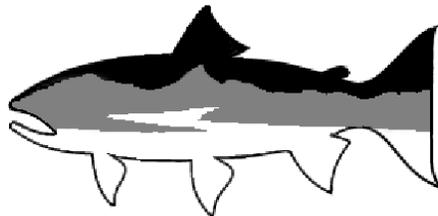


Field Protocol Manual

Aquatic and Riparian Effectiveness Monitoring Program

Regional Interagency Monitoring for The Northwest Forest Plan



2013 Field Season

Contacts	3
Acknowledgements	3
Introduction	3
Locating and establishing the start of the survey	5
Navigating with the Garmin Colorado 400t.....	5
Selection Criteria	5
Record the site UTM coordinates	7
Monument the site	8
Photo Documentation	10
Order of events for photographs at Tran A.....	10
Order of events of photographs at Tran K.....	10
Additional photos to take	11
Site Layout.....	12
Transect layout.....	14
Site Maps.....	16
Unusual situations	17
Side Channels	19
Using the Laser and Electronic Compass	23
Initial laser setup.....	23
Using the prism pole when surveying hard to reach spots	23
Channel Morphology	25
Bankfull Width (note all references to stream directions are looking downstream)	25
Order of events for shooting laser and prism	27
Change in Elevation	28
Pools.....	30
Pool Length and Residual Pool Depth.....	30
Entrenchment	34
Physical Habitat	36
Substrate – Pebble Counts.....	36
Pebble counts.....	36
Percent Surface Fines on Pool Tails	38
Large Wood.....	43
Biological Sampling.....	50
Benthic Macroinvertebrates.....	50
Invasive Species.....	52
Aquatic plants	52
Aquatic animals.....	52
Terrestrial plants	53
Terrestrial animals	54
Incidental invasives.....	54
Photographs of Biota.....	56
Appendix A – Contingency Protocol for Broken Compass & Laser.....	57
Appendix B - Invasive Species Disinfection Protocol.....	59
Appendix C– Procedure for Pressing Plants	62
References	63

Contacts

For information about the Aquatic and Riparian Effectiveness Monitoring Program, please contact the following:

Steve Lanigan – Team Lead	503.808.2261	slanigan@fs.fed.us
Peter Eldred – GIS Analyst	541.750.7078	peldred@fs.fed.us
Stephanie Miller – Fisheries Biologist	541.750.7017	stephaniemiller@fs.fed.us
Heidi Andersen – Fisheries Biologist	541.750.7067	hvandersen@fs.fed.us
Mark Raggon – Field Coordinator	541.750.7021	mraggon@fs.fed.us
Steve Wilcox – Cartographic Technician	541.750.7122	sewilcox@fs.fed.us

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, Jenni Dykstra, Ted Sedell, Peter Gruendike, Jake Chambers, Steve Wilcox, Heidi Andersen, Stephanie Miller, Hank LaVigne, John Speece, Jeff Metzger, Mark Raggon and Stephanie Miller helped improve subsequent drafts of the protocol. Thanks to all of the field crew members who tested, questioned, and provided feedback over the years. Steve Lanigan (AREMP), Kate Dircksen, Emily Hall, Deanna Vinson and Jeremiah Heitke from the PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program kindly shared their artistic drawings. Thanks to PIBO for cooperating to standardize a core set of sampling methods.

Finally, thanks to all those who have provided funding and logistical support over the years including the U.S. Forest Service (USFS) Regions 5 and 6, the Bureau of Land Management (BLM), the National Park Service (NPS), National Oceanic and Atmospheric Administration (NOAA)- National Marine Fisheries Service (NMFS) and the Environmental Protection Agency (EPA).

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 in the Pacific Northwest, 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 numerical 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).

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 “where to?” feature on the GPS unit to guide you toward 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.

Navigating with the Garmin Colorado 400t

1. To access the “Where To?” Menu:
 - a. Select Shortcuts > Where To?
 - b. Select the preferred search category (usually Waypoints or POI).
 - c. Select a point. A green circle containing the word “GO” appears at the bottom of the page.
 - d. Press Enter.
2. To navigate to a point on the map:
 - a. On the Map page, use the Rock ‘n Roller to move the pointer to a location and press ENTER, a green circle containing the word “Go” appears at the bottom of the page.
 - b. Press ENTER.
3. During navigation, select Shortcuts > Compass and follow the red arrow.

