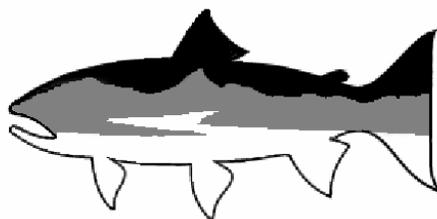


Field Protocol Manual

Aquatic and Riparian Effectiveness Monitoring Program

Regional Interagency Monitoring for the Northwest Forest Plan



2007 Field Season

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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 for assessment of watershed condition.

The field data collected is combined with upslope and riparian information to estimate watershed condition. Condition is determined using a decision support model that evaluates individual indicators 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. The data will 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 addresses 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 with 80 potential sample sites. Select survey sites in numerical order, omitting sites that cannot be sampled.

Note: The Reconnaissance crew will be responsible for establishing whether or not a site is surveyable based on location, condition and access. A crewleader 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, use 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 reach. 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 stream reaches cannot be completed within six days (the length of time available each sampling trip) due to time constraints, accessibility issues, or stream reach constraints (see below). *Accessibility*

Exclude a stream reach if:

1. The stream reach 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 stream reach 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 stream reach. 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 the

stream reaches are spread out, a crew will relocate camp to be closer to outlying survey reaches, reducing daily travel time.

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

Include a stream reach 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 reach 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 sufficient to 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 normally 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 stream reaches choked with willows (or similar dense vegetation) to an extent that it would excessively hinder the crew's productivity or restrict mobility while working in the channel.
- d. In order to sample for macroinvertebrates the reach must have a minimum wetted width of 1 meter, a minimum depth of 0.1 meter and riffle habitat present (See AREMP Field Protocol 2007 for further details regarding macroinvertebrate sampling methods).
- e. In order to collect water chemistry data there must be flowing water with sufficient depth to completely submerge the YSI meter's probe (See AREMP Field Protocol 2007 for further information regarding the collection of water chemistry parameters).

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

Record the site UTM coordinate

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 3 letter watershed code and a 3 number site code. (Example: RCK103) If the site is a QA/QC or trend site, place a 9 or a 6 in front of the site number. (RCK903, RCK603)
3. Hit the *MENU* button, scroll to *Average Position*, then hit *ENTER*. Place the GPS unit at Transect A and start other work, let the unit log at least 250 measurements.
4. Once all the measurements have been recorded, press *ENTER*, scroll to the *DONE* box, and press *ENTER*.
5. Enter the UTM coordinate in the field data recorder.

Monument the Site

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

1. Locate a distinct feature near the bottom of the reach 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 reach riparian zones 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 reach.
2. Attach one of the markers to your chosen spot.

- a. Use an aluminum nail to attach the marker. Make sure it 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, from the marker location take a compass bearing from the marker to Transect A Left Bank and record in the field data recorder. Record this bearing on the left side of the marker using a permanent pen.
5. Measure the distance from the marker to bottom of the reach and record (this will be done using the laser and prism, taking a point at Left Bank and at the marker and GPS locations).
 - First, take a laser shot of the monument.
 - Next, take a shot of the GPS unit located at Transect A (when getting average waypoint).
 - Finally, a shot at left bankfull on Transect A, independent of transect shots.
 - These points will be labeled as Transect Y.
6. Take a picture of the marker location and surrounding distinctive features. This will include a minimum 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.

Photo Documentation

Information about each reach 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 sample reach. In addition, photographs should be taken of rare or unique features in the sample reach, including culverts, logjams, beaver dams, or vertebrates that are difficult to identify.

The digital photos collected in the field will 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 "FINE". Set the top disc to SETUP and use the navigation disc (on the back of the camera) to choose Image Quality menu option. Under this option, select "FINE".
 - b. Verify the image size is set on "FULL". Set the top disc to SETUP and use the navigation disc (on the back of the camera) to choose Image Size menu option. Under this option, select "FULL".
 - c. Make sure that the date/time on the camera is in sync with the date/time on the GPS unit.
 - i. To display the time on the GPS unit go to the Main Menu, scroll down to Setup, and scroll across to Time. The time displayed is the time to set the digital camera to. To do this put the camera in "Setup" mode with the dial on the top of the camera. Press the "Menu" button and use the disc to scroll down to "Date." Use the disc again to enter the date and time.
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 time is set incorrectly on the digital camera.
 - a. On the GPS unit "Acquiring satellites" page, press the Page button once.
 - b. You should now be viewing a screen showing time and date at the bottom with a UTM coordinate of your current position.
 - c. 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 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° to take the next photo, which will be of the downstream view. Repeat 2 more 90° 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 the Wadeable Creek you would put "WAD103" WAD903 (603) 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 (ORWAD10), the UTM coordinate, the time the photo was taken, 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.

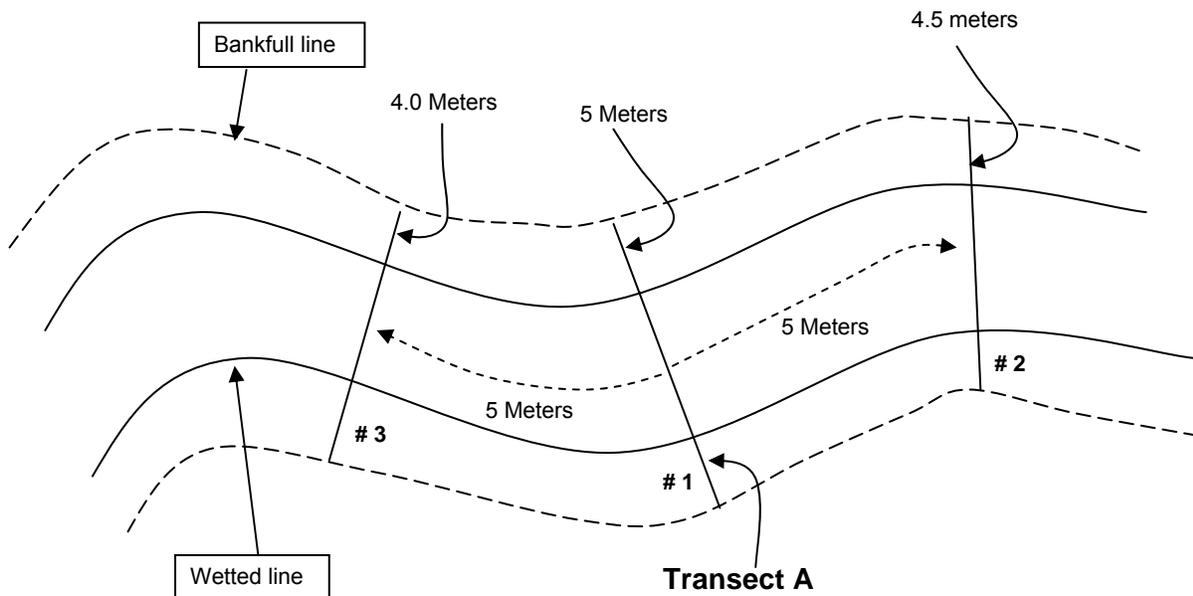
Order of events for photographs:

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 reach 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 normally 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 (Fig. 1). 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.*
4. 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 reach 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 reach length on Table1	160M

Figure 1: Three measurements taken to determine reach length.

Table 1

Average Bankfull Width in meters	Width Category	Reach 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 reaches, 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 (See Figure 4) and used for pebble counts and thalweg locations. Side channels and pools will also be identified and marked with blue flagging and Transect A will be marked with biodegradable flagging. Site information should be documented in one or 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.

From the example in table 1, the distance between transects would be $160/20=8$ m.

1. Following the thalweg, measure the distance between transects using a meter tape. Place a 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 has been completed. The flagging will be kept and reused for following surveys.

Site Maps

A site description map will be drawn on a template located on the back of the AREMP Description and Comment data form. The focus should be to capture any special features of a survey reach and to aid in monument description, so it is important to keep the maps simple and concise. There will be an additional template for survey reaches containing side channels.

Examples of features to capture: large log jams, culverts, monument location, waterfalls, roads.

