (Refer to Stop and Start of Survey section.)
Greater than 4 times Bankfull width category in length	Relocate start of site.
Large Logjams “LJ”	
Less than 4 times Bankfull width category in length	Stop and Start. (Refer to Stop and Start of Survey section.) This is only used if the logjam prevents the collection of data. (I.e. if a <u>major</u> transect cannot be moved a reasonable distance to avoid the logjams effect on data collection.)
Greater than 4 times Bankfull width category in length	Relocate start of site.
Impassible waterfall (for crew)	If it does not interfere with collection of data (does not prevent layout of at least 2 transects), include in survey. Do this only if it is determined safe for the crew. If not, do a Stop and Start. If one transect falls on the waterfall, adjust the transect location either above or below the waterfall (whichever is closer and is safe for the crew to survey).
Passable waterfall (for crew)“WF”	**If the waterfall prevents collection of data, Stop and Start. (Refer to Stop and Start of Survey section.)**

Side Channels

A side channel is any channel separated directly from the main channel by an island with an elevation above bankfull. All transects (both intermediate and major) that are affected by a side channel will be marked with an additional pink flag that is labeled with the channel number (in case of overlapping multiple channels). Place the pink flag adjacent to the orange transect flag in the main channel as well as one within any qualifying side channels at the transect location. Both the inlet and outlet of each qualifying channel will be flagged as well.

1. Only side channels that begin and end within the site will be considered (Figure 7; SC-D does not qualify).
2. A side channel begins (and ends) at the location where it becomes separated from the main channel by an island (Figure 7: see SC-E). SC-G is considered part of the main channel because the water is split by a gravel bar which is below bankfull.
3. The following criteria must be met in order for a side channel to be included in the survey:
    a. There must be clearly defined bankfull indicators at some point along the side channel.
    b. The bankfull width of the side channel must be ≥ 20% of the bankfull width category (Table 3). Measure the bankfull width of the side channel at 25%, 50%, and 75% of the way, up from the downstream end. Average the results and compare to the site's average bankfull width. In Figure 8, SC-B, C, and E would qualify, and SC-F would not as it is too narrow.
    c. The side channel must enter and leave the main channel within the site.
4. Do not collect measurements in discontinuous side channels, where at any location (normally at the upstream end) the side channel **bed elevation** is higher than the bankfull elevation of the main channel.
5. Channels that do not meet the above criteria are not included in the survey.

Measurements in qualifying side channels will include large wood, pebble counts, streambank measurements and wetted widths.

Table 3. Minimum bankfull width for qualifying side channels.

Average Bankfull Width in meters	Width Category	Minimum average bankfull width for qualifying side channel
1 to 8	8	1.6M
8.1 to 10	10	2.0M
10.1 to 12	12	2.4M
12.1 to 14	14	2.8M
14.1 to 16	16	3.2M
16.1 to 18	18	3.6M
18.1 to 20	20	4.0M
20.1 to 22	22	4.4M
≥22.1	24	4.8M

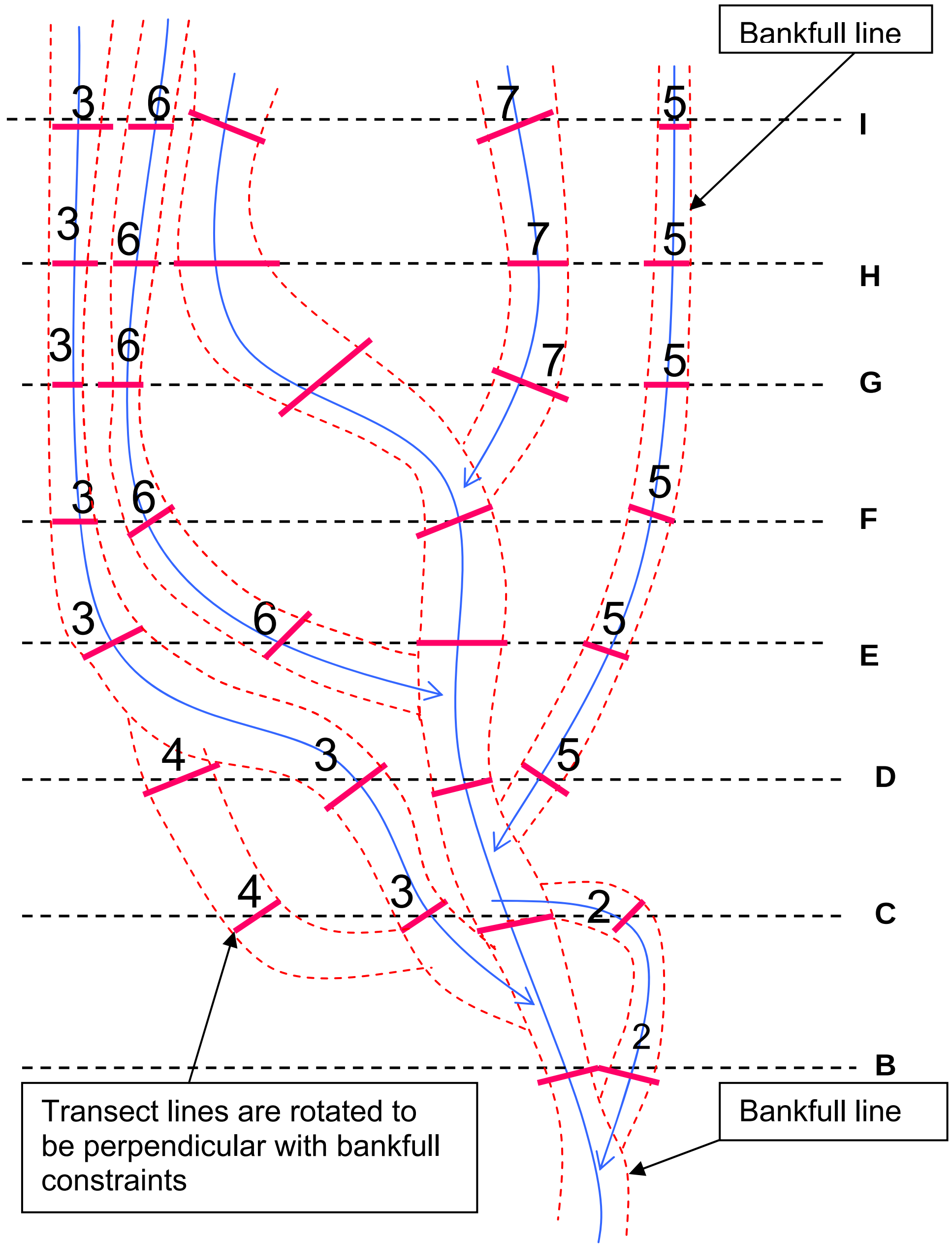


Figure 7. Numbering side channels and rotating transects at each channel. Major transects B - I are represented by the dashed lines and are labeled on the right. Channels are numbered by the order in which they are encountered in the site, while moving upstream. A channel does not need to enter the main channel or have water to qualify (side channel 4), as long as it meets the criteria for a side channels listed previously.

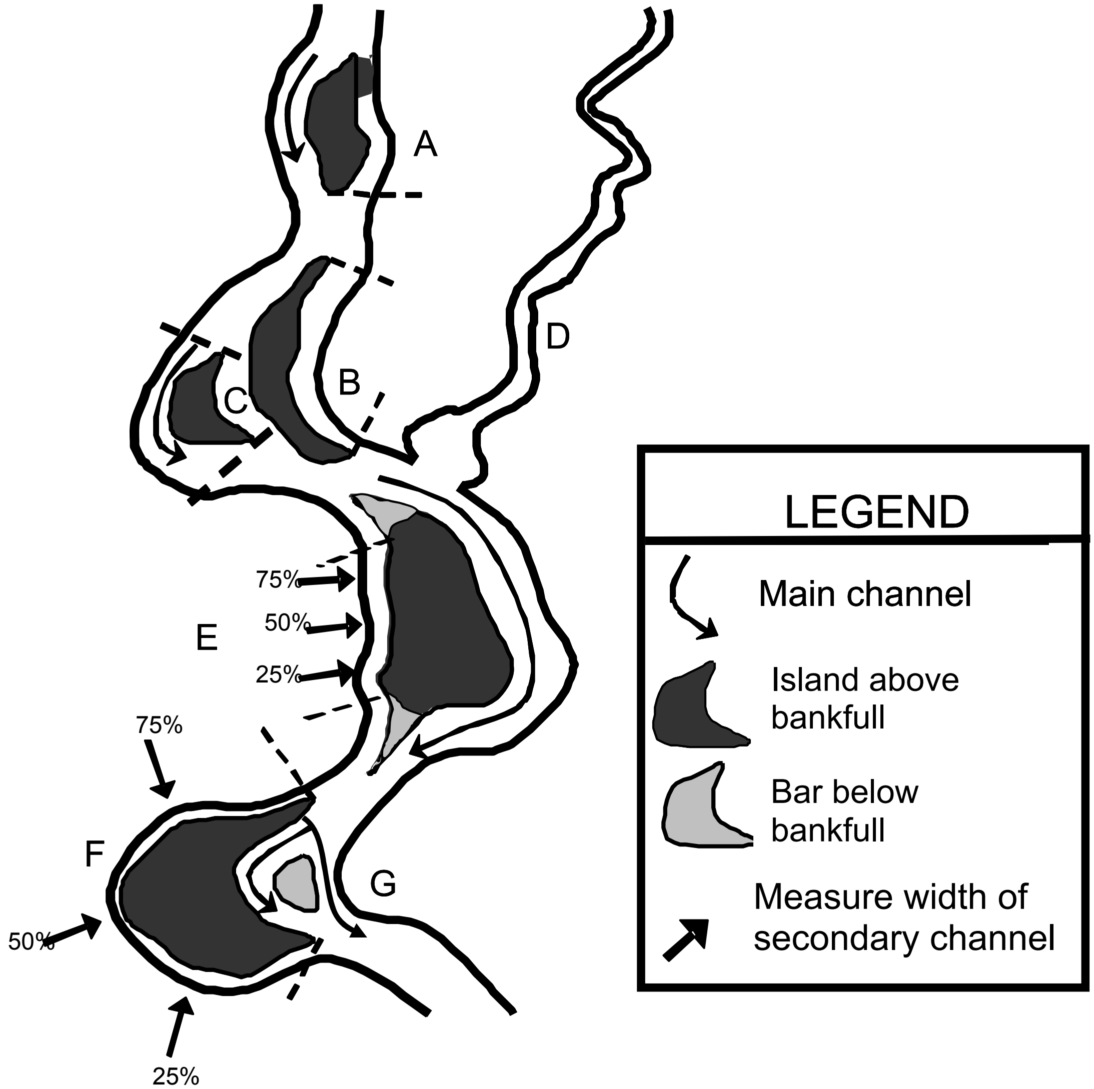


Figure 8. Examples of side channels. Channels B, C, and E are considered side channels ($\geq$ 20% of the bankfull width category) whereas channel F is excluded as it is too narrow. Channel A is excluded, because it does not have a head (entry point) to the channel. Channels E and F depict where to take width measurements within potential channels (at 25%, 50%, and 75% of the way up from the downstream end of the portion of the island that is ≥ the bankfull elevation). Channel D is not included because it began outside of the site. Channel G is part of the main channel since the bar is below the bankfull elevation.

Using the Laser and Electronic Compass

The laser rangefinder and electronic compass are used to accurately measure a variety of physical habitat attributes, such as; bankfull width, bankfull width to depth ratio, pool length, residual pool depth, gradient, and sinuosity. In addition, these instruments are used to create a map of the stream channel. For a more comprehensive guide on setting up and using these instruments consult the AREMP Electronics Protocol.

Initial laser setup

Set the laser and tripod up in a location that provides a clear line of site to the first transect and longitudinal. It is best to minimize the number of times the laser needs to be moved. When setting up the laser, the middle tripod pole should be **fully extended** and standing on a hard flat surface (usually a rock). The legs should be firmly dug into the ground so the tripod and laser are steady. The legs will have to be adjusted so that the unit is level, using the bubble on the tripod. Check the compass to ensure that the laser is level within 0.5 degrees. An alarm on the compass will sound if it is too far out of alignment. Conduct the compass calibration at each site location (use the AREMP Electronics Protocol compass calibration section to take you through this process). The LCD screen on the laser should always be set to HD (Horizontal Distance) and M (Meters).

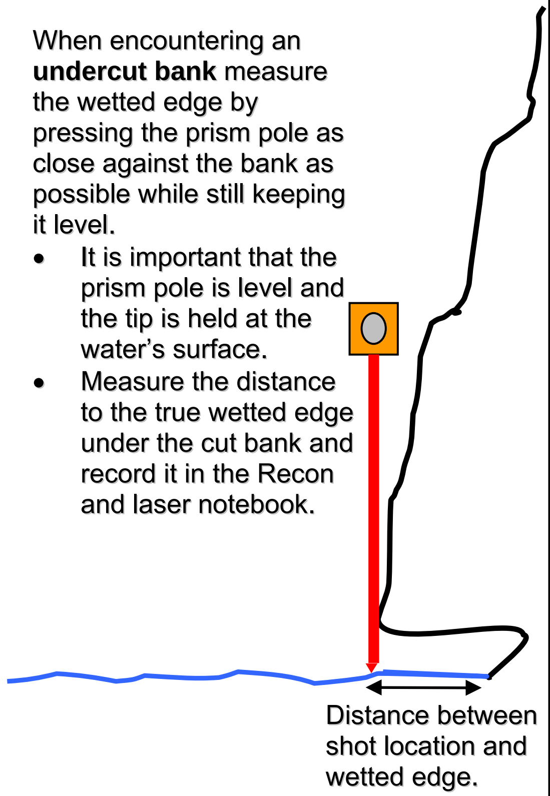
IMPORTANT: Be sure the center tripod pole is firmly placed on a flat surface, and the remaining legs are secured to the ground. A reasonable method is to place a heavy rock around the tip of the tripod legs to keep the whole unit from wobbling. The end piece of the center pole should be fully extended. When entering the Instrument Height (height of center leg) be sure to read the number at the bottom of the bracket.