Navigating with the Garmin Oregon 400t

1. From Main Menu: tap “Where To?”
 - a. Select the preferred search category (usually Waypoints or POI).
 - b. Select a point. A green circle containing the word GO appears at the bottom of the page.
 - c. Tap the green circle.
2. To navigate to a point on the map:
 - a. On the Map page, tap a location, an info box will appear at the top of the screen. Tap the box, a green circle containing the word “Go” appears at the bottom of the page.
 - b. Tap the circle.
3. During navigation, from the Main Menu select Compass and follow the red arrow.

Selection Criteria

Note: 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.

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 (done in office). *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.

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

Garmin Colorado 400t:

1. Select Shortcuts > Waypoint Averaging > Options > Create Waypoint.
2. When the Sample Confidence reaches 100%, select Save.
3. Edit waypoint name (Shortcuts > Waypoint Manager>select correct waypoint>Change Name) following the naming convention {creek_code}{site_no}{reach location}. e.g. ORABC####k.

Note: Make sure to use the letter "O" and the number "0" in the appropriate locations when naming a site (i.e., ORABC1007)

Garmin Oregon400t

1. Select Waypoint Averaging > Options > Create Waypoint.
2. When the Sample Confidence reaches 100%, select Save.
3. Edit waypoint name (Waypoint Manager>select correct waypoint>Change Name) following the naming convention {creek_code}{site_no}{reach location}. e.g. ORABC####k.

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 and National Parks.***

1. Locate a distinct feature near the bottom of the site for Tran A and near the top of the site at Tran K 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 log 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. If the marker is more than 10 meters from the Transect, take a GPS point and make a note in the Monument Description data form.
4. Next, standing at the marker location, take a manual compass bearing from the marker to Transect A/K 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/K 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/K (i.e. 10T 0479344 4934553)
 - g. Reach length for the site.
 - h. TR or BR (Top or Bottom of reach)