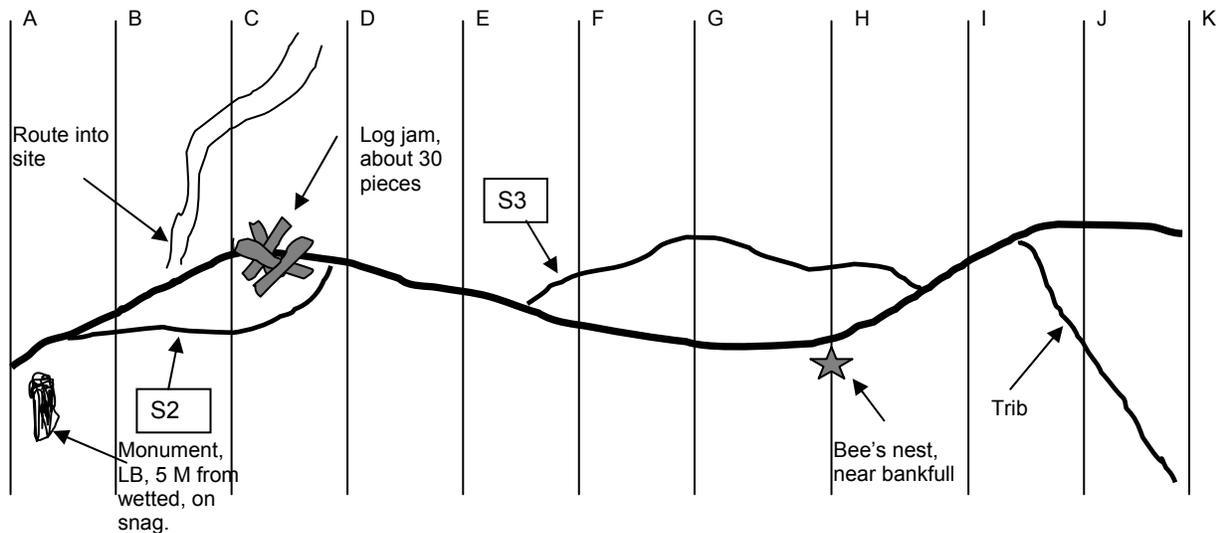


Figure 2: Example of site map for reach containing side channels.

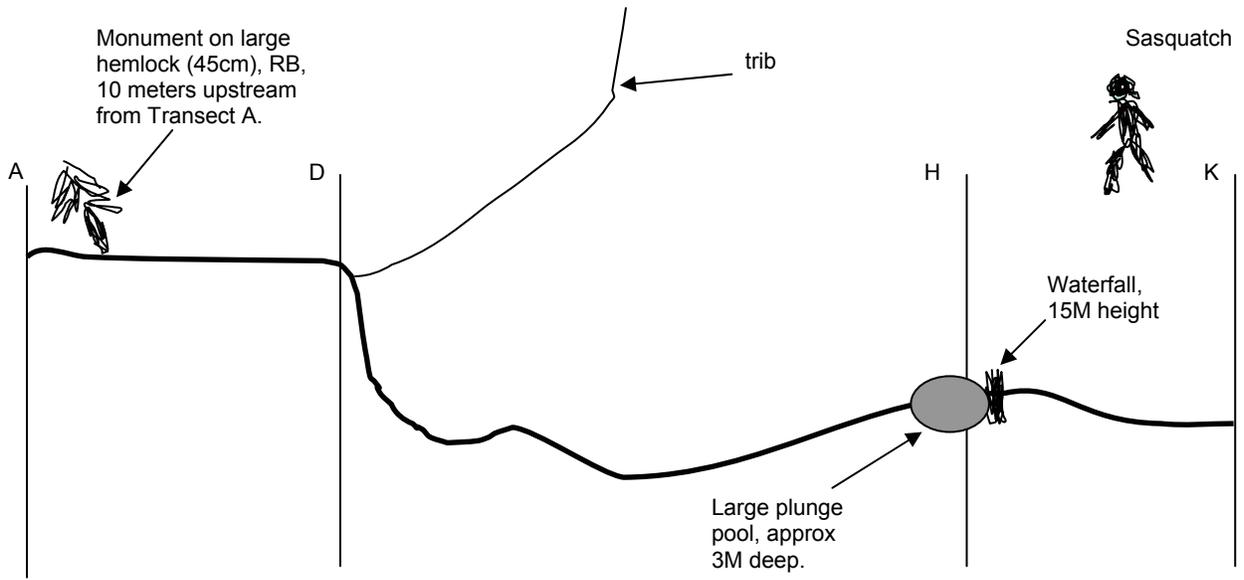


Figure 3: Example of site map in a reach without qualifying side channels.

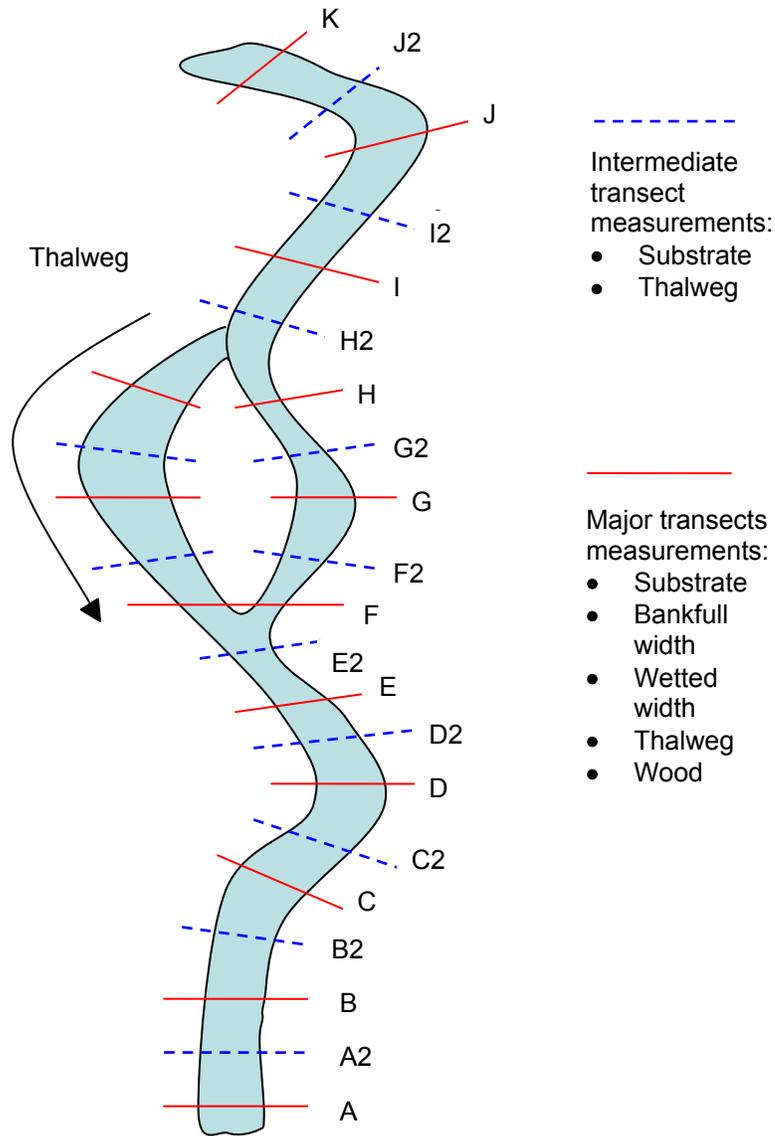


Figure 4: Reach layout and tasks performed at major and intermediate transects.