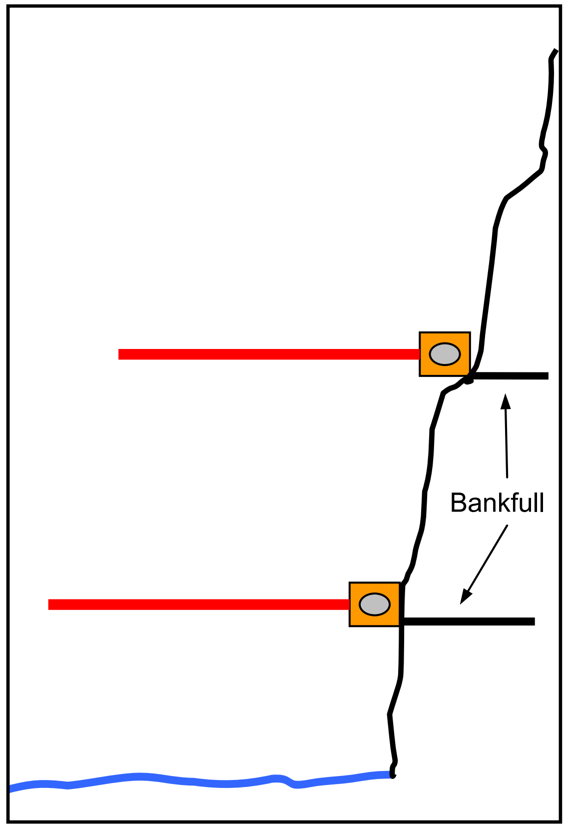
Using the prism pole and adjusting to survey hard to reach spots

1. Place the point of the prism pole on the substrate at the location you wish to measure with the laser and electronic compass.
2. Use the bubble level to ensure that the prism pole is oriented vertically. If the pole is leaning, it will change the location and elevation of the point that is taken.
3. The prism pole (Target Height) can be adjusted to prevent moving the laser unit. **Remind the laser operator to change the target height in the data recorder each time you change the height of the prism.** If the target height is not changed, the data will be incorrect and will require editing at a later date.
4. In the case of an undercut bank, it is important to capture the wetted edge at the point where you can see the wetted edge and shoot the point on the surface of the water only. Make a note of the undercut bank in the data recorder, and measure the distance of the undercut that is wetted.
5. In very tight situations, you may have to invert the prism pole or remove the prism from the pole and place the prism in the desired location. In this case, the rod height should be set at 0.08, the distance from the edge of the prism to the center of the glass.

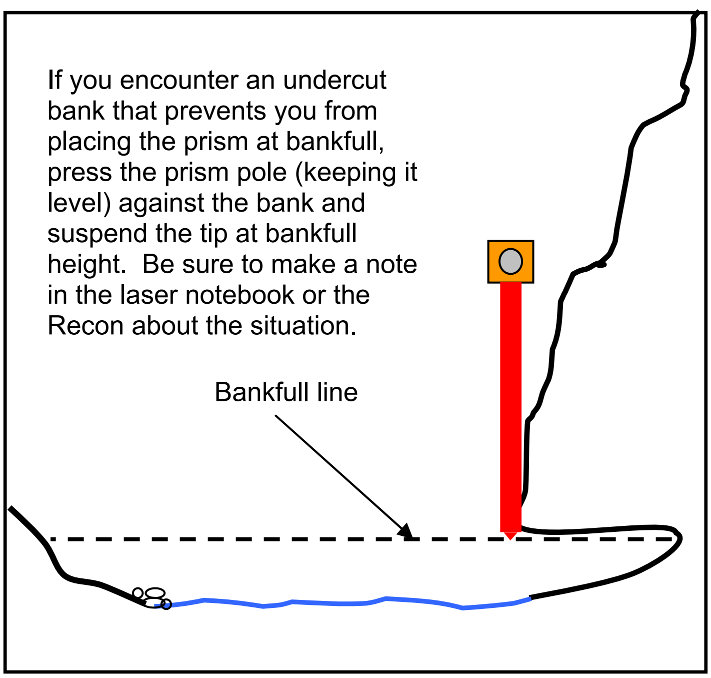
When encountering an **undercut bank** measure the wetted edge by pressing the prism pole as close against the bank as possible while still keeping it level.

- It is important that the prism pole is level and the tip is held at the water's surface.
- Measure the distance to the true wetted edge under the cut bank and record it in the Recon and laser notebook.





If you encounter an undercut bank that prevents you from placing the prism at bankfull, press the prism pole (keeping it level) against the bank and suspend the tip at bankfull height. Be sure to make a note in the laser notebook or the Recon about the situation.



Channel Morphology

Bankfull Width (note all references to stream directions are looking downstream)

Bankfull width will be measured at each major transect using the compass and laser. At each major transect, ten points will be collected; Left Bankfull, Left Wetted Edge, Thalweg, Right Wetted Edge, and Right Bankfull; and five equally spaced points visually estimated at 10%, 30%, 50%, 70%, and 90% across the channel (Figure 9). If the main channel is **dry**, collect 8 points at the transect, which include Left Bankfull, deepest point in channel along transect (where thalweg would be if water was present), and Right Bankfull; and five equally spaced points estimated at 10%, 30%, 50%, 70%, and 90% across the channel. Bankfull and wetted widths will also be collected in qualifying side channels. If the side channel is dry, points will be collected at both Left Bankfull and Right Bankfull locations and at the 25% and 75% locations of the bankfull width (Figure 10). At each intermediate transect take a point at the Thalweg (in a flowing channel) or in the deepest location (in a dry channel). Be sure to place the prism pole on the streambed when taking measurements.

Special Situation: If a large boulder or log is located on an increment point and the obstruction is <u>below</u> bankfull elevation, collect the point on top of the obstruction. If the obstruction is <u>above</u> the bankfull elevation, do not collect the point at that increment and make a note in the field data recorder.

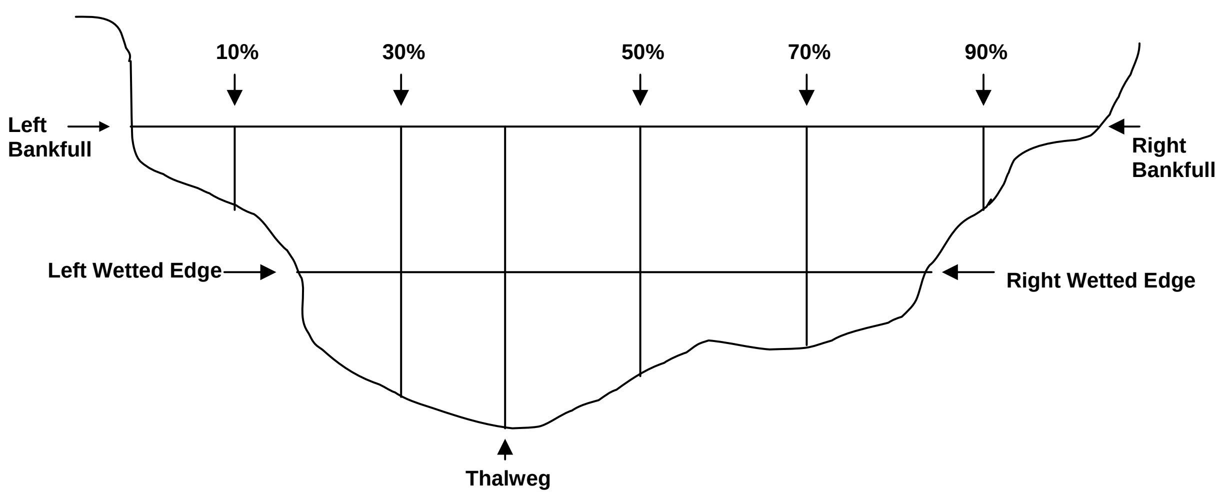


Figure 9. Example of the ten points collected at each major transect.

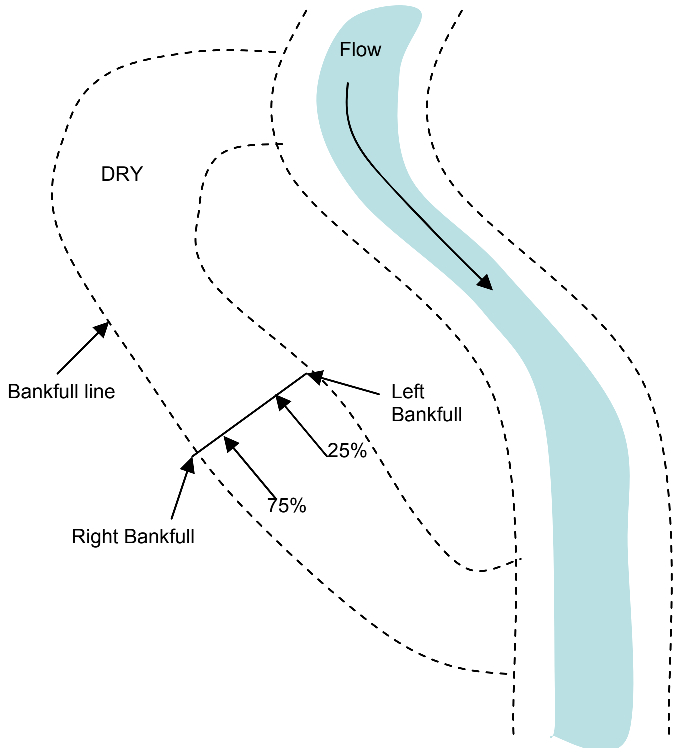


Figure 10. Four points will be collected on all side channel transects. If the channel is dry, place the prism at left bankfull, 25% and 75% of the bankfull width, and right bankfull. If the channel is wet, place the prism at left bankfull, left wetted edge, right wetted edge, and right bankfull.

Change in Elevation

Stream gradient is the average slope of the water's surface measured from the start of the site to the end of the site. To obtain gradient we use the change in elevation measured between left wetted at Transect A and left wetted at Transect K.

The elevation change will be measured twice, once upstream (traveling from Transect A-K) and once downstream (traveling from Transect K-A). These two elevation value differences will be averaged and used to calculate the site gradient. Using the steps listed below, recall the elevation values at both A and K left wetted (by double tapping on the point in the map screen) to calculate the difference and see if the two measurements are within 10% of each other. If they are not within 10%, you will measure the change in elevation a third time traveling from Transect A to K. All elevation values collected will be recorded, but no more than 3 changes in elevation will be measured.

Important: Be sure to mark where the points are taken for wetted edge at Transect A and K using a wax pencil to mark an "X"on the rock where the measurement is taken. Be very careful when working around these markers to ensure they are

not moved. Water levels can raise or drop during the course of a survey. In a dry channel, clearly mark where you took the point, as well.

Dry Channels

In the absence of water, find the deepest point in the stream channel, following the transect line for both A and K (Figure 11) for gradient measurements.

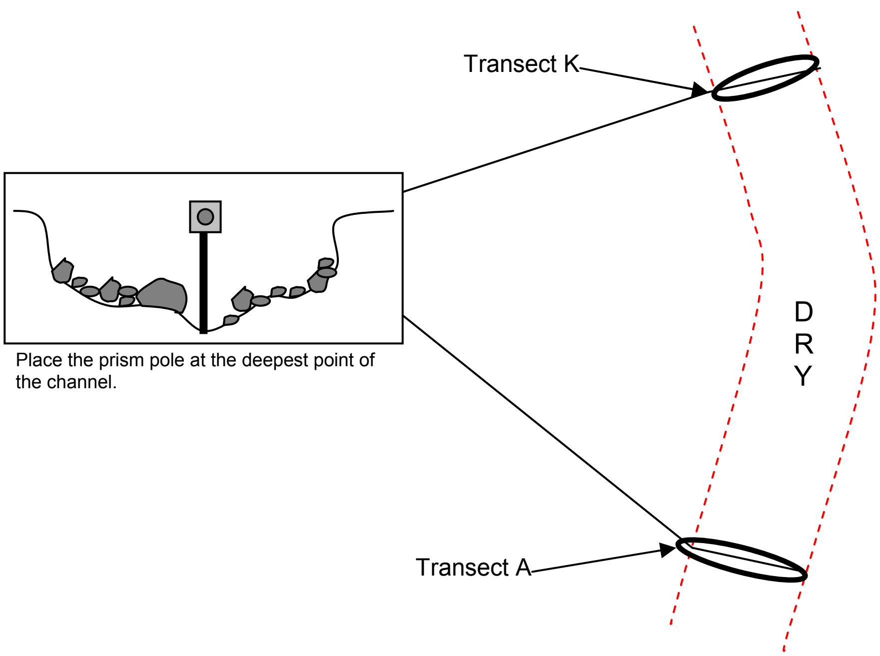


Figure 11. Example of where to place the prism pole in the situation where the stream channel is dry at both Transect A and K.

The following steps outline the process for collecting the appropriate data and how to calculate the elevation change. All of this information is entered into the Gradient Form on the field data recorder. At Transect A, write down the elevation value of the left wetted edge on the Gradient Form in the L (1) column. At Transect K record the elevation value for the left wetted edge in the L (2) column. When the laser survey is complete, re-shoot the left wetted edge of Transects K a second time. Then, traverse downstream and re-shoot the left wetted edge of Transect A, a second time. In the field data recorder, label these points as M (1) at Transect K and M (2) at Transect A, respectively.

The following calculations are automatically made in the Gradient Form, however, if the field data recorder fails follow these steps. Calculate the elevation change using the Z-values for each measurement as follows:

1. Calculate $L_2 – L_1$ = $Value_1$
2. Subtract $ZValue_1$ - [0.10 * $Value_1$]
3. Add $ZValue_1$ + [0.10 * $Value_1$]
4. Calculate $M_1 – M_2$ = $Value_2$
5. If the value calculated in step 4 is between the values calculated in steps 2 & 3, you are finished, otherwise go to step 6.
6. Re-shoot Transect A and K a third time.
7. Record values for N_1 and N_2 on Elevation Data Form and stop.