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

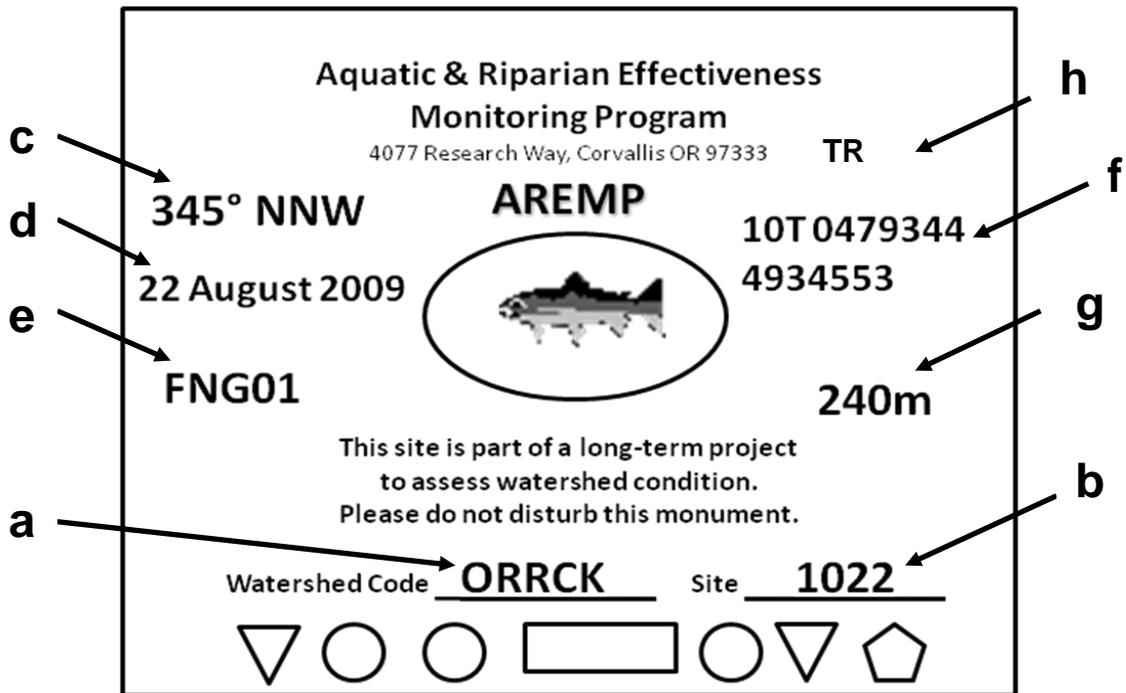


Figure 1. Schematic of site marker with required information filled out.

Photo Documentation

Information about each site will be documented in photographs and in the field data recorders. 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. Ten photos will be taken at Transect A and five at Transect K. In addition, photographs should be taken of rare or unique features in the site including culverts, log jams, beaver dams, or vertebrates that are difficult to identify.

1. Turn on your camera and do the following:
 - a. Verify the image quality is set on “MACRO”.
 - b. 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. 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.
2. 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 and K.

Order of events for photographs at Tran A

1. GPS screen showing date and time
2. Close-up of white board with site 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.”
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

Order of events of photographs at Tran K

1. Transect K left bank
2. Downstream from Transect K
3. Transect K right bank
4. Upstream from Transect K
5. Monument from Transect K left bank

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.

Site Layout

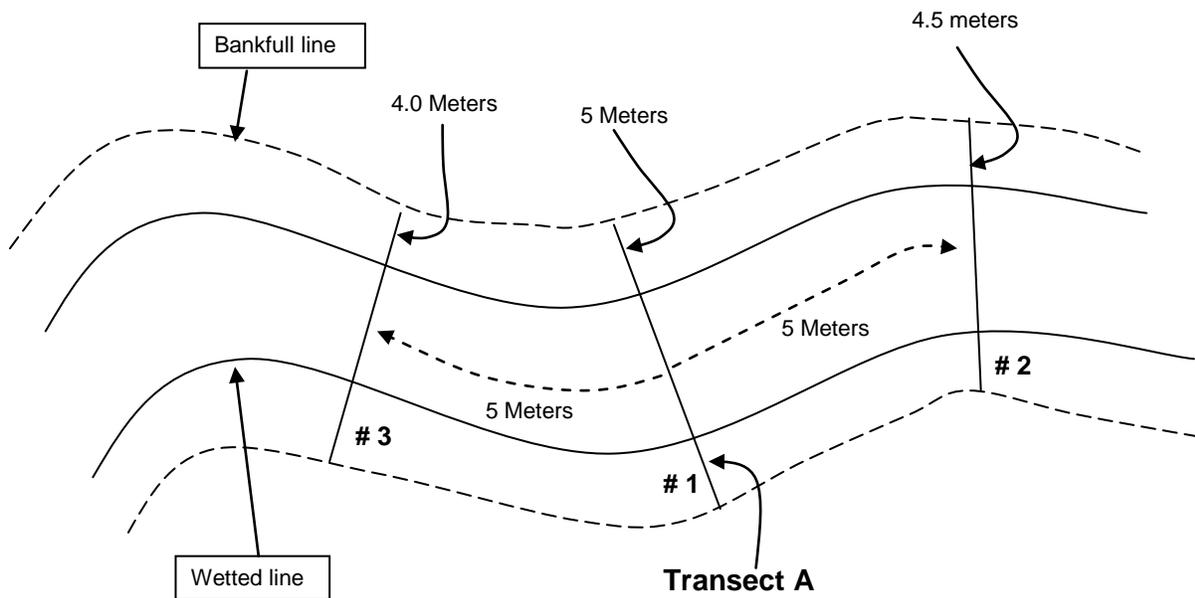
1. Examine the bankfull indicators (described below) throughout the site to identify the bankfull elevation. Recognize that all six indicators are rarely present at an individual site.
 - Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated 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 bankfull constraints (not channel)** at Transect A (Figure 2). Round the bankfull width to the nearest 0.1 meter. This number will be used to determine the location of two additional bankfull width measurements.
3. Two additional bankfull widths will be measured, one upstream and one downstream. 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 width 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 upstream bankfull width, 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 (Table 1 - this information is also provided in the field data recorders). The site length is defined for each width category and is equal to 20 times the bankfull width.