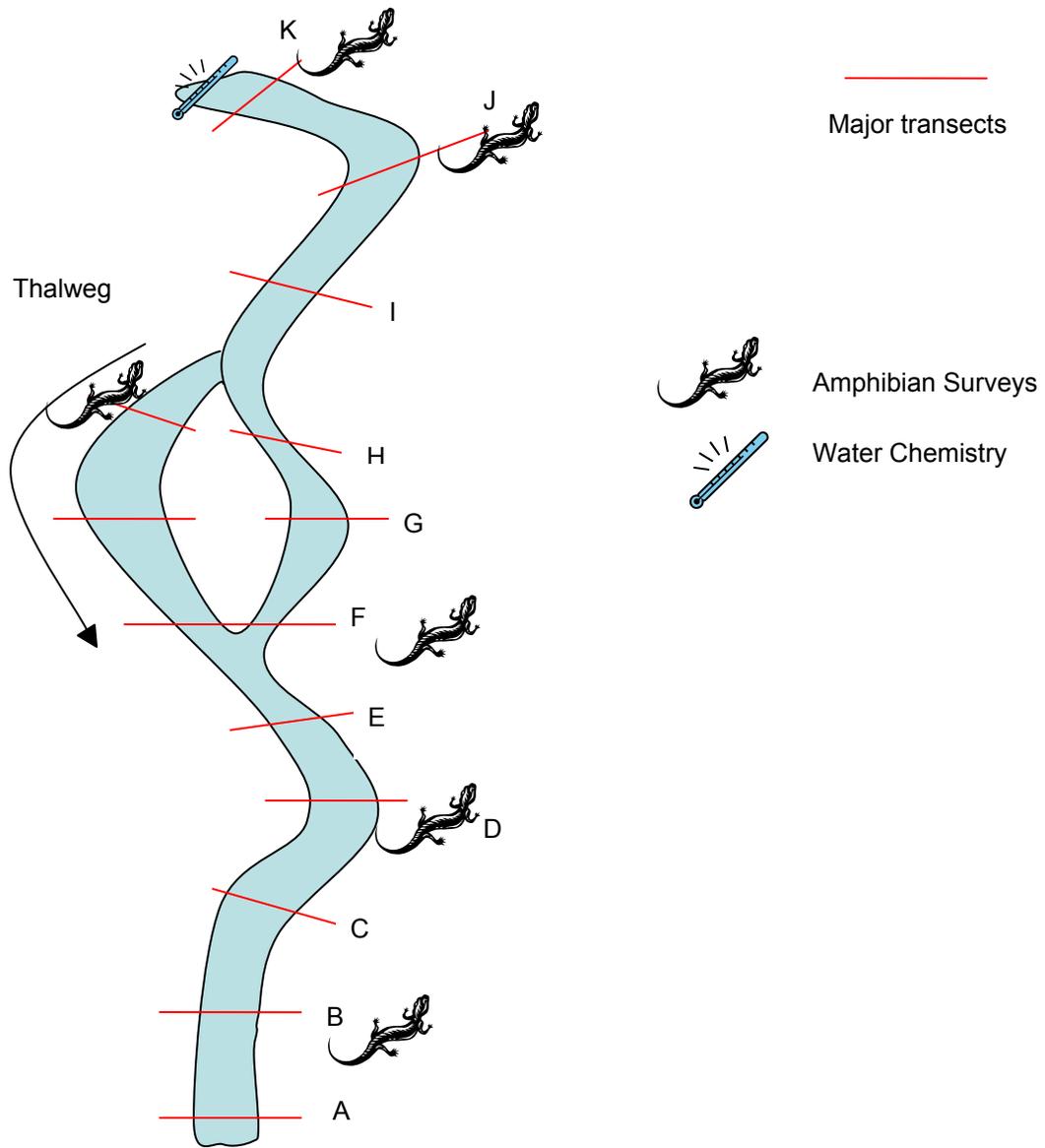


Figure 5: Location of biological surveys performed in a reach.

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 Recon data recorder and the Stream data form on the field data recorder.

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 reach upstream to the nearest surveyable location.

Impassible barriers

If you encounter an impassible barrier (waterfall, lake or glacier) or private land **during reach 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 reaches

Always survey the lowest numbered site first. Transect K of the first reach will be flagged as Transect A for the second reach. Drop the second site if the first site will overlap more than 50% of the second reach's length (In order to determine this you will have to measure the 3 bankfulls for the second reach). 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 use the code "LJ" in the Recon (avoid moving more than 2 meters up or downstream). However, 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 reach 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 Recon. 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 small obstructions (i.e. passable waterfall or small culverts) encountered in the reach that interfere with the collection of data or crew safety.

If there is an unsurveyable obstruction within the reach, such as a large log jam, passable waterfall, small 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 accordingly (Waterfall = WT, Culvert = CV, Log Jam = LJ). Enter a comment of “Stop Survey” or “Start Survey” in the Recon for these points.

Steps to deal with this situation if encountered are as followed;

1. Begin reach 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

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 reach.
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. (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 reach.
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.
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 effected by a side channel will be marked with an additional blue flag that is labeled with the channel number (in case of overlapping multiple channels). Both the inlet and outlet of each qualifying channel will be flagged as well.

1. Only side channels that begin and end within the reach 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.
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 $\geq 20\%$ 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 reach's average bankfull width. In Figure 4, SC-B, C, and E would qualify, and SC-F would not as it is too narrow.
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

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

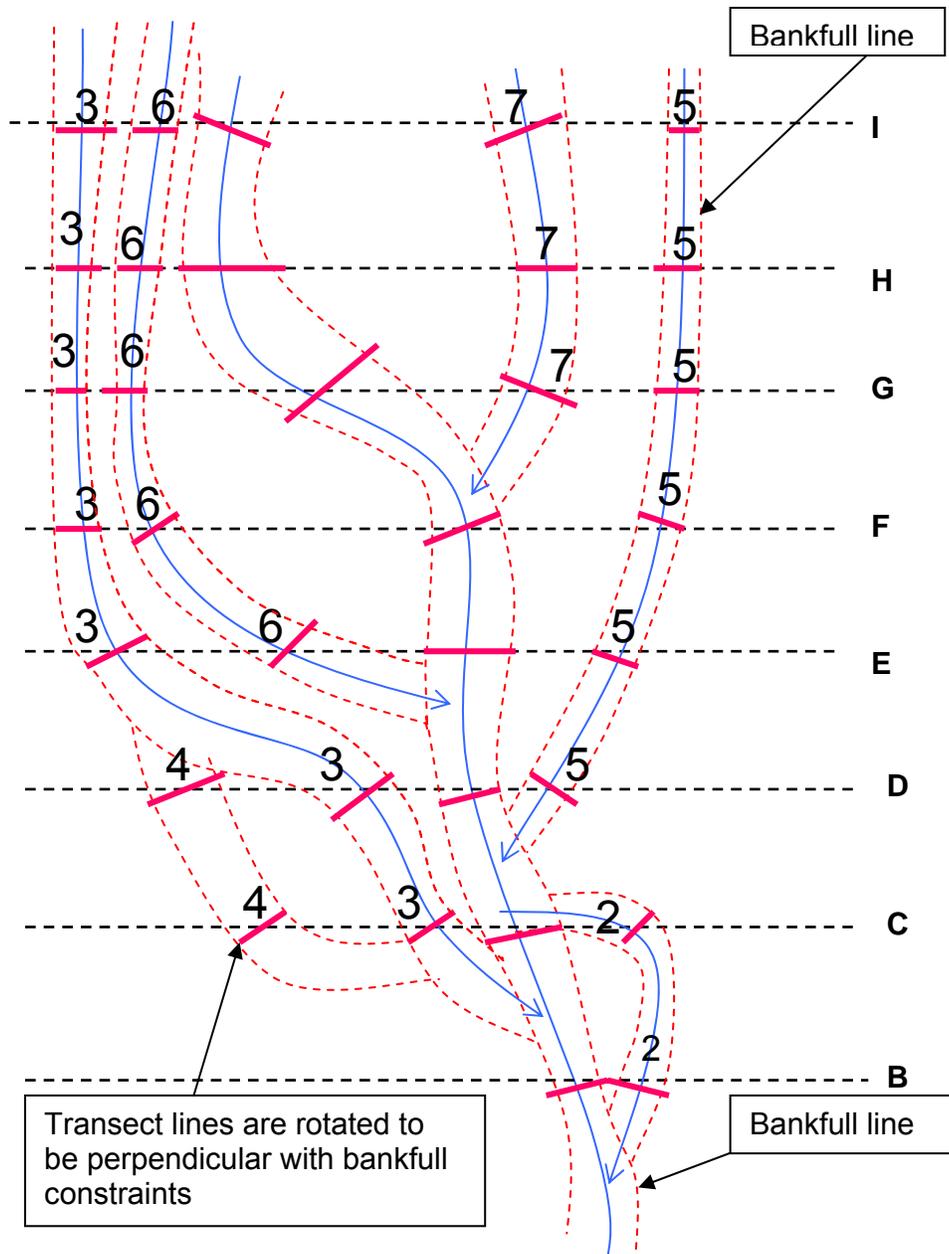


Figure 6. Channels are numbered by the order in which they are encountered in the survey reach, while moving upstream. A channel does not need to enter the main channel or have water to qualify (side channel 4).