For example, after shooting the four points (two at each transect) you have the following values:

Point Set	Value $A_{\#}$	Value $K_{\#}$	Value difference	Lower 10 %	Upper 10 %
1	100.5	125.5	25	22.5	27.5
2	101.2	125.8	24.6		

If the Value difference is within the 10 % range (as demonstrated in this example), then do not shoot a third set of elevation points.

Note: If Transect K is located on a dry segment of the stream, take the upper elevation points at the next major transect with a left wetted edge.

Order of events for shooting laser and prism

Triangulation of monument location

Transect A waypoint taken with GPS = Y Tran, GA
Monument = Y Tran, MO
Transect A left bankfull elevation = Y Tran, LB

Survey points

Transect A left bankfull elevation = Tran A, LB
Transect A left wetted edge = Tran A, LW (mark the location of this shot for elevation!!)
Transect A left wetted edge = L1 (gradient shot)
Transect A thalweg = Tran A, TH
Transect A right wetted edge = Tran A, RW
Transect A right bankfull elevation = Tran A, RB
Transect A 10%, 30%, 50% 70% 90% (wherever they fall in order between left and right bank).

Transect A2 thalweg = Tran A2, TH

Transect B…………

Transect K left bank = Tran K, LB
Transect K left wetted edge = Tran K, LW
Transect K left wetted edge = L2 (gradient shot)
Transect K thalweg = Tran K, TH ……………
Transect K right wetted edge = Tran K, RW
Transect K right bank = Tran K, RB
Transect K left wetted edge = M1 (gradient shot)
Transect K 10%, 30%, 50% 70% 90% (wherever they fall in order between left and right bank).
Transect K waypoint taken with GPS = Y Tran, GK

Pools

Pool Length and Residual Pool Depth

Objectives:

- Quantify the relative length and frequency of pool habitat in each site.
- Determine the average residual depth of the pools.

Pool Criteria:

Sample every pool within the sample site that meets **ALL** of the following criteria for low flow conditions.

1. Pools are depressions in the streambed that are concave in profile, laterally and longitudinally.
2. Pools are bounded by a head crest (upstream break in streambed slope) and a tail crest (downstream break in streambed slope).
3. Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
4. Pools span at least 90% of the wetted channel width at any one location within the pool.
5. Pool length, measured along the thalweg from the head to the pool tail crest, is greater than its width. Pool width is measured perpendicular to the thalweg at the widest point of the pool.
6. Maximum pool depth is at least 1.5 times the maximum depth of the pool tail crest.

Keep in mind, the water surface gradient of a pool is typically less than the water surface gradient of the adjacent habitat units.

Note: When considering whether to lump or split two potential pools and both habitat units meet the above criteria for pools, consider them two pools if the pool tail depth of the upstream pool is similar to depths from other pools within the site. Conversely, consider it one pool if that pool tail depth is significantly deeper than other pools within the site.

Note: When islands are present, describe the habitat unit in the main channel regardless of the habitat type in the other channel.

Sampling method:

1. Place the prism pole at the deepest spot along the pool tail crest (see pool criteria #2.) to capture the pool tail crest location and label the point by the longitude it is located in, and as “PT” in the field data recorder (e.g. BC LONG, PT).
2. The maximum depth represents the deepest point in the pool and is found by probing the substrate with the prism until the deepest point is located. Label this point by the longitude it is located in, and as “PM” in the field data recorder (e.g. BC LONG, PM).
3. Place the prism pole at the pool head crest (see pool criteria #2) and label this point by the longitude it is located in, and as “PH” in the field data recorder (e.g. CD

LONG, PH). If the pool is a plunge pool, take the point at the headcrest with the prism point at the waters surface (see figure 12).

> ***If a sharp bend in a pool is encountered, capture extra points with the laser and prism. These will be labeled with the two letter longitudinal code that the pool is located in.*

4. Measure the pool tail crest depth on dammed pools along the top of the obstruction (mostly large wood) if all flow is going over the obstruction. Conversely, measure to the streambed if some of the water is observed flowing under the obstruction.

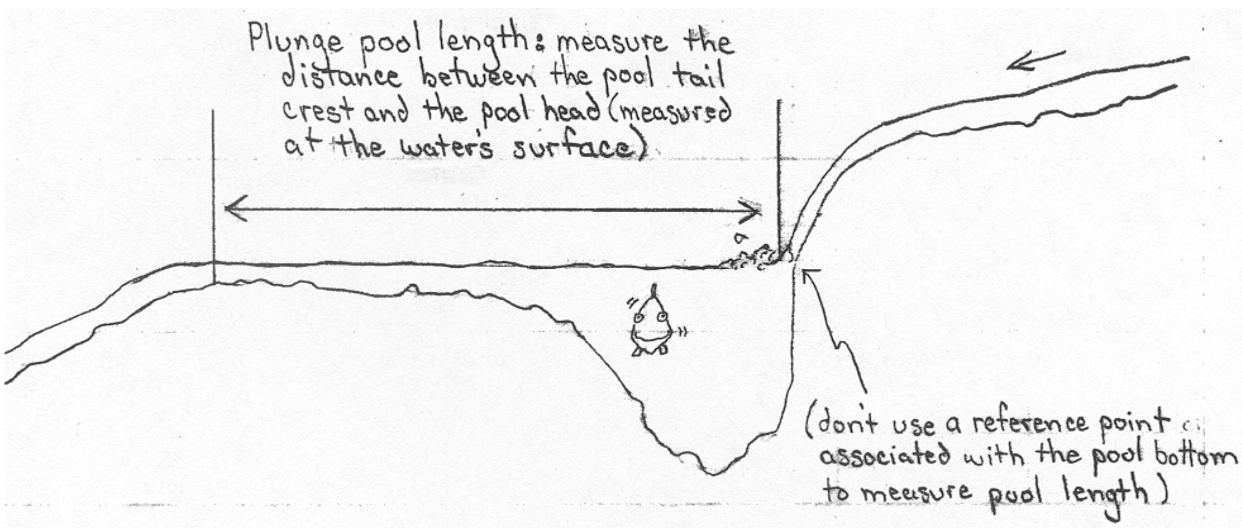


Figure 12. Example of a plunge pool situation in which you would measure the head of a pool where the surface of the water intercepts the bedrock/substrate.

Entrenchment

Entrenchment will be determined at all sites with less than 30 m in average bankfull width (average calculated during site determination; Table 4), and are less than 4% gradient (determined at end of the laser survey). Therefore, this task is one of the last tasks completed at a site.

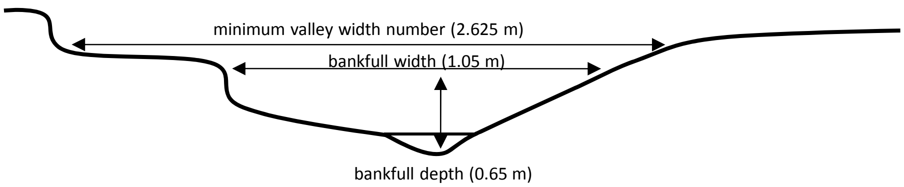
		Average BF width	
		≥ 30 m	**< 30 m**
Gradient	**≥ 4%**	***NO***	***NO***
	< 4%	***NO***	***YES***

Table 4: How to determine if a site is surveyed for entrenchment.

Determine whether the site is entrenched at Transect A. If the crew cannot measure the bankfull depth at Transect A due to deep water, move upstream to the next suitable major transect.

Sampling Method (Figure 13):

1. Stretch a meter tape from the left bankfull elevation to the right bankfull elevation, ensuring that the tape is level and perpendicular to the bankfull channel. Record the bankfull width in meters (to the nearest cm, for example; 1.05m) in the Entrenchment data form.
2. Multiply bankfull width by 2.5 to determine the minimum valley width number for entrenchment (*Note: This is automatically done in the Entrenchment data form*).
3. Using a meter stick or the prism pole, measure maximum bankfull depth, from the meter tape to the substrate at the thalweg (see page 11 for definition) along the transect. Record the bankfull depth in meters (to the nearest cm, example 0.65m) in the Entrenchment data form.
4. Multiply the maximum bankfull depth by 2 to determine the flood prone elevation (*Note: This is automatically done in the Entrenchment data form*).
5. At the flood prone elevation, stretch the meter tape perpendicular to the valley walls until you reach the minimum valley width number determined in Step 2. If you touch the ground of the valley wall on **both** sides of the channel, before you reach the minimum valley width number, measure and record the valley width to the nearest cm. (The site is entrenched). If you are not touching the ground of valley wall on both sides of the channel when you reach the minimum valley width number, record the minimum valley width number. (Site is not entrenched).



Bankfull width	Minimum valley width number	Maximum bankfull depth	Flood prone elevation
1.05 m	1.05 m * 2.5 = 2.625	0.65 m	0.65 m * 2 = 1.3

Figure 13. To measure entrenchment, the bankfull elevation and bankfull depth are measured. The minimum valley width number and flood prone elevation are calculated using the bankfull width and depth. This calculation is done automatically in the Entrenchment data form.

Physical Habitat

Substrate – Pebble Counts

Bed and bank materials of a stream are key elements in the formation and maintenance of channel morphology. These materials influence channel stability and resistance to scour during high flow events. The frequency of bed load transport can be critically important to fish spawning and other aquatic organisms that use the substrate for cover. The pebble count procedure was originally designed to quantify streambed substrate without having to collect substrate samples and take them back to the lab for sieve analysis. The procedure requires taking measurements of substrate *at increments along main channel and side channels transects within bankfull constraints.*

Pebble counts

1. Substrate will be measured at the 21 transect locations (Transects A – K) which may extend into adjacent qualifying side channels.
2. Measure 5 substrate samples at each transect. When a single main channel is present, visually locate the10%, 30%, 50%, 70% and 90% increment points within the bankfull width starting at left bank (See Figure 14).
3. When side channels are present at a transect, split the 5 substrate measurements between the main and side channels in proportion to their bankfull widths and adjust the measurement increments accordingly. For example, if the main channel has a 10-meter bankfull width and the adjacent side channel has a 5-meter bankfull width, take 3 substrate measurements at 25%, 50% and 75% of main-channel bankfull width and then 2 measurements at 25% and 75% of the side-channel bankfull width.
4. Without looking directly at the substrate of your sample location, step forward bringing your meter stick lightly down to touch the substrate. Reach down to the tip of the meter stick and pick up the first substrate that you touch with the tip of your finger. DO NOT LOOK while you are selecting the substrate.
5. Measure the substrate along the intermediate axis with a ruler (scale = mm). The intermediate axis is the median side (B axis) of the rock; it is not the longest side (length-wise) or the shortest side (depth) of the rock. Visualize the B axis as the smallest width of a hole that the particle could pass through.
6. If the substrate has a smooth dirt feel and is not gritty, call it silt and record it as 0.031. If it is gritty and is < 2 mm, call it sand and record it as 1.0. Anything 2 mm and greater should be measured and recorded. Bedrock (substrate 4096mm and larger) is defined as a boulder large enough to park a car on. When in doubt, measure the substrate. If you are unable to access the substrate due to a large piece of wood, enter the value -9998 on the Substrate data form. Only use the code if you are unable to get under the log*. Do not call it "wood" if it is a piece of bark or a twig.*
7. On larger boulders, you may have to use a field tape or flip the ruler end-over-end several times to get a measurement.
8. If rocks are embedded, you may have to feel for the intermediate axis with your hand and use your fingers as calipers.

9. Enter all data on the Substrate data form, starting with Transect A. Write each measurement in the appropriate blank. Only use –9998 if the wood is embedded in the substrate and it is impossible to reach under to select a pebble. If it is not possible to measure the substrate, perhaps because of a deep pool where the substrate is not visible for an ocular estimate, record –9999 for no measurement in the field data recorder.

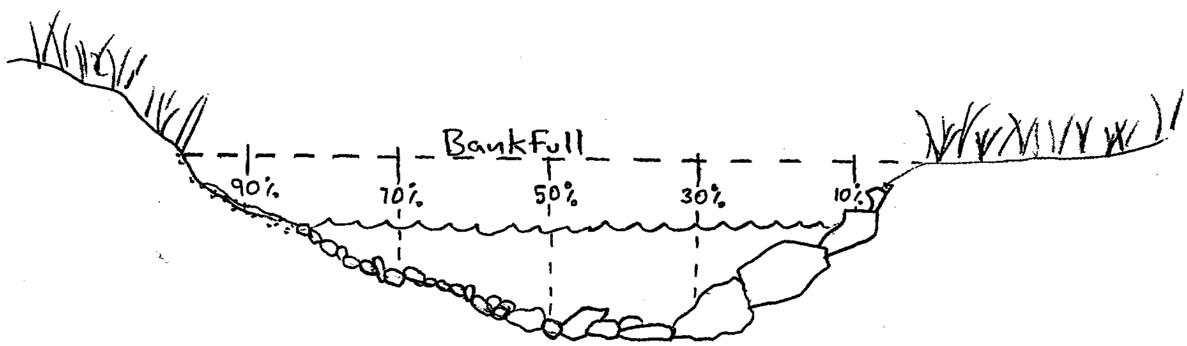


Figure 14. Transect divided for substrate measurement.

The Substrate data form - pebbles

1. To complete the pebbles portion of the substrate form, measurements should be taken at the appropriate transects and recorded in the appropriate location.
2. Take measurements and record at all main and intermediate transects.
3. For all measurements, enter either a number (mm) or the appropriate code for type of substrate encountered.
4. For data collected in side channels, change the channel code from S1 (main channel) to the code that corresponds to the side channel (e.g. S2, S3, etc.)

Percent Surface Fines on Pool Tails

Objective:

- Quantify the percentage of fine sediments on the surface of pool tail substrate.

Where to take measurements:

1. Collect measurements in the **first ten pools** of each site beginning at the downstream end. Exclude beaver or man-made dam pools.
2. Sample within the wetted area of the channel.
3. Take measurements at 25, 50, and 75% of the distance across the wetted channel, following the shape of the pool tail.
4. Take measurements upstream from the pool-tail crest a distance equal to 10% of the pool’s length or one meter, whichever is less.
5. Locations are estimated visually.