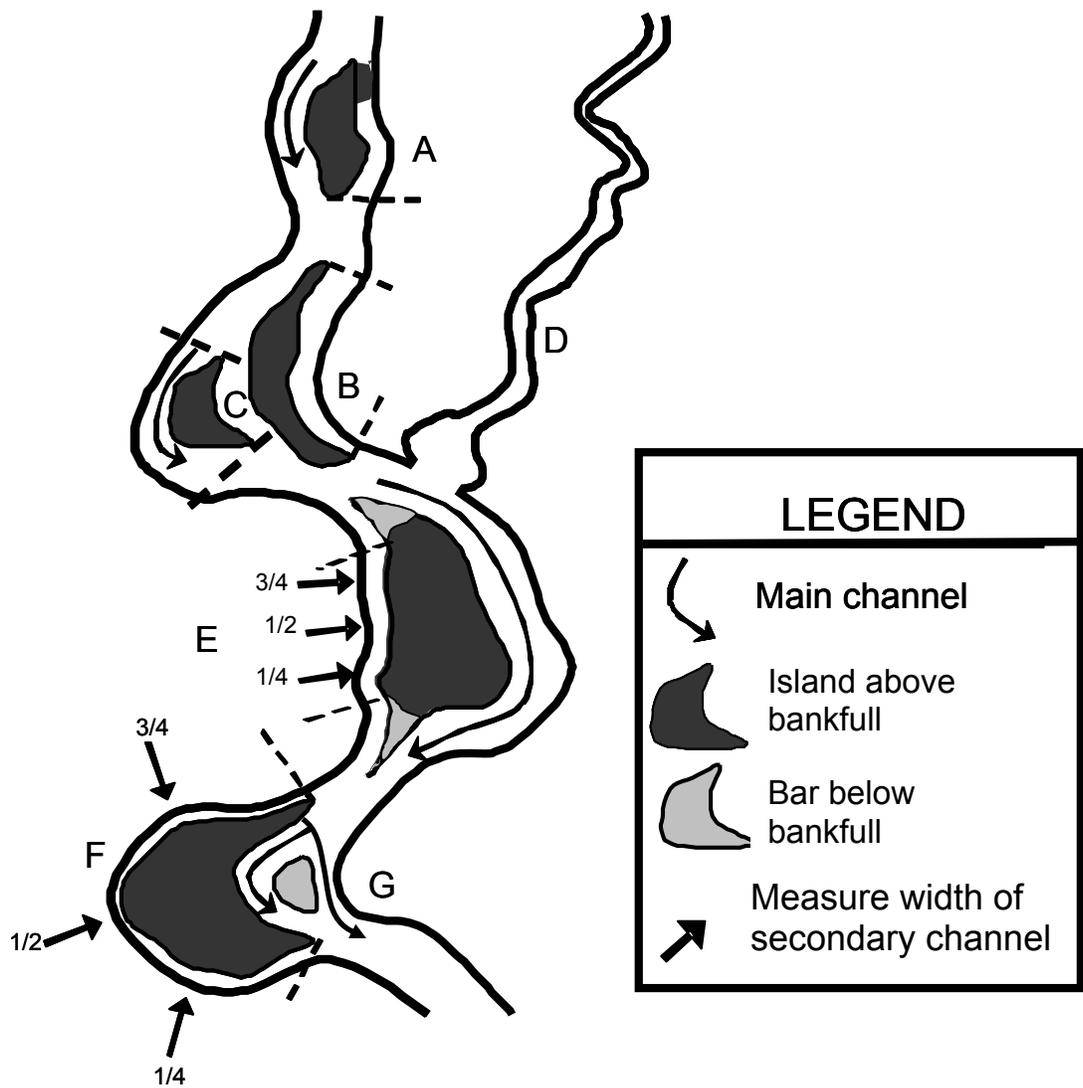


Figure 7. Examples of side channels. Channels B, C, and E would be considered side channels ($\geq 20\%$ of the bankfull width category) whereas channel F would be excluded as it is too narrow and channel A would be excluded, because it does not have a head (entry point) to the channel. Channels E and F depict where to take width measurements within potential channels (at $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of the way up from the downstream end of the portion of the island that is \geq the bankfull elevation). Channel D would not be included because it began outside of the reach. Channel G is part of the main channel since the bar is below the bankfull elevation.

Channel Morphology

Bankfull Width

Bankfull width will be measured at each major transect. Using the compass and laser, 10 points will be collected; Left Bankfull, Left Wetted, Thalweg, Right Wetted and Right Bankfull, including five equally spaced points estimated at 10%, 30%, 50%, 70%, and 90% across the channel (Figure 8). If the main channel is dry, collect 8 points at the transect, which include the two bankfull points, five estimated points, and a point at the deepest location in the channel (i.e., approximate “thalweg” location). 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 and right bankfull locations and at the $\frac{1}{4}$ and $\frac{3}{4}$ locations of the bankfull width (Figure 9). At each intermediate transect take a point at the thalweg (in a flowing channel) or in the deepest location (in a dry channel).

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

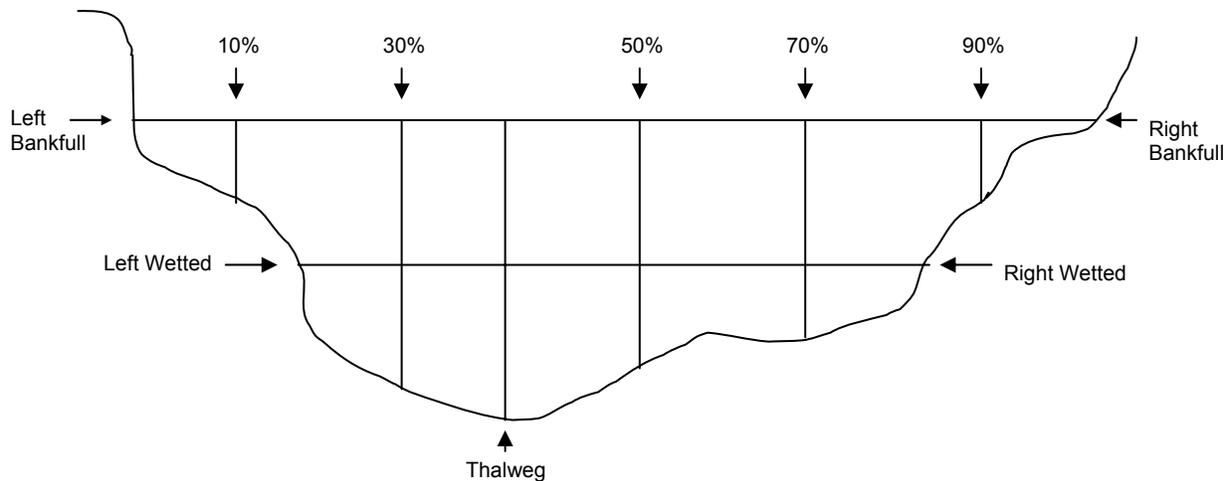


Figure 8: Example of the ten points collected at each major transect.

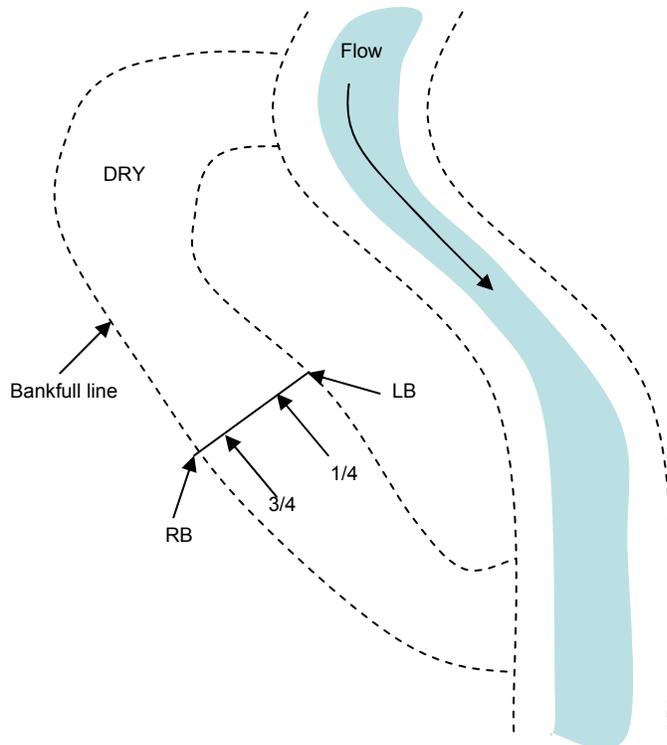


Figure 9: Four points will be collected on all side channel transects. If the channel is dry, place the prism at $\frac{1}{4}$ and $\frac{3}{4}$ of the bankfull width.

Change in Elevation

Stream gradient is the average slope of the water's surface measured from the beginning of the reach to the end of the reach. 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 reach gradient. Using the steps listed below, recall the elevation values at both A and K left wetted (from the sideshot screen after the point is shot) and calculate the difference to see if the 2 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 and mark where the points were taken for wetted edge at Transect A and K. Water levels can rise 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 10).

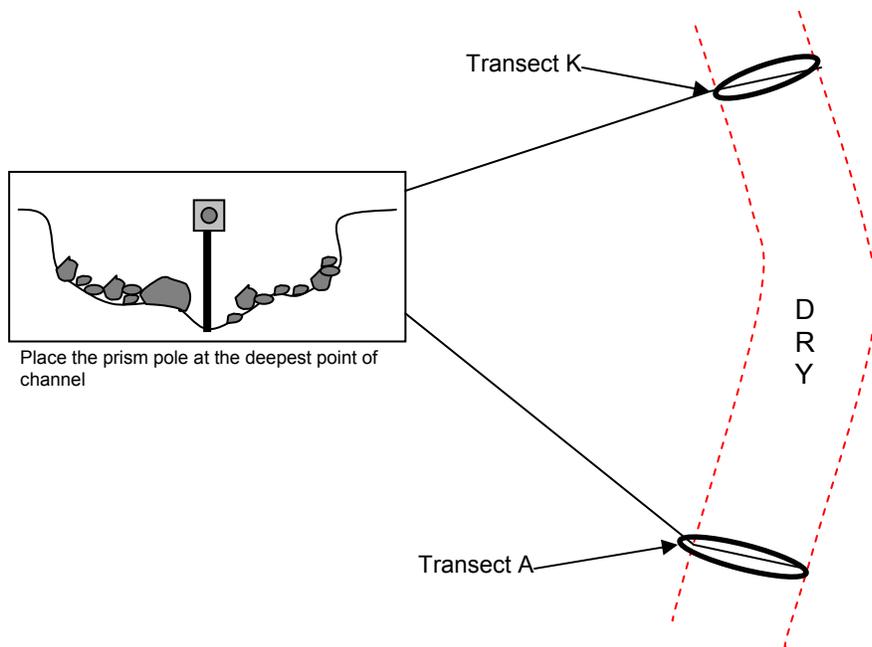


Figure 10: Example of where to place the prism pole in the situation where the stream channel is dry at both Transect A and K.

At Transect A, write down the elevation value of the left wetted edge on the Elevation 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 habitat survey is complete, shoot the left wetted edges of Transects K and A a second time. You will need to traverse downstream to re-shoot the left wetted edge of Transect A. In the Recon, label these points as M (1) at Transect K and M (2) at Transect A, respectively.

Calculate the elevation change using the Z-values for each measurement as follows:

1. Calculate $L_2 - L_1 = \text{Value}_1$
2. Subtract $Z\text{Value}_1 - [0.10 * \text{Value}_1]$
3. Add $Z\text{Value}_1 + [0.10 * \text{Value}_1]$
4. Calculate $M_1 - M_2 = \text{Value}_2$
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

Monument = Y*MO

Location of where site waypoint was taken with GPS = Y*GP

Transect A left bankfull elevation = Y*LB

Survey points

Transect A left bankfull elevation = A*LB

Transect A left wetted edge = A*LW (mark the location of this shot for elevation!!)

Transect A left wetted edge = L (gradient shot)

Transect A thalweg = A*TH

Transect A right wetted edge = A*RW

Transect A right bankfull elevation = A*RB

Transect A2 thalweg = A2*TH

Transect B.....

Transect K left bank = K*LB

Transect K left wetted edge = K*LW

Transect K left wetted edge = L (gradient shot)

Transect K thalweg = K*TH

Transect K right wetted edge = K*RW

Transect K right bank = K*RB

Transect K left wetted edge = M (gradient shot)

Pools

Pool Length and Residual Pool Depth

Objectives:

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

Pool Criteria:

Sample every pool within the sample reach that meets 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 reach. Conversely, consider it one pool if that pool tail depth is significantly deeper than other pools within the reach.

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. Measure the pool length (nearest 0.1m), maximum depth (nearest cm), pool head (nearest cm) and pool tail crest depth (nearest cm) for each pool. Place the prism pole in the deepest spot of the pool tail crest to capture the pool tail crest location and label as "FT". Proceed up the pool and locate the maximum depth by probing and label this point as "FM".
2. Measure pool length along the thalweg between the tail crest and headcrest.
***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.*
3. The maximum depth represents the deepest point in the pool and is found by probing with a depth rod until the deepest point is located.
4. The pool tail crest depth is measured at the maximum depth along the pool-tail crest and is normally (but not always) at the thalweg.
5. Measure the pool tail crest depth on dammed pools along the top of the obstruction (mostly LWD) if all flow is going over the obstruction. Conversely, measure to the streambed if some of the water is observed flowing under the obstruction.

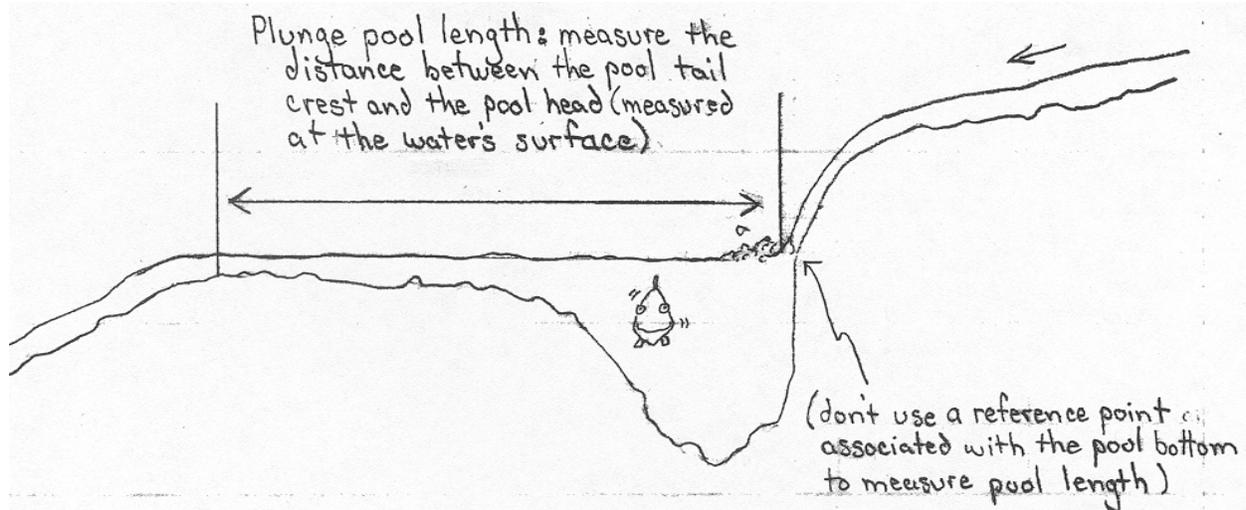


Figure 11: Example of a plunge pool situation in which you would measure the head of a pool where the surface of the water intercepts the bedrock/substrate.

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 on an increment within the bankfull channel.

Pebble counts –

1. The substrate will be measured at the 21 transect locations (Transects A – K).
2. 5 samples will be measured at each transect. Standing at left Bankfull divide the transect (estimate) up into 10%, 30%, 50%, 70% and 90% (See Figure 12).
3. 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.
4. 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 short side (depth) of the rock. Visualize the B axis as the smallest width of a hole that the particle could pass through.
5. 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.*

6. On larger boulders, you may have to use a field tape or flip the ruler end-over-end several times to get a measurement or use a field tape.
7. If rocks are embedded you may have to feel for the intermediate axis with your hand and use your fingers as calipers.
8. 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.

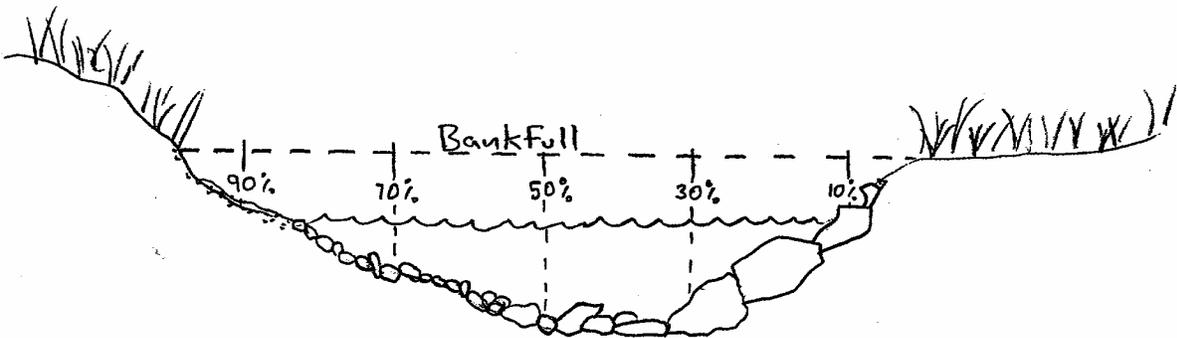


Figure 12: Transect divided for substrate measurement.

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 sub-transects.
3. For all measurements, enter either a number (mm) or the appropriate code for type of substrate encountered.

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 reach 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.