Sampling method:

1. Assess surface fines using a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid and there are a total of 50 intersections.
2. Take 3 measurements per pool (See Figure 13).
    a. Place the bottom edge of the grid upstream from the pool-tail crest a distance equal to 10% of the pool's length or one meter, whichever is less. Make sure that the grid is parallel to and following the shape of the pool-tail crest. (It is important to note that the pool tail crest is not always exactly perpendicular to the channel, See figure 13 below.)
    b. Place the center of the grid at 25, 50, and 75% of the distance across the wetted channel, making sure the grid is parallel to and following the shape of the pool-tail crest.
    c. If a portion of the fines grid lands on substrate 512mm or larger in size, on the b-axis, record the intersections affected as non-measurable intersections (Fig. 14).
3. Record the number of intersections that are underlain with fine sediment < 2 mm in diameter at the b-axis. Place a 2 mm wide piece of electrical tape on a ruler and use this to assess the particle size at each intersection.
4. Aquatic vegetation, organic debris, roots, or wood may be covering the substrate. First attempt to identify the particle size under each intersection. If this is not possible, then record the number of non-measurable intersections.

Note: Your total number of measurements should not exceed 50 total measurements per grid. I.e., you measured 20 fines under the intersections, but 30 intersections were completely covered in thick cover of macrophytes = 50. Therefore, 20 is recorded in the measured section and 30 in the non-measured column of the data sheet.

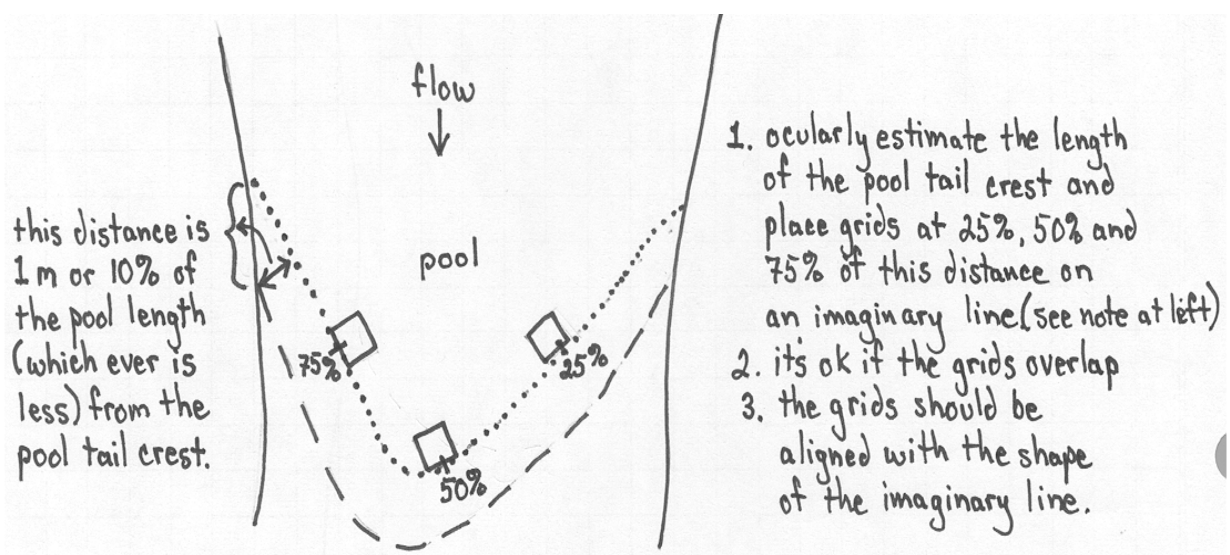


Figure 13: Example of where to place fines grid on a pool tail at 25%, 50% and 75%.

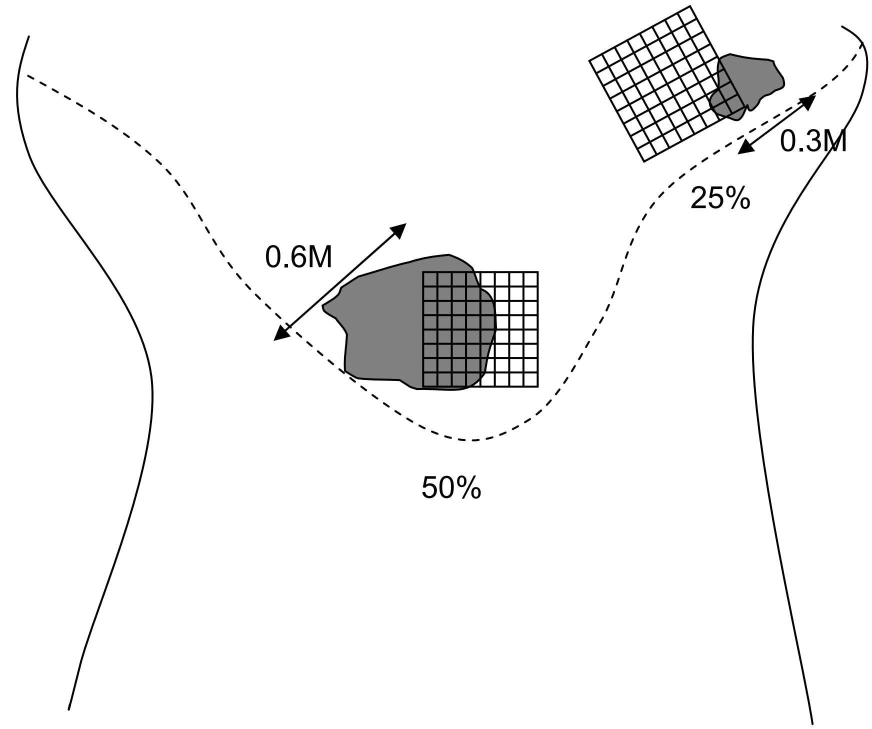


Figure 14: In this figure, all intersections of the fines grid at the 25% placement will be counted and recorded. For the 50% placement, the intersections of the fines grid that land on the boulder will be recorded as non-measurement.

Large Wood

<u>Objective:</u>

- Quantify the number and size of large wood pieces that are present within the bankfull channel, including qualifying side-channels.

<u>Sampling method:</u>

1. In order to be counted, each piece must meet **ALL** of the following criteria.
   a. Each piece must be greater than 3 meter in length and at least 30 cm in diameter one-third of the way up from the base, or largest end.
   b. Only include standing trees that lean within the bankfull channel if they are dead. Dead trees are defined as being devoid of needles or leaves, or where **<u>ALL</u>** of the needles and leaves have turned brown. Consider it living if the leaves or needles are green (Figure 15).

      Note: Use caution when assessing the condition of a tree or fallen log. Nurse logs can appear to have living branches when seedlings or saplings are growing on them.

   c. Wood that is embedded within the stream bank is counted if the exposed portion meets the length and width requirements.
   d. Do not count a piece if only the roots (but not the stem/bole) extend within the bankfull channel (Figure 16).
   e. Some pieces crack or break when they fall. Include the entire length when the two pieces are still touching at any point along the break (Only count as one piece if they are from the same original piece of wood). Treat them separately if they are no longer touching along the break. Count only the portion within the bankfull channel when they are no longer touching (Figures 17 &18).

2. Record the piece number, estimated length (nearest 10 cm), and estimated width (nearest cm) of all pieces in the site. The same person will make all estimates for a given site.
3. Also measure the length (nearest 10 cm) and diameter (nearest cm) of the first 10 pieces you encounter. The person estimating should not be made aware of the measured value.
4. A subset of pieces will be measured at sites with more than 10 qualifying pieces of wood.
   a. For sites estimated to have between 11 and 100 pieces, measure the first 10 pieces of wood encountered. Starting at piece number 11, measure every 5th piece of wood up to and including the 35th piece of wood. All subsequent pieces of wood will be measured every 10th piece (starting with number 45).
   b. For sites estimated to have over 100 pieces, measure the first ten pieces, then starting at the 11th piece only measure every 10th piece.

    c. If the piece of wood designated for measurement can not be measured safely; then measure the next piece of qualifying wood. Then continue measuring as specified above in a and b.

5. Measure the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.
6. Do not measure (just estimate) standing dead trees, pieces buried in log jams, or pieces that are unsafe to measure.
7. Begin counting from the bottom up when pieces are stacked on each other.
8. For wood in qualifying side channels, count only the pieces that are within bankfull.
9. Percent of the wood submerged at bankfull is an estimate of how much of the piece of wood will be underwater when the stream reaches its **bankfull** height.
10. Number of pieces touching, wood location and wood type will be collected and recorded. Evaluate wood location relative to the bankfull channel (See Table 5 and Figure 19).

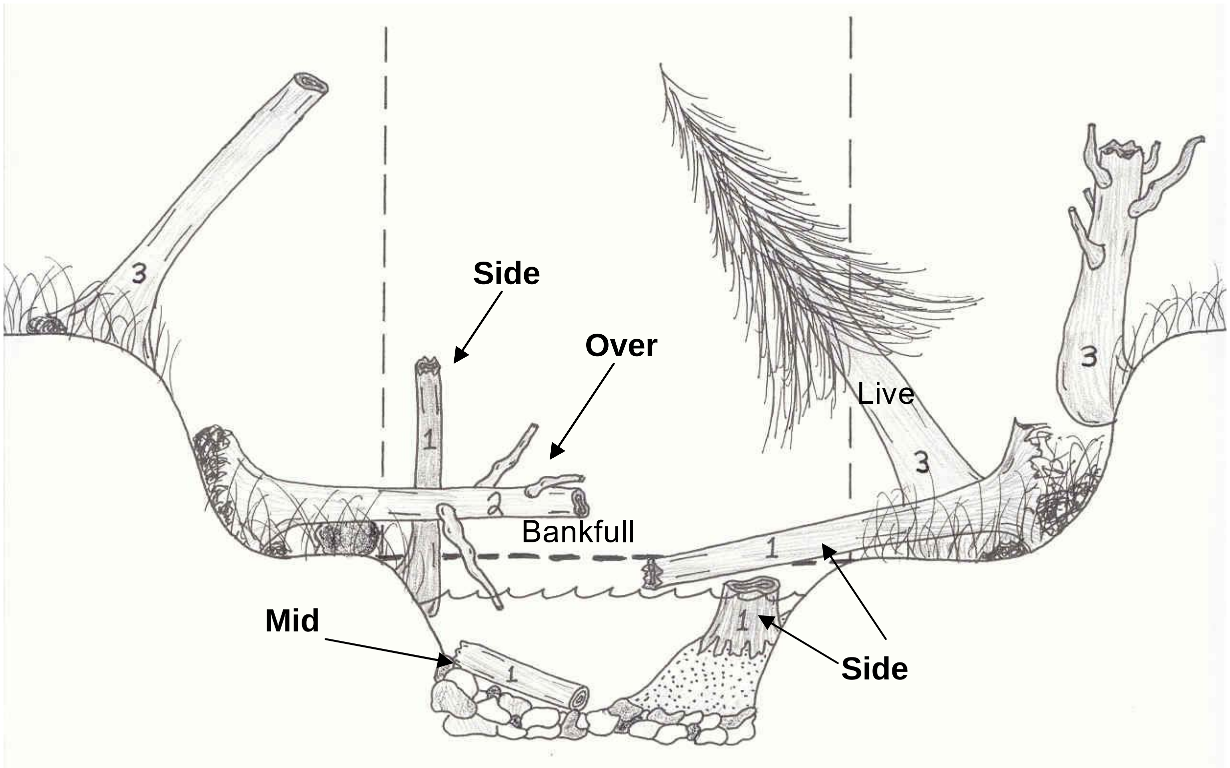


Figure 15. Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

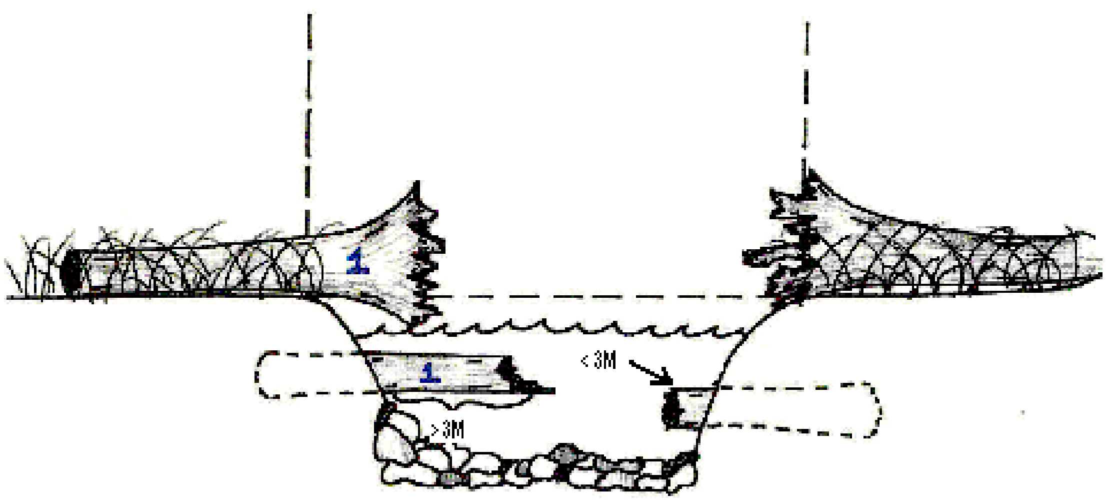


Figure 16. Examples of qualifying large woody debris (1). The pieces on the right side (3) are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

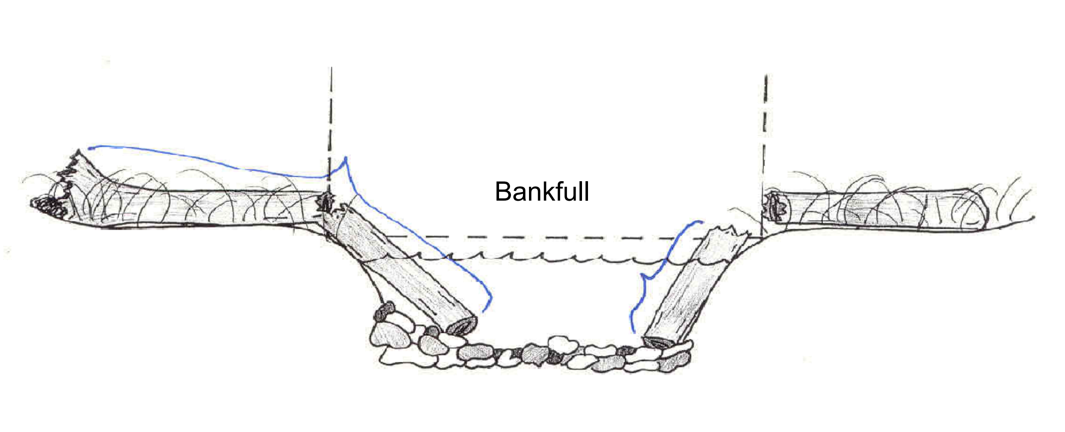


Figure 17. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

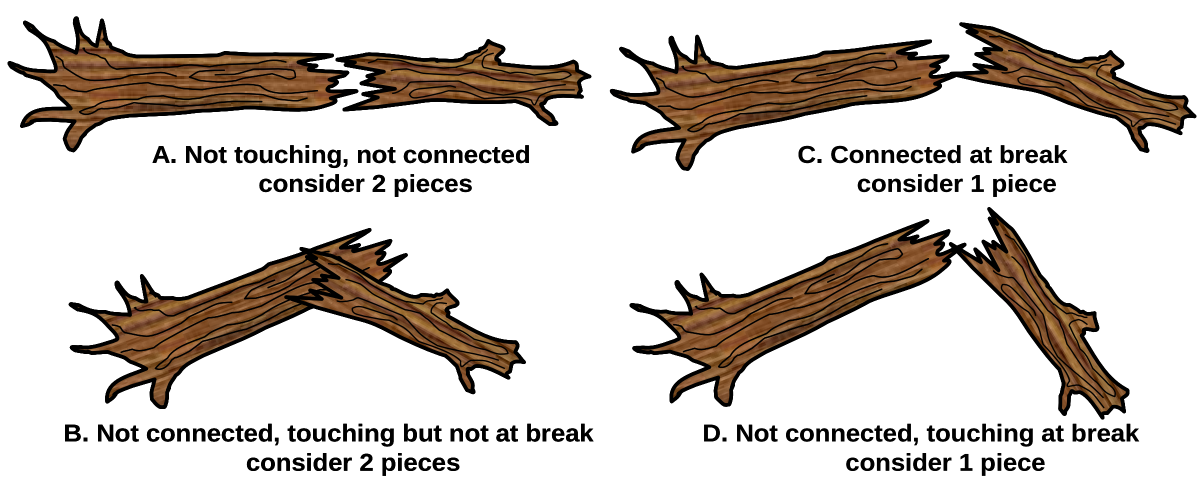


Figure 18. Variations of touching vs. not touching along the break.

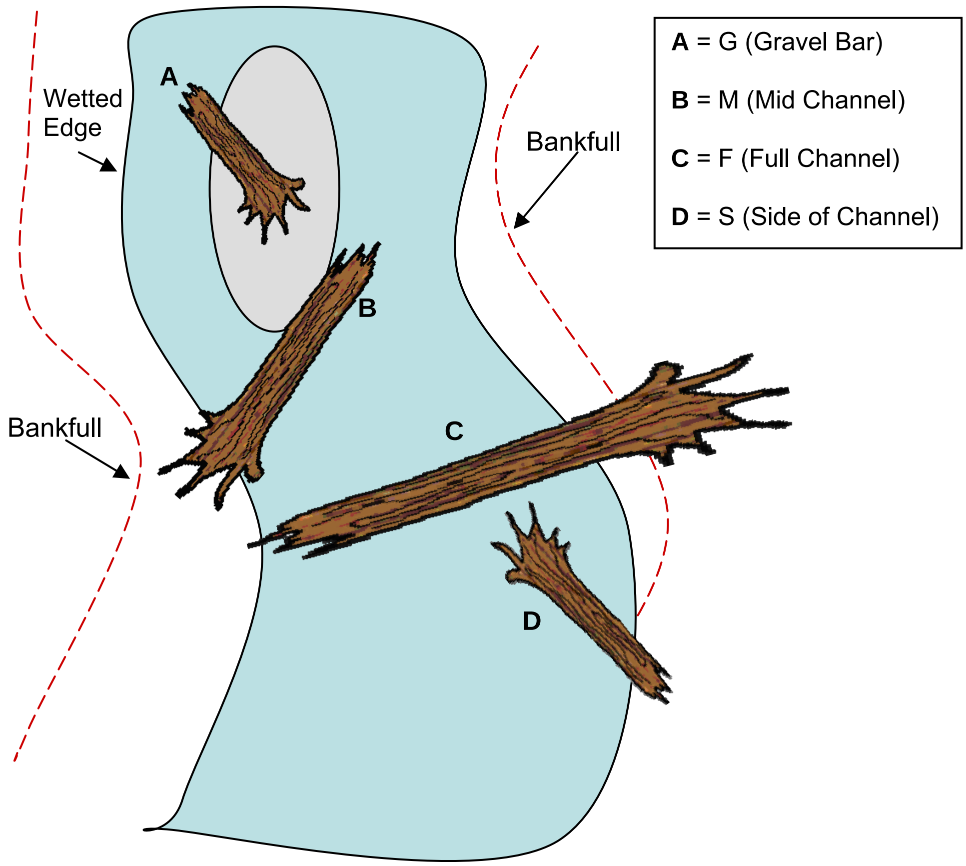


Figure 19. Example of wood locations in relation to the stream channel.

Table 5. Codes to be used with the wood data form.

Code Type	Definition
# Pieces Touching	
S →	**S**ingle piece
**A (1, 2, 3…) →	**A**ccumulation (2-4 pieces)
**J (1, 2, 3….) →	**J**am (>5 pieces)
Wood Type	
N →	**N**atural (broken ends or entire trees)
C →	**C**ut end
A →	**A**rtificial (part of a man-made structure)
RN →	**R**oot wad attached to trunk with **N**atural end (broken or entire tree)
RC →	**R**oot wad with opposite end **C**ut
Wood Location	
S →	**S**ide of the channel - Piece of wood covers or extends over a small portion (0-25%) of the stream channel (near bankfull edge).
M →	**M**id channel - Wood is in the main flow of the channel at bankfull (can be any orientation, not exclusive to center of the channel).
G →	**G**ravel Bar- (Build up of sediment below bankfull elevation with water flowing on both sides.) - 50% or more of the piece of wood is located on the gravel bar
F →	**F**ull channel - Wood extends across 75% or more of the stream channel. Portions may extend beyond bankfull elevation.
O →	**O**ver the channel - Suspended over the active channel, above the bankfull elevation. Includes pieces with a suspended bole but the branches extend below bankfull elevation.
Percent Submerged	Categories:
A	0-25%
B	25-50%
C	50-75%
D	≥75%

****Jams and accumulations will be numbered sequentially, in the order that they are encountered.**

If you do not encounter any wood on a longitude, fill-in the datasheet with the longitude and add to comments that there is no wood on that particular longitude.

Measuring Stream Shade

The Solar Pathfinder is used to quickly and accurately measure existing stream shade. This information will be used with data derived from satellite images of riparian vegetation to validate a shade prediction model.

Equipment Setup

Tripod set-up procedure (Figure 20):

1. Open the tripod and slip the legs into the grommets of the base support.
2. Using the sliding legs, rough level the base with the stream bottom.
3. Place the base with dome on the base support, then rotate the base so the south end of the compass dial is pointing south on the compass base.
4. Ensure the red end of the compass needle is pointing north.
5. Holding the sides of the base, move it to center the level bubble.

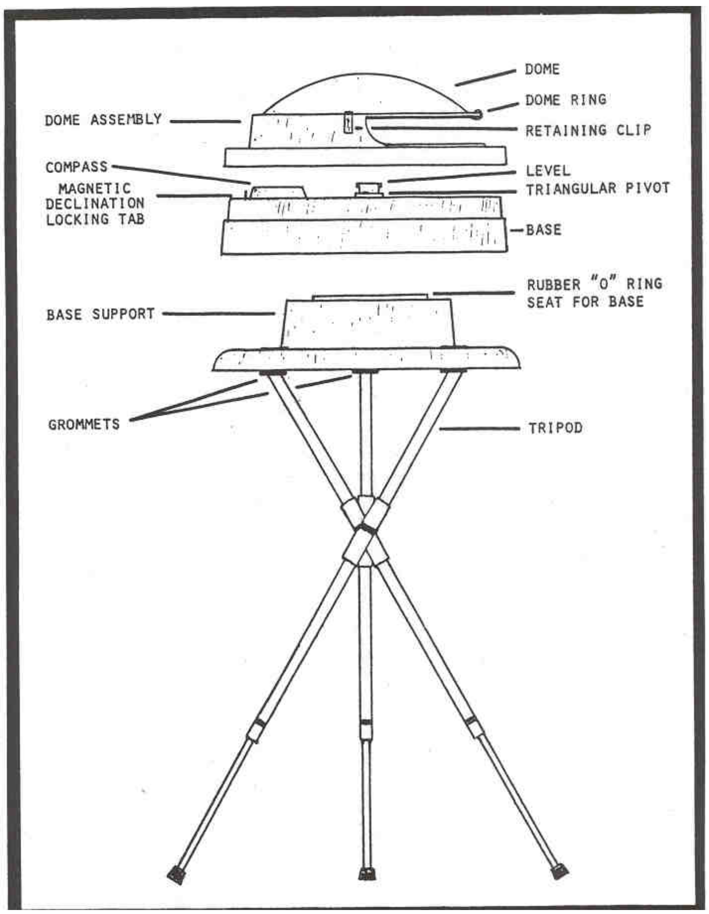


Figure 20. Parts of the Solar Pathfinder

Placement of the sun-path diagram:

1. Remove the dome and place the sun-path diagram over the level-bubble frame. Be sure you are using the correct sun-path diagram for your location as it varies with latitude and longitude.

Set the magnetic declination:

1. Magnetic declination west and east of north is marked at the top of the sun chart.
2. Pull out the declination locking tab at the base of the compass to allow the diagram to be rotated to set the magnetic declination.
3. Grab the frame of the level bubble and rotate the diagram counterclockwise to the appropriate magnetic declination, then push the lock tab in.
4. All declination values for the western U.S. are positive values on the declination number line (i.e., to the right of zero).

Measuring Stream Shade

Sampling Method:

1. Stream shade measurements will be taken at major transects A, C, E, G, I and K.
    a. If the **bankfull** width of the transect is less than 20 meters, collect one measurement at the mid-point of the bankfull width. If the **bankfull** width of the transect is greater than 20 meters, take measurements at one-quarter and three-quarters of the **bankfull** width.
2. Set up the Solar Pathfinder at the appropriate point(s) along the Transect as described above.
    a. Hold the unit with both hands at about one-half meter above the water's surface. Orient and level the dome, and take readings. Make a note in the Stream Shade datasheet stating that the tripod was not used at that transect.
    b. If the water is too deep to stand in, move upstream until you reach the next mid-bankfull channel location where measurements can be taken. Make a note in the Stream Shade datasheet describing the change in location (e.g., Site moved 5 m upstream from Transect A due to water depth).
3. Ensure that the unit is level and the dome is oriented south.
4. On the dome, follow the **August** sun-path line and observe the two small numbers between each of the vertical hour break lines. The numbers represent the percent of daily solar energy available for each half-hour.
5. Estimate the percentage of each hour line segment is shaded or blocked by shadow-casting objects.
6. Record the estimated values in the Stream Shade table on the field data recorder.

Biological Sampling

Benthic Macroinvertebrates

The benthic invertebrate protocol is the same as that described by Hawkins et al. (2001). Benthic invertebrate samples should be collected at all sites.

Objectives: Describe the composition and health of the macroinvertebrate community.

Where to take samples:

1. Begin sampling at the first fast-water riffle habitat encountered at the site and continue upstream to the next 3 fast-water riffle habitat units. Two samples will be collected from each of the four riffles.
2. Determine net placement within each habitat unit by generating 2 pairs of random numbers between 0 and 9 on the data logger. The first number in each pair (multiplied by 10) represents the percent upstream along the habitat unit's length. The second number in each pair represents the percent of the stream's width from river left looking downstream (RL). Each sample will be obtained from the location where the length and width distances intersect (estimate by eye).
3. Repeat this process to locate the second sampling location. If it is not possible to take a sample at one or both of these locations (log in the way, too deep, cannot seal bottom of net, etc.), generate an additional set of random numbers and sample the new location.

Sampling method:

These methods were described by Hawkins et al. (2001)

1. Collect samples using a Fixed Area Design (0.72 m^2) from fast water habitats with a 500 μm mesh net. Take invertebrate samples from 4 different fast-water (e.g. riffles, runs) habitat units. Take 2 separate 0.09 m^2 fixed-area kick net samples from each unit for a total of 8 samples. If no fast-water habitats occur, take the 8 samples from shallow, slow-water habitat units. Combine the 8 individual samples into a single sample that will be used to represent the study area.
2. Place the kick net so the mouth of the net is perpendicular to and facing into the flow of water. If there is no detectable flow, orient the net to most easily facilitate washing benthic material into the net. Collect invertebrates from within the 0.09 m^2 sampling frame in front of the net. Work from the upstream edge of the sampling plot backward and carefully pick up and rub stones directly in front of the net to remove attached organisms. Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations. After removing all large stones, disturb small substrates (i.e. sand or gravel) to a depth of about 10 cm by raking and stirring with your hands. Continue this process until you can see no additional organisms or organic matter being washed into the net. After completing the sample, hold the net vertically (cup down!) and rinse material into the bottom of the cup. If a substantial amount of material is in the net, empty the net into the 14-liter bucket for processing before continuing to the next sample location. Otherwise,

move to the next sample location and repeat the above procedure to create a composite sample.