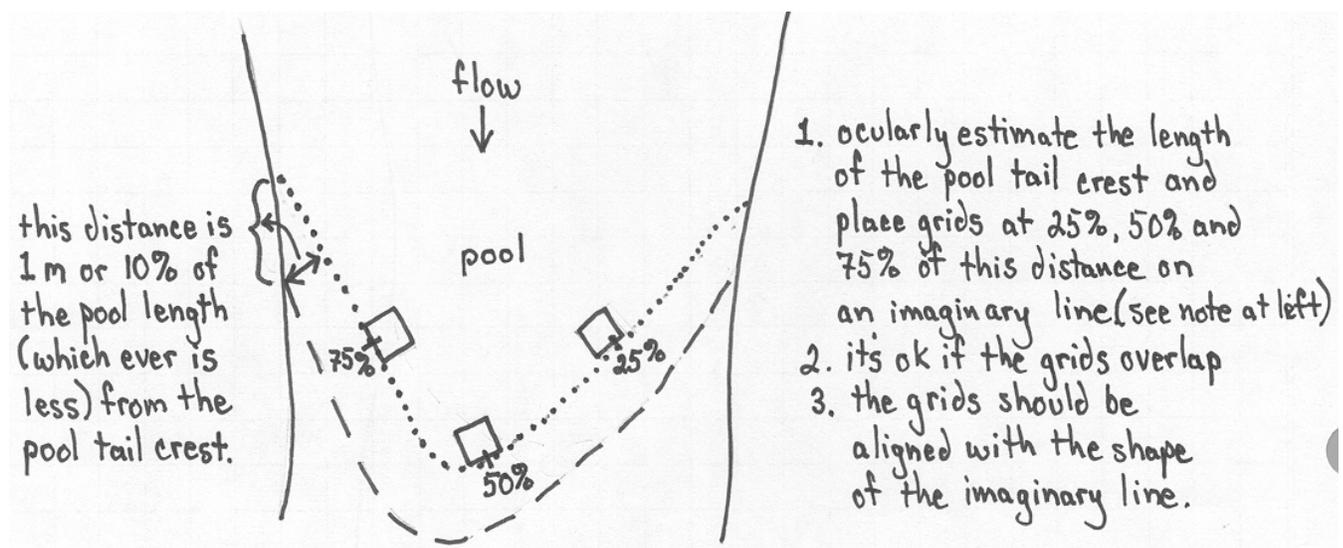


Figure 13: Example of where to place fines grid on a pool tail at 25%, 50% and 75%.

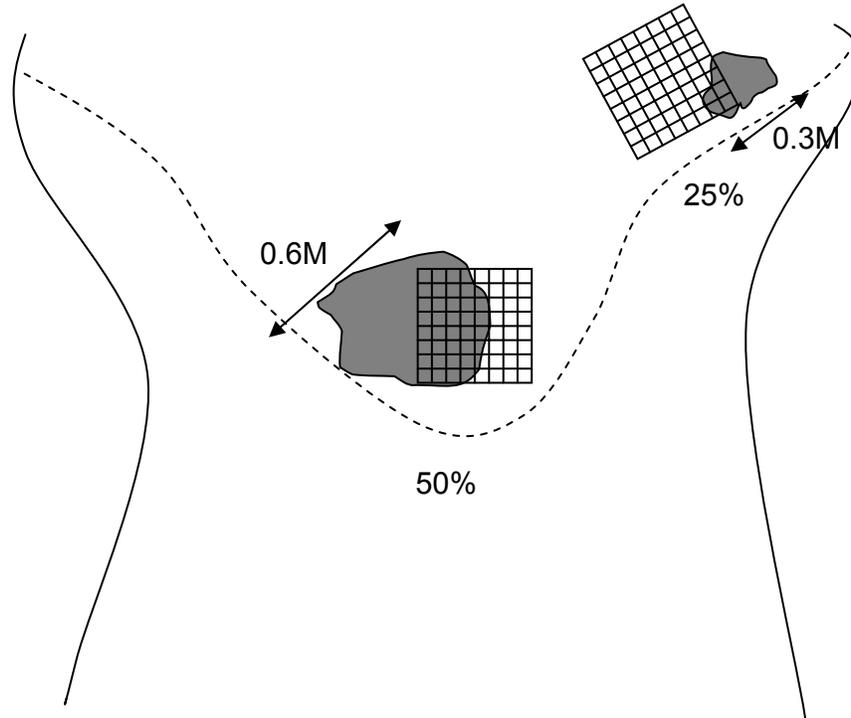


Figure 14. In this figure, all intersections of the fines grid at the 25% placement will be counted and recorded. For the 50% placement, the intersections of the fines grid that land on the boulder will be recorded as non-measurement.

Large Wood

Objective:

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

Sampling method:

1. In order to be counted, each piece must meet 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 all of the needles and leaves have turned brown. Consider it living if the leaves or needles are green.

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 imbedded within the stream bank is counted if the exposed portion meets the length and width requirements (Fig. 16).
 - d. Do not count a piece if only the roots (but not the stem/bole) extend within the bankfull channel (See 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 (See Figures 15 & 18).
2. Record the piece number, estimated length (nearest 10 cm), and estimated width (nearest cm) of all pieces in the reach. The same person will make all estimates for a given reach.
 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.
 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 4 and Figure 19).