3. Field processing requires a 14-liter bucket, a white plastic washtub, and a 500 μm sieve. Use the bucket to decant organisms from inorganic substrates into the sieve. Use the washtub to transfer stream water into the bucket and then to visually inspect inorganic residue for heavy organisms that were not decanted.
4. Continue this process until all 8 samples have been collected and placed in the bucket. Make sure you thoroughly wash organisms from the net by vigorously pouring water down the net and into the cup. If the net has a cup at the end, remove the cup over the top of the bucket and wash it out.
5. Examine the contents of the bucket for non-native snails, mussels, or crayfish as described in the Invasive Species section below.
6. Remove and release from the bucket/washtub/sample jar all vertebrates, including fish and amphibians. Also remove and release native crayfish.
7. Add water to the bucket and decant invertebrates and organic matter from the sample by stirring the contents of the bucket and then pouring suspended material through the 500-μm sieve. Repeat this process until no additional material can be decanted. Transfer the material in the sieve (invertebrates and organic matter) into the 2-liter sample jar with a small spoon and then wash any remaining material in the sieve into the jar with a squirt bottle. Place the inorganic residue remaining in the bucket into the plastic washtub and cover with water to a depth of 1 cm. Inspect the gravel on the bottom of the tub for any cased caddis flies or other organisms that might remain. Remove any remaining organisms by hand and place in the sample jar.
8. Once all samples have been processed, fill the jar/s with 95% EtOH. Immediately label the jars both inside and outside. Preserve this composite sample in 1 or more sample jars depending on the amount of material collected. If there are multiple jars, label them as 1 of 2 and 2 of 2, etc. and then tape them together.

Invasive Species

Invasive species can have a multitude of effects on native flora and fauna. The presence of invasive species can indicate degraded watershed condition. All sites will be examined for the presence of any invasive species listed in Table 6. Invasive species surveys will occur at three different times (associated with other protocols) at each site and will target different species and their preferred habitats. Incidental occurrences of any non-native plants or animals should be recorded on the Incidental Invasives data form.

Aquatic plants

Sampling methods

1. During site layout, examine the wetted portion of the channel for any potential non-native invasive plants. Be sure to cover the entire site, and thoroughly examine any off-channel wetted areas as well.
2. If a non-native plant is encountered, take photographs and collect specimens and place them between two sheets of paper in a plant press (see Appendix D for plant press protocol). Label the paper in the plant press with watershed code, site number, date, species code, and personnel code. Try to keep specimens in a cool dark place to avoid rapid decomposition.
3. On the Aquatic Invasives data form, record the longitude segment, the species code, the jpeg number of any photographs taken, and whether or not a sample was taken of any non-native plants found.

Aquatic animals

Sampling methods

1. During site layout, examine the wetted portion of the channel for any potential non-native invasive animals. Be sure to cover the entire site, and thoroughly examine any off-channel wetted areas as well.
2. After obtaining eight benthic macroinvertebrate samples in the first four fast-water riffles of the survey (as described in the Benthic Macroinvertebrates section above), empty the contents of the sample collection net into a large washtub or bucket.
3. Examine the contents of the sample for the presence of any non-native snails, mussels, or crayfish listed in Table 6 and pictured in the reference material.
4. If a non-native crayfish is found in the sample, take photographs, and then place it into a separate jar. Preserve the specimen using 95% EtOH as described in the Benthic Macroinvertebrate section of this protocol. Label the jar with watershed code, site number, species code, date, and personnel code. Record any native crayfish found in the macroinvertebrate sample on the Incidental Vert sheet, then release the native crayfish
5. If any non-native snails or mussels are found in the sample, take photographs and enter the species code and jpeg numbers on the Aquatic Invasives data

form. Place the animals back into the bucket to be processed with the macroinvertebrate sample.

6. If you found non-native species, finish decanting and preserving the eight original subsamples, and collect more samples at various locations in the site until you find more of the non-native specimens.
7. Place the extra specimens into a separate jar, preserve them with 95% EtOH, and label the jar with watershed code, site number, species code, date, and personnel code.
8. On the Aquatic Invasives data form, record the location as "Benthic Sample", the species code, the jpeg number of any photos taken, and whether or not a sample was collected of any non-native animals found.

Terrestrial plants

Sampling method

1. Terrestrial plant surveys will be performed in longitudes A-B, F-G, J-K.
2. Left and right bank on each side of the site will be examined for 5 minutes.
3. Crew members should start at the bankfull indicator of the upper transect (B, G, K) on opposite banks, and thoroughly examine an area from the transect to downstream transect that is no more than 5 meters in width from the bankfull indicator line. If you reach the next major transect before the 5 minute search time elapses, you may continue downstream, but do not pass the next major transect where a plant survey will be performed.
4. If multiple channels occur at the search location (ie, side channels), conduct the search on the outermost left and right banks. Do not conduct searches on islands or mid-channel gravel bars.
5. Work in a zig-zag pattern for 5 minutes, examining the riparian vegetation for any non-native plants as indicated in the species list (Table 6) and the reference material.
6. When a non-native plant is encountered, pause the stopwatch and document the plant. On the Terrestrial Invasives data form, record longitude segment, the species code, the bank the plant was found on (L or R), and the jpeg number of any photos taken. Take a GPS reading at the location of the non-native plant.
7. Re-start the stopwatch and continue the survey until 5 minutes have elapsed.
8. At the end of the 5 minutes, fill out the Terrestrial Invasives data form, recording the longitude, the time, and the estimated length and width of the area searched on each bank during the survey.
9. If a suspected invasive plant species is encountered, but can not be identified in the field, collect a specimen and place in plant press (See Appendix D for plant press procedures).

Terrestrial animals

Sampling method

1. During the terrestrial plant survey and large wood surveys, crew members should examine the riparian area for any sign of feral swine.

2. Take photographs of any tracks, feces, or disturbed areas that would indicate the presence of feral swine. The most consistent indication of feral swine presence in the area are large dig outs, or disturbed areas that look similar to areas heavily grazed by cattle, but are lacking other signs of domesticated livestock in the area.
3. On the Terrestrial Invasive data form, record the species code, the location, and the jpeg number of any photos taken documenting the presence of feral swine.
4. Do not collect any samples of feral swine or feces (feral swine carry diseases that can infect humans).

Incidental invasives

If any plants or animals listed in Table 6 are found during other protocol surveys or while traveling to and from sites, be sure to document their presence on the Incidental Invasives data form. Take photographs of any specimens found and collect samples of any aquatic plants or animals that are encountered.

Table 6: Invasive species of concern

Type	Common name	Genus species	Species Code
Aquatic animals	New Zealand mudsnails	Potamopyrgus antipodarum	POAN
	Zebra mussels	Dreissena polymorpha	DRPO
	Quagga mussels	Dreissena rostriformis bugensis	DRRO
	Rusty Crayfish	Orconectes rusticus	ORRU
	Red Swamp Crayfish	Procambarus clarkia	PRCL
	Ringed Crayfish	Orconectes neglectus	ORNE
	Northern Crayfish	Oronectes virilis	ORVI
Aquatic plants	Yellow Flag Iris	Iris pseudacorus	IRPS
	Hydrilla	Hydrilla verticillata	HYVE
	Parrot Feather Watermilfoil	Myriophyllum aquaticum	MYAQ
	Eurasian Watermilfoil	Myriophyllum spicatum	MYSP
	Giant Reed	Arundo donax	ARDO
	Brazilian Elodea	Ergeria densa	ERDE
	Didymo	Didymosphenia geminata	DIGE
Terrestrial animals	Feral Swine	Sus scrofa	SUSC
Terrestrial plants	Japanese Knotweed	Fallopia japonica	FAJA
	Cultivated Knotweed	Polygonum polystachyum	POPO
	Giant Knotweed	Polygonum sachalinese	POSA
	Giant Hogweed	Heracleum mantegazzianum	HEMA
	Old Man's Beard	Clematis vitalba	CLVI
	Garlic Mustard	Alliaria petiolata	ALPE
	Himalayan blackberry	Rubus discolor	RUDI
	English Ivy	Hedera helix	HEHE

Vertebrates

Terrestrial Amphibians

Terrestrial amphibian searches will occur at each site within specified watersheds. Above all else, care must be taken when handling organisms. Remember that amphibians absorb substances through their skin, and the chemicals in sunscreen and bug repellent will be toxic to amphibians. Under no circumstance will the crew members performing amphibian searches be wearing bug repellent or sunscreen until they have completed surveying.

1. Surveys will be performed at Transects B, D, F, H, J and K within the site. Crew members should start at the wetted edge and search their way downstream on each bank for five minutes (ten minutes total at each transect). Do not pass the next major transect downstream. Be sure to estimate the total area searched along each bank: the width (away from the wetted edge) of the area searched will be restricted to a maximum of 2 meters. (Note: the dimensions recorded are the actual meters searched, not covered.)
2. If multiple channels occur at the search location (ie, side channels), conduct the search on the outermost left and right banks. Do not conduct searches on islands or mid-channel gravel bars.
3. During this time, roll over rocks and logs, and dig carefully through leaves and soil. Make every effort to minimize your impact on the habitat. Return rocks and logs and other objects back to their original locations on the bank.
4. When an amphibian is found, stop the time and identify and measure the organism for total length and snout to vent length, in millimeters. When returning animals to the field, place them in the same area you found them in and resume the survey. If you found the animal under a rock, place it beside the rock rather than back under the rock to avoid smashing the animal. Continue searching for the remainder of the 5 minute survey.
5. Be sure to target riparian areas along both banks between transects that amphibians might use as habitat, e.g. seeps or springs, mossy areas, or other moist, cool areas.
6. Other data to record:
    a. Estimate the length and width of the area searched in meters, the type of habitat searched (you will enter the appropriate code on the Terrestrial Amphibian data form), and the air temperature.
    b. If an amphibian was captured, identify 1) which bank it was caught on (left or right looking downstream),2) habitat (ranking from most, condition of the habitat, 3) location of specimen (in/on/under) within the habitat, 4) measure snout vent length (SVL) and total length (TL) (however, do not measure the total length of frogs or toads) 5) what habitat it was in, 6) the distance from the waters edge, 7) the life history stage (juvenile or adult), and 8) any mortality information.
7. It is important to be very specific about the habitat when an amphibian is found. This can include; slope aspect, distance from stream, and the specific habitat type. Write these conditions on the comments section next to the individual amphibian captured.

Photographs of Biota

Follow these general guidelines when taking photographs of animals.

- Please be aware that you may be working with threatened or endangered species in some areas and that handling all species with care is your first priority. Keep all individuals moist and place them back into their habitat as soon as possible. Only take a picture of the animal if it doesn't put any further stress on the individual.
- Use a small object for scale (e.g., pencil, ruler, fish board).
- Avoid having people in the picture (hands or fingers are ok).
- Zoom in to capture the specimen only.
- Re-take the picture if the clarity, color, focus, angle or lighting is poor.
- It is especially important to take pictures of specimens that cannot be identified.

A picture should be taken of each new species encountered by each crew member at a site. Only take a few pictures of the representative sample of each species found at the site.

Aquatic Amphibians

1. Place specimen on its abdomen next to a ruler and capture the full length of the amphibian.
2. Also, take any pictures on the ventral and lateral side that may help further identify the individual.
3. Take a picture of any distinguishing feature about the specimen.
4. Take a picture if you can't identify the species of the animal.

Terrestrial Amphibians

1. Place active amphibians in a moist, aerated transparent bag and quickly take a picture (puff up the bag to protect the animal and place a small amount of water inside).
2. Important: do not place amphibians in a closed hand, because they are heat intolerant and may become highly metabolic, which can cause death.
3. Hold gently in moist hand that is free of bug repellent and sun screen and take abdominal picture.
4. Take pictures from all angles, so that you can capture mottling, skin color, limbs and other distinguishing features.
5. Take a picture if you can't identify the species or family.

Aquatic Snails, Mussels, and Crayfish

1. Place the specimen on something that provides a good scale reference.
2. Take pictures of the dorsal and ventral sides.
3. Take pictures of any distinguishing feature about the specimen (i.e., operculum, gills, etc.).

Aquatic and Terrestrial Invasive Plants

1. Take pictures of the entire plant, including something in the picture for scale reference.
2. Take close-up (macro) pictures of different key areas of the plant that could aid in identification (i.e., flowers, leaves, stems, roots).

Water

Water Chemistry

Water temperature and conductivity data will be logged at five minute intervals for a minimum of two hours at each site using a YSI meter. Place the meter at the *top* of the site just above Transect K unless a ***significant* tributary** enters the site. A significant tributary has a discharge equal to at least *15% of the total stream discharge.* If a significant tributary enters the site, place the YSI two bankfull width categories downstream of the tributary junction. If the tributary enters the site between Transect A and B, place the YSI in suitable habitat below Transect A.

1. The YSI meter and probe module is an extremely precise and delicate piece of equipment and should be handled with care. Always store the probe with the calibration/transport sleeve on and make sure the sponge at the bottom of the sleeve is moist. When the YSI meter is in the stream, it should be protected by the probe sensor guard. Remove the calibration/transport sleeve prior to logging data.
2. At Transect K, place the probe into the center of the stream, away from the banks in an area such as a riffle or pool tail crest where the water flowing past the probe is representative of the water in the stream. Avoid placing the probe in a turbulent area or pool. (Pools do not have adequate mixing to ensure a uniform temperature throughout the pool.) Gently place rocks on the cord to hold the probe in place.
3. Turn on the YSI and allow it to warm up for **three** minutes.
4. Record the current time (military time), temperature, conductance, and specific conductance in the data recorder.
5. The meter will be in run mode when powered up. To begin logging:
    a. Scroll to “Start logging” and press ↵(Enter).
    b. From the submenu, scroll to Site List and either choose the site code file from the list or choose New Site and enter the site code as the file name. The site code file name format is as follows: state code (two letters), watershed code (three-letters) and the site number (four numbers). **Example:** ORRCK1003 (ORRCK9003, ORRCK6003).
    c. When you are finished selecting or entering the filename press Enter,
    d. The Run screen will appear. Choose Start Logging and the YSI will begin logging data every five minutes. Allow the YSI to log data for at least two hours.
6. When you are finished logging data, select “Stop logging” and press Enter. Turn off the YSI and insert the probe into the transport/calibration sleeve (with moistened sponge inside) for transport and storage.

Placing and Retrieving Thermographs

Thermographs are to be placed in each watershed prior to the field season by the Recon Crew. A survey crew may be asked to retrieve a thermograph at the end of the field season. Temperature data will be collected hourly from June 1 through September 15. All thermographs should be removed from the watersheds by October 15.

Thermograph location and placement:

1. The thermograph should be placed in the lower-most, accessible point of the watershed on federal land, with these exceptions:
    a. If the federal landholdings are discontinuous, place the thermograph on the lower-most continuous portion of federal land that will be surveyed, downstream of all sites and tributaries with sites.
    b. If the HUC is a composite watershed (a drainage basin that has water input from outside the basin) and the mainstem will not be sampled, place the thermograph in the largest tributary <u>that will be sampled</u> at the lower-most point on federal land.
2. Launch the thermograph on the day of placement. Make sure it begins logging prior to placement in the stream.
    a. Program the thermograph to log temperature hourly for 331 days
    b. Label the file with watershed name, code and year.
    Example: ORSES_E_Fork_Smelly_Creek_2003
3. Secure the thermograph in the steel pipe to a steel cable with a bolt.
4. Place the thermograph in deep, flowing water (not a pool), ideally in the thalweg or other area which will remain underwater throughout the summer. Avoid high-traffic locations.
5. Secure the thermograph under rocks and attach the cable to a tree or other anchor point. Bury the cable under rocks or wood.
6. Document the time and water temperature using a NIST-approved thermometer at the exact time the thermograph is logging a temperature. Make sure the thermograph has stabilized in the water for 5 to 10 minutes prior to the scheduled logging time.
7. Document the location:
    a. Flag a tree 5 meters upstream or downstream of the anchor so that attention is not brought to the cable. You may want to place an inconspicuous marker at the base of the anchor point.
    b. Get a GPS waypoint at the thermograph location, labeled with the serial number of the thermograph.
    c. Write detailed notes on the location of the thermograph relative to the anchor (distance and direction) and stream channel, what it is attached to (tree, size, type, bank, etc.) and where the flag is relative to the anchor. Draw a map of its location. Be very specific so another person can follow your directions to retrieve a thermograph if necessary.

Example: Thermograph mid-channel, under .4m boulder, 1.5m from/attached to .3m Douglas Fir, right bank. Flag on willow, upstream 6m, right bank.

   d. Take photos of the thermograph location, anchor (up close, from the flag, including the flag), the flag (from access direction 15 meters away) and any other photos that will facilitate finding the thermograph. Have one person point at the thermograph location and take a photograph.
   e. Mark the location on the field map.
   f. Write parking and walking directions to the site.
8. Download all waypoints from the GPS unit and photos from the camera.
   a. Using Photoshop place arrows on one or two photographs pointing out the location of the thermograph, anchor and flagging.

Thermograph Retrieval:

1. Prior to removing the thermograph, measure the water temperature using a NIST-approved thermometer at the exact time the thermograph is logging a temperature. Enter both the temperature and time it was taken into the data recorder.
2. Remove the thermograph from the assembly and double check the serial number on the thermograph to make sure it matches the one on the data sheet.

Appendix A – YSI Meter Calibration & Maintenance

The office staff will calibrate the specific conductance once each month.

The YSI meter and probe module is an extremely precise and delicate piece of equipment and should be handled with care. Always store the probe with the calibration/transport sleeve on and ensure the sponge inside the sleeve is moistened with clean water. When it is in the stream, it should be protected by the probe sensor guard.

Calibrating specific conductance (monthly)

1. Rinse the YSI probe module and clean a calibration vessel of your choice three times with distilled water. Rinse and swirl the water inside the vessel and around the probes for at least 10 seconds during each rinse. Shake the excess water out of the vessel between rinses.
2. Place enough calibration solution into the calibration vessel so the entire probe can be submerged. Use a small vessel to conserve the expensive solution.
3. Immerse the probe into the solution, making sure the entire probe assembly is submerged. Allow at least three minutes for the temperature to stabilize.
4. Note the temperature recorded on the YSI. Press the CAL hot key and select Conductivity. Select Specific Conductance. Select SPC-uS/cm. Scroll to and select Calibration Value and then enter the calibration solution value listed on the bottle. Press Enter after entering the value.
5. Back at the Calibration Sp. Conductance menu, record the Actual Reading and Temperature listed on the YSI screen in the log and then select Accept Calibration.
6. Rinse the probe three times with distilled water before use.

Calibrating Dissolved Oxygen

The YSI meter needs to be calibrated for dissolved oxygen (DO) daily before being used in the field. It is best to calibrate for DO in the morning and out of the sun to ensure that the temperature remains stable. Record all calibration and maintenance information in the calibration log in the field data recorder. Also record in detail any problems with the YSI. In addition to the daily DO calibration, the office staff will change the DO membrane and calibrate the specific conductance once each month.

The YSI meter and probe module is an extremely precise and delicate piece of equipment and should be handled with care. Always store the probe with the calibration/transport sleeve on and ensure the sponge inside the sleeve is moistened with distilled or filtered water. When it is in the stream, it should be protected by the probe sensor guard. Do not touch the DO membrane with your hands or any other object.

Calibrating dissolved oxygen (daily)

1. With the YSI off, use a clean cotton swab to gently dry off the thermister, the space inside the conductivity channels, and the DO membrane.
2. When calibrating DO, inspect the membrane and make sure it is intact and there are no air bubbles inside the membrane. If there is a large (greater than 1/8 inch) bubble in the membrane, the membrane will need to be replaced.
3. Ensure the sponge inside the probe sleeve is fully moistened and that there is no excess water in the sleeve.
4. Being careful not to wet the probe, place the probe module into the sleeve all the way. The sleeve is self venting and will allow air to enter. The moist sponge will create a humid atmosphere in the sleeve for the calibration.
5. Power on the YSI and place the probe on its side in a place where it will not be disturbed for at least five minutes. Make a note of the time. The probe should be in the shade, out of sunlight, where the temperature is stable.
6. After five minutes, observe the AS (Autostable) code to the right of the DO values on the screen. The AS code will be solid and not blinking when the DO values have stabilized.
7. Press the CAL hot key on the keypad, scroll to and select DO. Select DO%. Record the barometer and Actual Readings for DO and temperature in the calibration log.
8. Scroll to Accept Calibration and once the temperature and DO values have stabilized, press ↵to calibrate the probe. Record the final DO value on the log sheet. The calibration is complete.
9. If the calibration was not accepted, consult the crew leader. The calibration may need to be repeated or the DO membrane may need to be replaced.

Changing the DO membrane cap (monthly)

1. Ensure the YSI is off.
2. Thoroughly clean the probe module. Unscrew the DO membrane cap from the DO probe and discard it. Thoroughly rinse the probe tip with distilled or filtered water.
3. If the gold cathode or silver anode are dull or black, respectively, and the sensor has had difficulty stabilizing or calibrating, use the sanding disk in the maintenance kit to gently wet-sand these parts. Clean the gold cathode with a twisting motion two to three times to remove any tarnish or silver deposits. Clean the silver anode by wrapping the sandpaper around the anode and twisting to remove the dark build-up on the anode.
4. Rinse the probe well and wipe thoroughly with a wet paper towel or wet clean cotton swabs to remove all grit. Rinse the probe again with distilled water.

5. Prepare the electrolyte solution according to the instructions on the bottle or remix (shake) a pre-made solution. Let the solution stand for 1 hour before use when replacing a DO membrane.
6. Carefully fill the new membrane cap at least ½ full with electrolyte solution trying not to form air bubbles. Tap the side of the cap gently to release any air bubbles in solution.
7. Tip the DO probe down and gently screw the membrane cap onto the probe moderately tight. Do not touch the DO membrane with your hands. A small amount of electrolyte solution should overflow.
8. Rinse the probe thoroughly with distilled water and replace the storage sleeve. The meter can be used immediately as long as the solution that was used to replace the DO membrane sat for one hour after mixing.

<u>Storing the probe module</u>
The calibration/storage sleeve should be installed snugly with the sponge inside moistened with distilled or filtered water to keep the DO membrane moist, but not submerged in water. It is very important that the probe stays moist. If there is no other water available, stream water can be used temporarily. However, do not store the probe overnight in stream water and be sure to rinse the probe well with filtered water if stream water was used for temporary storage.

<u>Cleaning the probes (as needed)</u>
An invisible film gradually builds up on the probes of the YSI. To ensure accurate readings and calibrations, the probes should be cleaned daily, but at least one time at the end of each stint. If the DO readings drift or the calibration fails, the probes should be cleaned. Rinse the three probes thoroughly with filtered water using the squirt bottle, paying close attention to the inside of the conductivity probe.

Using the bottle brush included in the maintenance kit, or a clean and moistened cotton swab, scrub the inside of the conductivity probe using 15 to 20 strokes. Wet the end of a cotton swab and use it to gently wipe the DO membrane and thermister. Do not touch the membrane with anything other than a cotton swab, and be very careful not to force the swab around the sides. Wipe the outside of the probes.

Appendix B – Contingency Protocol for Broken Compass & Laser

Regardless of whether a compass or laser is malfunctioning, certain key pieces of data still need to be collected at a site. For this protocol the site will be laid out and all transects will be surveyed identically to the regular field protocol, without using the compass and laser. Contingency data forms titled "AREMP Survey for Width" and "AREMP Surveys for Pools" have been designed to facilitate and ensure these data are collected properly and completely <u>(the crew should not leave the stream until all information is collected and recorded)</u>. Copies of these data forms are provided on the field data recorder and in the crew notebook.

<u>Monument</u>
Using a meter tape, measure the distance from the monument site to Transect A left bank. This is a straight line distance so it is important that the meter tape is level when taking this measurement. If something is blocking the path you will need to break the distance up by taking multiple measurements. Record the distance on the AREMP description and comment data form.

<u>Transects</u>
Bankfull widths and wetted widths and depths will be collected at all major transects using a meter tape and meter stick.

Bankfull widths
- Stretch a meter tape from the left bankfull elevation to the right bankfull elevation, ensuring that it is level and perpendicular to the bankfull channel.
- Record the width in meters (to the nearest cm, example; 1.05m) on the "AREMP Survey for Width" datasheet.

Wetted widths
- Stretch a meter tape from left wetted edge to right wetted edge, ensuring that it is level and perpendicular to the channel. Take this measurement on the same axis as the bankfull tape was strung.
- Record the width in meters (to the nearest cm) on the "AREMP Survey for Width" datasheet.

Depths
- Stretch a meter tape from left bankfull elevation to right bankfull elevation, ensuring that it is level and perpendicular to the channel. Secure each side of the meter tape with bank pins.
- Place a meter stick at left wetted edge, thalweg and right wetted edge and record the height from the substrate to where the meter tape crosses the meter stick (to the nearest cm) on the "AREMP Survey for Depth" datasheet.

Note: If the distance from the substrate to the bankfull tape is greater than a meter, use the prism pole to mark the height and then measure that height on the pole with a meter stick.

Pools

Pool length, pool maximum depth and pool tail depth will be collected using a meter stick and tape at all qualifying pools, according to the protocol (page 27).

- Pool length will be measured from the pool tail to the pool head with a meter tape, following the thalweg.
- Capture significant bends in pools by breaking up the measurements at the corners. Also, if there are obstructions along the thalweg (log jams, root wads…), do not run the meter tape up over the barrier but take multiple measurements to ensure the length is accurate.
- Record the length in meters (to the nearest cm) on the "AREMP Survey for Pools" datasheet.
- Pool tail depth and maximum depth will be measured with a meter stick at the same locations as specified in the field protocol (page 27).

Note: If a pool has a maximum depth greater than a meter, use the prism pole to capture the depth. Note the location of the water's height on the prism pole and then use the meter stick to measure that height from the bottom to the appropriate location up the prism pole.

Appendix C - Invasive Species Disinfection Protocol

Invasive species are increasingly becoming a matter of concern in the Pacific Northwest. Species such as the New Zealand mud snail have been detected in stream systems of nine Western states (including Oregon's Columbia River estuary) and are steadily expanding their range. The Aquatic and Riparian Effectiveness Monitoring Program hereafter referred to as "the program," works in the field across the Northwest Forest Plan area (all federal lands from Point Reyes National Park to the Canadian border and from the Pacific Ocean to the eastern flanks of the Cascade mountains) in a variety of aquatic and terrestrial habitats. Because of the spatial extent to which the field crews travel, the potential to serve as a vector for exotic species and diseases is great. The program has proactively developed this protocol as a mechanism to reduce the potential for spreading exotic species and diseases. The procedures that follow assume that all appropriate field gear starts each trip into the field in a clean (disinfected) state.

Field Gear

Survey gear to be disinfected:

• Macroinvertebrate collection vessel • Decanting sieve • Chest waders • Shovels	• Macroinvertebrate net and handle • Wading boots • Neoprene booties • Fingernail brush (supplied for scrubbing mud from gear)

Disinfection equipment provided:

Field crews	QAQC, Trend site and Recon crews
• Large 40 gallon Tupperware bin (stored at Corvallis headquarters) • Stiff bristle fingernail brush • Car wash certificates	• Propane burner stand • Propane • Stiff bristle fingernail brush • Large quart canning pot • Metal tongs • Rubber Safety Apron • Large 40 gallon Tupperware bin • Reimbursement for carwashes

Field Crews

Survey crews perform the initial visit to a watershed, surveying multiple sites but remaining within the watershed boundary the entire work stint.

1. At the site: Before leaving the stream all waders, boots, nets and net handles, carried to the site that day, will be rinsed with stream water and any mud or dirt will be scrubbed off with a stiff bristle fingernail brush.

2. At camp: The gear should be hung to dry overnight and rigorously shaken out the next morning to remove any remaining debris/organisms.

3. In Corvallis: The crew disinfects their waders, boots and nets in boiling water.
    a. Bring water to a rolling boil in a large canning pot. Fully immerse boots (laces as well), waders, nets and net handles in large tub of boiling water for a minimum of 2 minutes.

    b. Remove gear from tub and lay out or hang up outside for 10 to 15 minutes to remove any excess water. Hang equipment in cages over the break and allow for it to dry for the entire duration (5-6 days) between the field stints.

    c. Before packing the bags on departure day, the crew should shake out all the waders, boots and nets to remove any residual mud or debris.