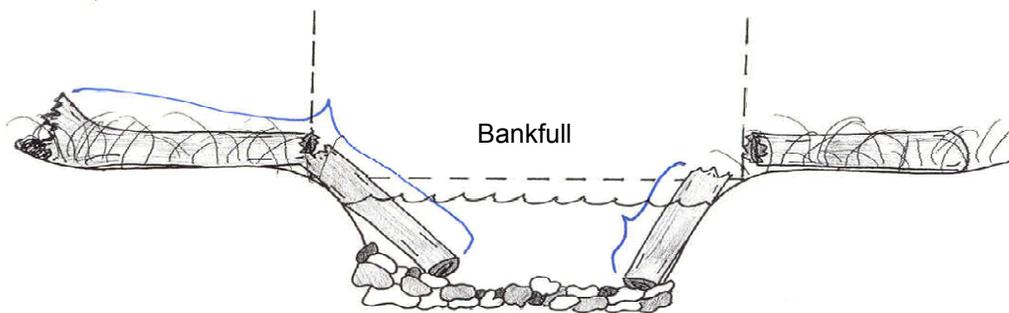


Figure 15: Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

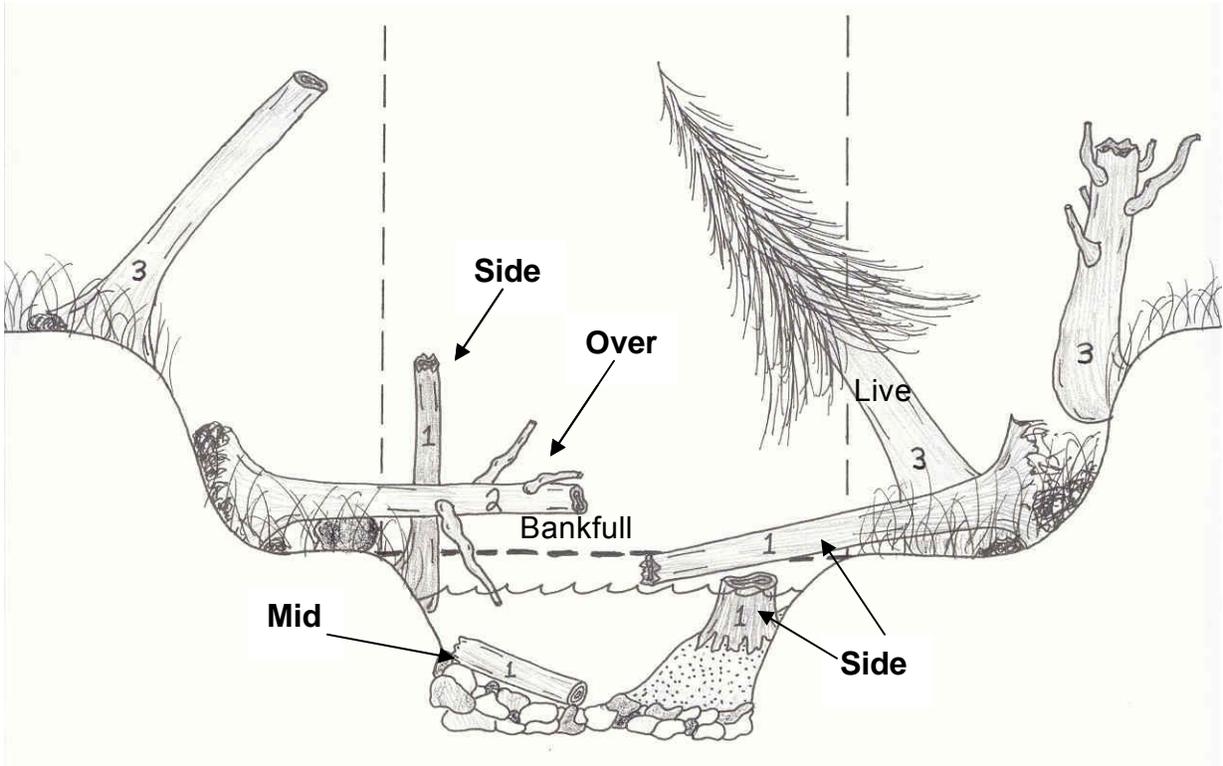


Figure 16: Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

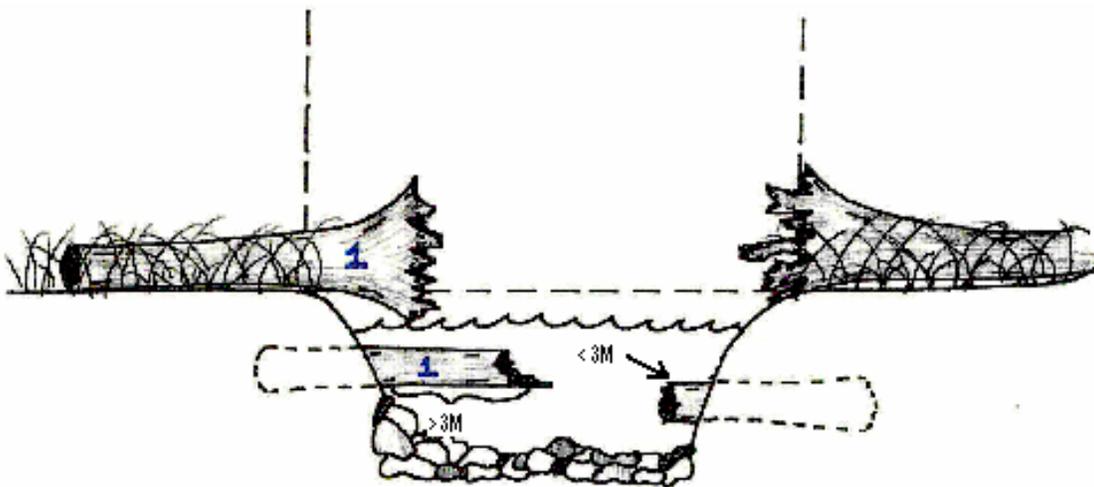


Figure 17: Examples of qualifying large woody debris (1). The pieces on the right side (3) are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

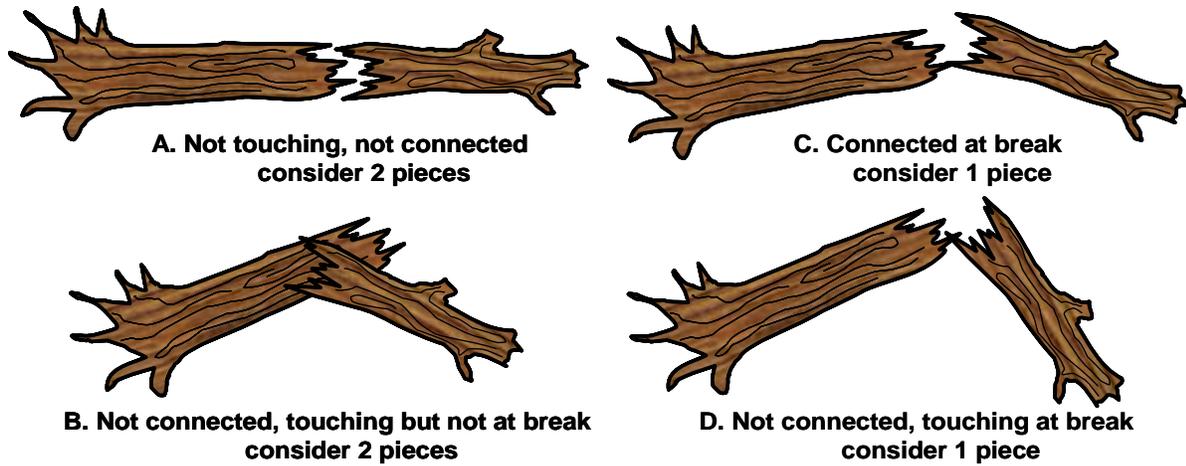


Figure 18: Variations of touching vs. not touching along the break.

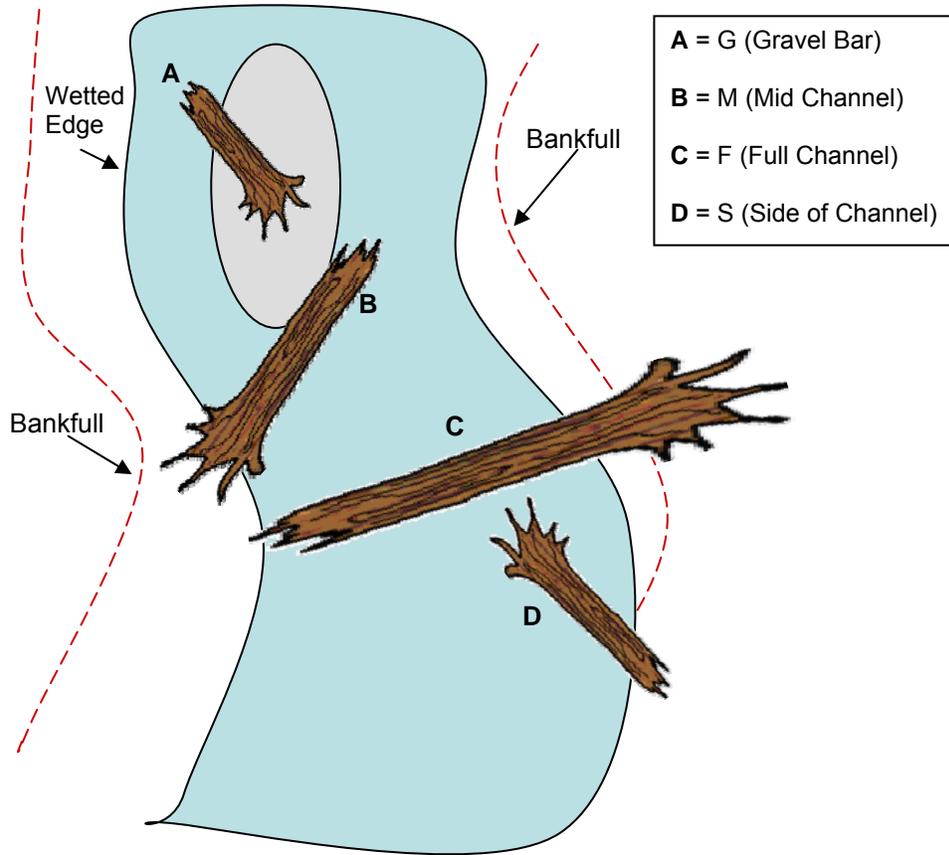


Figure 19: Example of wood locations in relation to the stream channel.

Table 4: Codes to be used with the wood data form.

Code Type	Definition
# Pieces Touching	
S	Single piece
**A(1,2,3...)	Accumulation (2-4 pieces)
**J(1,2,3....)	Jam (≥5 pieces)
Wood Type	
N	Natural (broken ends or entire trees)
C	Cut end
A	Artificial (part of a man-made structure)
RN	Root wad attached to trunk with Natural end (broken or entire tree)
RC	Root wad with opposite end Cut
Wood Location	
S	Side of the channel - Piece of wood covers or extends over a small portion (0-25%) of the stream channel (near bankfull edge).
M	Mid channel - Wood is in the main flow of the channel at bankfull (can be any orientation, not exclusive to center of the channel).
G	Gravel Bar- (Build up of sediment below bankfull elevation with water flowing on both sides.) - 50% or more of the <u>piece of wood</u> is located on the gravel bar
F	Full channel - Wood extends across 75% or more of the stream channel. Portions may extend beyond bankfull elevation.
O	Over 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	
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.

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 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 C. Hawkins, J. Ostermiller, and M. Vinson (pers. Commun.)

1. Collect samples using a Fixed Area Design (0.72 m^2) from fast water habitats with a $500 \mu\text{m}$ 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. Remove and release from the bucket/washtub/sample jar all vertebrates, including fish and amphibians. Also remove and release crayfish.
6. 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.
7. 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.

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 crewmembers 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 reach. Crewmembers should start at the wetted edge and search their way upstream on each bank for five minutes (ten minutes total at each transect). Be sure to estimate the total area searched along each bank: the width of the area searched will be restricted to a maximum of 2 meters. The length will not have a restriction. (Note: the dimensions recorded are the actual meters searched, not covered.)

2. 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.
3. 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 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.
4. 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.
5. Other data to record: 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. If an amphibian was captured, identify which bank it was caught on (left or right looking downstream), habitat (ranking from most, condition of the habitat, location of specimen (in/on/under) within the habitat, measure snout vent length (SVL) and total length (TL) (however, do not measure the total length of frogs or toads) what habitat it was in, the distance from the waters edge, the life history stage (juvenile or adult), and any mortality information.
6. 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 specific 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 species encountered by each crewmember in an individual watershed. Only take a few pictures of the representative sample of species found within your watershed. For example, we don't need 400 brook trout photographs within a watershed.

Fish

1. Place specimen on its side with the head facing the top of the fish board (0 mm) and the abdomen on the bottom of the board. Be sure to capture the full length of the fish. The head of the fish should be on the left side of the photograph.
2. If the fish appears to have features resembling spawning colors take photographs of the abdomen and paired fins.
3. If you don't know what the species is, take pictures of the key areas that are used in guidebooks (i.e., fin rays, leading edges of fins, vermiculations (trout) on the back etc.).
4. Take a picture of any distinguishing feature about the specimen.
5. Take a picture if you can't positively identify the fish to species.