Note: These techniques only apply if the gear will have the full 5-6 days to thoroughly dry between trips in the field. If this is not the case, please refer to the steps below for QAQC and Trend crews.

QAQC, Trend Site and Reconnaissance Crews
Quality control and Trend crews will travel to multiple watersheds during a work stint, sometimes visiting two separate watersheds in one day. These steps will be completed before entering and working in a new watershed.

1. At the site: Before leaving the stream all waders, boots and nets will be rinsed and any mud or dirt will be scrubbed off.

2. At camp:
    a. Bring water to a rolling boil using a large canning pot and propane burner stand. Completely submerge all surfaces of nets, waders, neoprene booties and boots (making sure not to miss the eyelets of the wading boots). If a piece of gear is too large to fit in the pot, pour boiling water over the gear ensuring all the surfaces have been covered with substantial amounts of the boiling water. (Boiling water is the best method found that will kill the New Zealand Mud Snail and needs to be done after each site before traveling into the next watershed.)

    b. The gear should then be hung to dry overnight and rigorously shaken out the next morning to remove any residual mud or debris.

Vehicles

The tires and undercarriage need to be sprayed off with a high pressure hose (if available, check at a nearby government field station or office) or by going through a car wash.

QAQC, Trend site and Reconnaissance crews: The vehicle should be cleaned of mud before driving (use a high pressure commercial carwash whenever possible) into the next watershed.

Field Crews: Back in Corvallis the vehicles will be run through a car wash to ensure the undercarriage is clean and free of debris.

Firewood

When working in Humboldt, Mendocino, Lake, Sonoma, Napa, or Marin counties in California, as well as Curry County in Oregon, **do not** transport firewood or other plant materials outside of the 6th field watershed boundary. These counties have been quarantined by their respective states because of the presence of Sudden Oak Death Syndrome. Transporting firewood, soil, or plant materials can result in substantial fines and penalties.

Appendix D– Procedure for Pressing Plants

Collect a plant specimen when a plant is identified as a potential invasive species and can not be identified in the field. Only collect a plant specimen if the plant is abundant in number. If only one or two plants are present, leave the plant and take photographs. Crews will be given two plant presses; one for the field and one which will be left in the vehicle. Store the "field' plant press in a plastic bag to prevent the cardboard and newspaper from getting wet. In the vehicle, keep the plant press in a warm well-ventilated area to speed up the process of drying the specimens and to prevent growth of mold.

1. The plant press consists of alternating layers of corrugated cardboard and newspaper with plywood on each side (Figure 21). The cardboard layers allow for air circulation which helps the plant specimens dry more quickly. All the layers are held together and secured with straps.

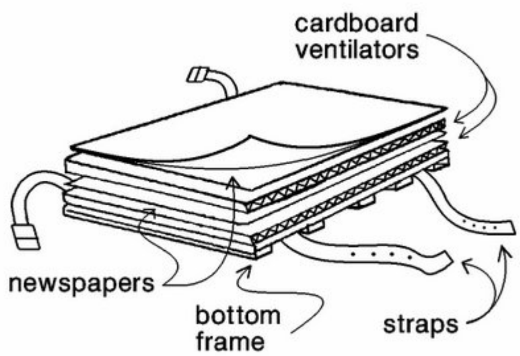


Figure 21. Schematic of a plant press for preserving plant specimens in the field.

2. When collecting a plant specimen, collect all parts of the plant including roots, stem, leaves, and flowers (if present). Clean the specimen of all debris and dirt.
3. Carefully place the collected plant specimen between two layers of newsprint. Be sure to spread the plant out so that all parts of the plant are visible. Make a note on the margin of the newspaper with the creek code, site number, date, and the suspected species name. Also make a note on the Terrestrial Invasives data form that a specimen was collected.
4. Place the newsprint layers in the plant press between two pieces of corrugated cardboard. Replace the plywood and secure the straps. Be sure to secure the straps tightly to create pressure which helps the plant specimen dry. The plant press should be kept in a warm area with good ventilation.

Appendix E – Species list and corresponding species codes

Code	Genus	Species	Common Name
Species List - Fish			
ACME	Acipenser	medirostris	Green Sturgeon
ACTR	Acipenser	transmontanus	White Sturgeon
ACAL	Acrocheilus	alutaceus	Chiselmouth
ARIN	Archoplites	interruptes	Sacramento Perch
CAOS	Catostomus	occidentalis	Sacramento Sucker
CARI	Catostomus	rimiculus	Klamath Smallscale Sucker
CASN	Catostomus	snyderi	Klamath Largescale Sucker
CASP	Catostomus	species	UNKNOWN Sucker
CASA	Catostomus	species	Salish Sucker
CHBR	Chasmistes	brevirostris	Shortnose Sucker
COAL	Cottus	aleuticus	Coast Range Sculpin
COAR	Cottus	armatus	Staghorn Sculpin
COAS	Cottus	asper	Prickly Sculpin
COAP	Cottus	asperrimus	Rough Sculpin
COGU	Cottus	gulosus	Riffle Sculpin
COKL	Cottus	klamathensis	Marbled Sculpin
COPE	Cottus	perplexus	Reticulate Sculpin
COTT	Cottus	species	UNKNOWN Sculpin
CYSP	Cyprinus	species	UNKNOWN Cyprinid
DELU	Deltistes	luxatus	Lost River Sucker
GAAC	Gasterosteus	aculeatus	Three-Spined Stickleback
GIBI	Gila	bicolor	Tui Chub
GICO	Gila	coerulea	Blue Chub
HESY	Hesperoleucus	symmetricus	California Roach
LAAY	Lampreta	ayresi	River Lamprey
LALE	Lampreta	lethophaga	Pit-Klamath Brook Lamprey
LARI	Lampreta	richardsoni	Western Brook Lamprey
LASI	Lampreta	similis	Klamath Lamprey
LASP	Lampreta	species	UNKNOWN Lamprey

LATR	Lampreta	tridentata	Pacific Lamprey
LAEX	Lavinia	exilicauda	Hitch
MYCA	Mylocheilus	caurinus	Peamouth Chub
MYCO	Mylopharodon	conocephalus	Hardhead
NOHU	Novumbra	hubbsi	Olympic Mudminnow
ONCL	Oncorhynchus	clarki	Cutthroat Trout
ONGO	Oncorhynchus	gorbuscha	Pink Salmon
ONKE	Oncorhynchus	keta	Chum Salmon
ONKI	Oncorhynchus	kisutch	Coho Salmon
ONMY	Oncorhynchus	mykiss	Rainbow Trout
ONNE	Oncorhynchus	nerka	Sockeye (Red) Salmon
ONSA	Oncorhynchus	SALMON	UNKNOWN Oncorhynchus Salmon
ONSP	Oncorhynchus	species	UNKNOWN Oncorhynchus Species
ONTR	Oncorhynchus	TROUT	UNKNOWN Oncorhynchus Trout
ONTS	Oncorhynchus	tshawytscha	Chinook Salmon
ORCR	Oregonichthys	crameri	Oregon Chub
ORKA	Oregonichthys	kalawatseti	Umpqua Chub
ORMI	Orthodon	microlepidontus	Sacramento Blackfish
PETR	Percopsis	transmontana	Sand Roller
PRWI	Prosopium	williamsoni	Mountain Whitefish
PTGR	Ptychocheilus	grandis	Sacramento Pikeminnow
PTOR	Ptychocheilus	oregonensis	Northern Pikeminnow
PTUM	Ptychocheilus	umpque	Umpqua Pikeminnow
RHCA	Rhinichthys	cataractae	Longnose Dace
RHEV	Rhinichthys	evermanni	Umpqua Dace
RHOS	Rhinichthys	osculus	Speckled Dace
RHSP	Rhinichthys	species	UNKNOWN Dace
RIBA	Richardsonius	balteatus	Red-Side Shiner
SASA	Salmo	salar	Atlantic Salmon
SATR	Salmo	trutta	Brown Trout
SALM	Salmonidae	species	UNKNOWN Salmonidae
SACO	Salvelinus	confluentus	Bull Trout
SAFO	Salvelinus	fontinalis	Brook Trout

SASP	Salvelinus	species	UNKNOWN Salvelinus Species (Bull/Brook)
THPA	Thaleichthys	pacificus	Eulachon
WWWW	UNKNOWN	FISH	UNKNOWN FISH
ZZZZ	NONE	NONE	Nothing Captured

Species List - Amphibians

Code	Genus	Species	Common Name
AMGR	Ambystoma	gracile	Northwestern Salamander
ANFE	Aneides	ferreus	Clouded Salamander
ANPL	Aneides	flavipunctatus	Black Salamander
ASTR	Ascaphus	truei	Tailed Frog
BAWR	Batrachoseps	wrighti	Oregon Slender Salamander
BUBO	Bufo	boreus	Western Toad
DICO	Dicamptodon	copei	Cope's Giant Salamander
DIEN	Dicamptodon	ensatus	California Giant Salamander
DISP	Dicamptodon	species	Unknown Dicamptodon
DITE	Dicamptodon	tenebrosus	Coastal Giant Salamander
ENES	Ensatina	eschscholtzii	Ensatina
HYSH	Hydromantes	shastae	Shasta Salamander
UNFR	NONE	FROG	Unknown Frog
UNSA	NONE	SALAMANDAR	Unknown Salamandar
UNTO	NONE	TOAD	Unknown Toad
PLDU	Plethodon	dunni	Dunn's Salamander
PLEL	Plethodon	elongatus	Del Norte Salamander
PLLA	Plethodon	larselli	Larch Mountain Salamander
PLSP	Plethodon	species	Unknown Plethedon
PLST	Plethodon	stormi	Siskiyou Mountains Salamander
PLVA	Plethodon	vandykei	Van Dyke's Salamander
PLVE	Plethodon	vehiculum	Western Red-Back Salamander
PSRE	Pseudacris	regilla	Pacific Chorus Frog
RAAU	Rana	aurora	Red-Legged Frog
RABO	Rana	boylii	Foothill Yellow-Legged Frog
RACA	Rana	cascadae	Cascades Frog
RAPR	Rana	pretiosa	Spotted Frog

RHCS	Rhyacotriton	cascadae	Cascade Torrent Salamander
RHKE	Rhyacotriton	kezeri	Columbia Torrent Salamander
RHOL	Rhyacotriton	olympicus	Olympic Torrent Salamander
RHVA	Rhyacotriton	variegatus	Southern Torrent Salamander
TAGR	Taricha	granulosa	Rough-Skinned Newt
TARI	Taricha	rivularis	Red-Bellied Newt
TASP	Taricha	species	Unknown Newt
TATO	Taricha	torosa	California Newt
YYYY	UNKNOWN	AMPHIBIAN	Unknown Species - Amphibian
XXXX	UNKNOWN	EGG MASS	Unknown Species Egg Mass
Species List- Invasive Animals			
POAN	Potamopyrgus	antipodarum	New Zealand Mudsnails
DRPO	Dreissena	polymorpha	Zebra Mussels
DRRO	Dreissena	rostriformis	Quagga Mussels
ORRU	Orconectes	rusticus	Rusty Crayfish
ORNE	Orconectes	neglectus	Ringed Crayfish
ORVI	Orconectes	virilis	Northern Crayfish
PRCL	Procambarus	clarkia	Red Swamp Crayfish
SUSC	Sus	scrofa	Feral Swine
Species List- Invasive Plants			
IRPS	Iris	pseudacorus	Yellow Flag Iris
HYVE	Hydrilla	verticillata	Hydrilla
MYAQ	Myriophyllum	aquaticum	Parrot Feather Watermilfoil
MYSP	Myriophyllum	spicatum	Eurasian Watermilfoil
ARDO	Arundo	donax	Giant Reed
ERDE	Ergeria	densa	Brazilian Elodea
DIGE	Didymosphenia	geminata	Didymo
FAJA	Fallopia	japonica	Japanese Knotweed
POPO	Polygonum	polystachyum	Cultivated Knotweed
POSA	Polygonum	sachalinese	Giant Knotweed
CLVI	Clematis	vitalba	Old Man’s beard
ALPE	Alliaria	petiolata	Garlic Mustard
RUDI	Rubus	discolor	Himalayan blackberry

HEHE	Hedera	helix	English Ivy
HEMA	Heracleum	mantegazzianum	Giant Hogweed

References

Adams, J. and L. Mannik. 1998. Impulse LR: User's Manual. Laser Technology, Inc., United States of America. 80 p.

Harrelson, C. C., C. L. Rawlins, and J. P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Hawkins, C. P., J. Ostermiller, and M. Vinson. 2001. Stream invertebrate, periphyton, and environmental sampling associated with biological water quality assessments. Field Protocols. Utah State University, Logan, UT.

Henderson, Rick. 2001. Effectiveness monitoring of streams and riparian areas within the Upper Columbia River Basin: Sampling Protocol for Integrator Reaches (Draft). Fish Ecology Unit – U.S. Forest Service Effectiveness Monitoring Team, Logan, UT

Moore K, K. Jones, and J. Dambacher. 1999. Methods for stream habitat surveys, aquatic habitat inventory project, Natural Production Program: Oregon Department of Fish and Wildlife, Corvallis, OR.

Palmer, C.J. In preparation. Quality System Management Plan for Environmental Data Collection Projects, Interangency Regional Monitoring, Northwest Forest Plan.

Peck, D. V., J. M. Lazorchak, and D. J. Klemm (editors). Unpublished draft. Environmental monitoring and assessment program – surface waters: Western pilot study field operations manual for wadeable streams. EPA/XXX/X-XX/XXXX. U.S. Environmental Protection Agency, Washington, D.C.

Pleus, A.E. and D. Schuett-Hames. 1998a. TFW Monitoring Program methods manual for stream segment identification. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-98-001. DNR #103. May.

Pleus, A.E. and D. Schuett-Hames. 1998b. TFW Monitoring Program methods manual for the reference point survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-98-002. DNR #104. May.

Pleus, A.E. and D. Schuett-Hames. 1999. TFW Monitoring Program methods manual for the habitat survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-003. DNR #105. June.

Rosgen, Dave. Applied River Morphology. Pagosa Springs, Colorado: Wildland Hydrology, 1996.

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