Aquatic Amphibians

1. Place specimen on its abdomen at the top of the fish board 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 (same as fish).
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 water inside).
2. Important: do not place amphibians in the 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.

Water

Water Chemistry

Water temperature, dissolved oxygen and conductivity will be logged at five minute intervals for two hours at each site using a YSI meter. Place the meter at the upstream end of the reach unless a tributary enters the reach. If a tributary enters the reach, place the YSI two bankfull widths downstream of the tributary junction. If the tributary enters the reach between Transect A and B, place the YSI in suitable habitat below Transect A.

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 cup on, filled with ½ inch of drinking water or tap 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.**

1. Calibrate the YSI for dissolved oxygen in the morning prior to going out into the field.
(For information on calibration, refer to Appendix A.)
2. Remove the calibration/transport cup and replace it with the probe sensor guard.
3. 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. (In turbulent areas such as those with white water, the DO will be elevated, and pools do not have adequate mixing to replenish the DO probe or ensure a uniform temperature throughout the pool.) Place rocks onto the cord to hold the probe in place.
4. Turn on the YSI and allow it to warm up for **ten** minutes.
5. Record the current time (military time), temperature, conductance, specific conductance and dissolved oxygen in the data recorder.
6. To begin logging:
 - a. In the upper left corner of the “Run” screen, scroll to “Start logging” and press ↵.
 - b. On the “Enter Info” screen, scroll to the file name, press ↵ and enter the file name as follows: state code (two letters), watershed code (three-letters) and the site number (two characters). If the site is a QA/QC or trend site, leave out the state code and include a 9 or 6 before the site number. **Example:** ORRCK03 (RCK903, RCK603)
 - c. When you are finished entering the filename press ↵, select “OK”, and press ↵.
 - d. The YSI will begin logging data every five minutes. Allow the YSI to log data for at least two hours.
7. When you are finished logging data, select “Stop logging” and press ↵. Turn off the YSI and replace the probe sensor guard with the transport/calibration cup and ½ inch of drinking water or tap water.

Note: If when you select “Start logging” the “Pick a site” screen appears instead of the “Enter info” screen, press “configure”. On the “Logging setup” screen, deselect the “Use site list” option.

Placing and Retrieving Thermographs

Thermographs are to be placed in each watershed prior to 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 survey sites and tributaries with survey 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 that will be sampled 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.
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.
 - 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.

Using the Laser

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 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).

Adjusting the prism pole to survey hard to reach spots

Frequently, large branches, logs, or undercut banks get in the way of surveying.

1. The prism pole (Rod Height (HR)) can be adjusted to prevent moving the laser unit. **Remember to change the target height on the Recon data processor each and every time you change the height of the prism.** If the rod height is not changed, the data will be incorrect and will require editing at a later date.
2. 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 Recon, and measure the distance of the undercut that is wetted.

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.

IMPORTANT: Be sure the middle 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. Also, when entering the Instrument Height (height of center leg) be sure to read the number at the bottom of the bracket. The end piece of the center leg should be fully extended as well.

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.

Distance between shot location and wetted edge.

On a vertical bank, capture the bankfull height by placing the prism head against the bank (for a 0.08 meter shot) making sure the bottom edge is level to the bankfull line.

Bankfull

Bankfull

Yes

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.

Bankfull line

Appendix A

YSI Meter Calibration and Maintenance

The YSI meter needs to be calibrated for dissolved oxygen daily before being used in the field. Once each month you will need to change the DO membrane and calibrate specific conductance. It is best to calibrate in the morning and out of the sun to ensure that the temperature remains stable. Store calibration standards in a cool, temperature-stable location (never in direct sun). Before calibrating dissolved oxygen, the DO probe will need to warm up for 20 minutes. All calibration and maintenance information should be recorded in the calibration log. Also record in detail any problems with the YSI.

Calibrating dissolved oxygen (daily)

1. Make sure the YSI has been turned on for at least 10 minutes.
2. Remove the entire calibration cup from the probe module. Shake the excess moisture off of the probes and, using a clean cotton swab, gently dry off the thermister and the DO membrane. When calibrating DO, inspect the membrane and make sure it is in tact 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. Pour ½ inch of water into the calibration cup.
4. Being careful not to wet the probe, place the probe module on its end into the cup and screw the cup onto the probe ½ turn so that the cup remains **loosely** fitted onto the module. Make sure the thermister is not submerged and the DO membrane remains free of water.
5. Wedge the probe into a place where it will not be disturbed for at least 10 minutes. Make a note of the time. The probe should be in the shade, out of sunlight, where the temperature is stable.
6. On the “Calibrate” menu of the YSI select “Dissolved Oxygen (DO)”. Select “DO%”.
7. The barometric pressure should appear on the “DOsat” screen by default. Press ←to confirm it. Record this value in the calibration log.
8. When ten minutes has passed since the probe was last disturbed, record the initial DO value on the log sheet. Press ←to calibrate the probe and record the final DO value on the log sheet. Press ←to continue.

Storing the probe module

The calibration/storage cup should be screwed on snugly with approximately ½ inch of water (tap or filtered) inside to keep the DO membrane moist, but not submerged in water. It is very important that the probes stay 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 if stream water was used. If the calibration cup leaks, the O-ring may need to be replaced.

Cleaning the probes (as needed)

An invisible film gradually builds up on the probes of the YSI. To ensure accurate readings and calibrations, the probes should be cleaned at least one time at the end of each stint. If the DO readings drift or are difficult to calibrate, the probes should be cleaned.

1. Rinse all three probes thoroughly with distilled water using the squirt bottle, paying close attention to the inside of the conductivity probe.
2. Using the bottle brush included in the maintenance kit, scrub the inside of the conductivity probe using 15 to 20 strokes.
3. 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.

Calibrating specific conductance (monthly)

1. Rinse the YSI probe module and calibration cup **three** times with distilled water. Open the cap and pour one inch of water into the cup. Replace the cap and rinse, swirling the water inside the cup and around the probes for at least 10 seconds during each rinse. Shake the excess water out of the cup between rinses.
2. Pour a 1/2 inch of 1000 $\mu\text{S}/\text{cm}$ conductivity calibrator into the cup and rinse one time with the calibrator.
3. Fill the calibration cup to the line on the side of the cup with the conductivity calibrator. Replace the cap and gently turn the probe on its end.
4. On the YSI meter, note the temperature of the solution then press escape to get to the main menu. Scroll to "Calibrate" and press \leftarrow .
5. Select "Conductivity". Select "Specific Conductance".
6. The YSI will prompt you for the specific conductance in **mS/cm**. Enter the standard used on the bottle of solution and press \leftarrow .
7. The parameters will be displayed and "calibrate" will be highlighted in the upper left hand corner of the screen. Wait a few minutes for the temperature and conductance to stabilize. When they have stabilized, record the initial value and temperature on the log sheet. Press \leftarrow to calibrate. Record the final value on the log sheet and press \leftarrow to continue.
8. Rinse the probe three times with distilled water.

Changing the DO membrane cap (monthly)

1. Unplug the probe from the YSI.
2. Thoroughly clean the probe module.
3. Unscrew the DO membrane cap from the DO probe and discard it.
4. Rinse the probe with distilled water.
5. Using the sanding disk in the maintenance kit, gently wet-sand 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.

6. Rinse the probe well and wipe thoroughly with a wet paper towel making sure all grit has been removed. Rinse the probe again with distilled water
7. Prepare the electrolyte solution according to instructions on the bottle. Try not to shake up the solution just before use as it may cause air bubbles to form.
8. Carefully fill the new membrane cap at least $\frac{1}{2}$ full with electrolyte solution trying not to form air bubbles. Tap the side of the cap gently to release any air bubbles in solution.
9. 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.
10. Rinse the probe thoroughly and replace the storage cup with about $\frac{1}{2}$ inch of water. The membrane should sit for 24 hours before use.

Appendix B

Contingency Protocol for Broken Compass and Laser

Regardless of whether a compass or laser are malfunctioning, certain key pieces of data still need to be collected at a survey site. For this protocol the reach will be laid out and all transects will be surveyed identical to the regular field protocol, minus the compass and laser. Datasheets titled “AREMP Survey for Width” and “AREMP Surveys for Pools” have been designed to facilitate and ensure these data are collected properly and completely (the crew should not leave the stream until all information is collected and recorded). Copies of these datasheets are provided in the crew notebooks and in each crew’s laser and compass case.

Monument

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.

Transects

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 25).

- ❖ 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 25).

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

Species List for Aquatic and Terrestrial Vertebrates

Species List - Fish

Code	Genus	Species	Common Name
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 Pacific Giant Salamander
DISP	Dicamptodon	species	Unknown Dicamptodon
DITE	Dicamptodon	tenebrosus	Pacific 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 Plethodon
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	boylei	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

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