- If the watershed has been surveyed before the original bankfull width will be used to determine site length but still record three bankfull widths in the data recorder.

Trend and QAQC Sites (i.e. repeat sites):

Measure and then record the three bankfull widths in the Nomad field data recorder. The reach length used for surveys will be the same as measured in the previous survey and will be provided to crew leaders prior to leaving the office. If a crew conducts a repeat visit to a site that was previously surveyed, they will use that reach length.



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 (Figure 3). Side channels and pools will also be identified and marked with **pink** and **blue** flagging respectively. Transect A will be marked with **biodegradable** orange flagging.

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. Keep the flagging to reuse for future surveys.**

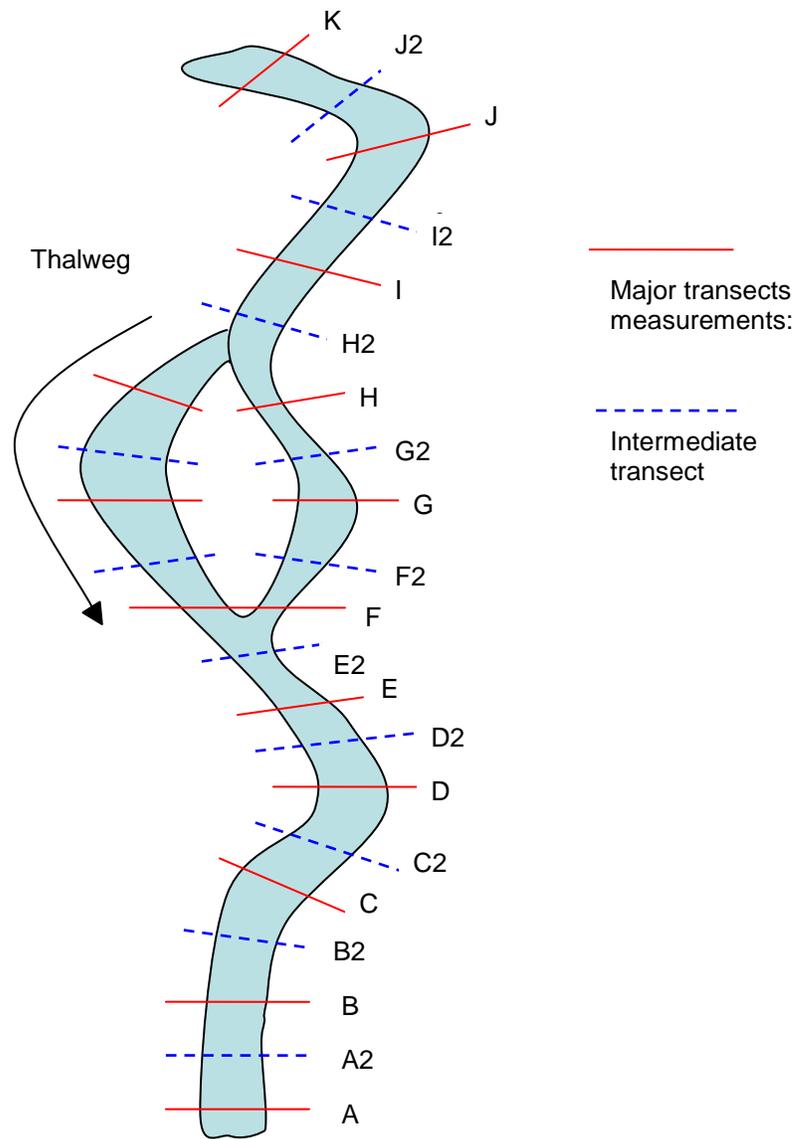


Figure 3. Site layout at major and intermediate transects.

Site Maps

A site description map will be drawn on a template located on the Algiz field computer (Figure 4). 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.

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

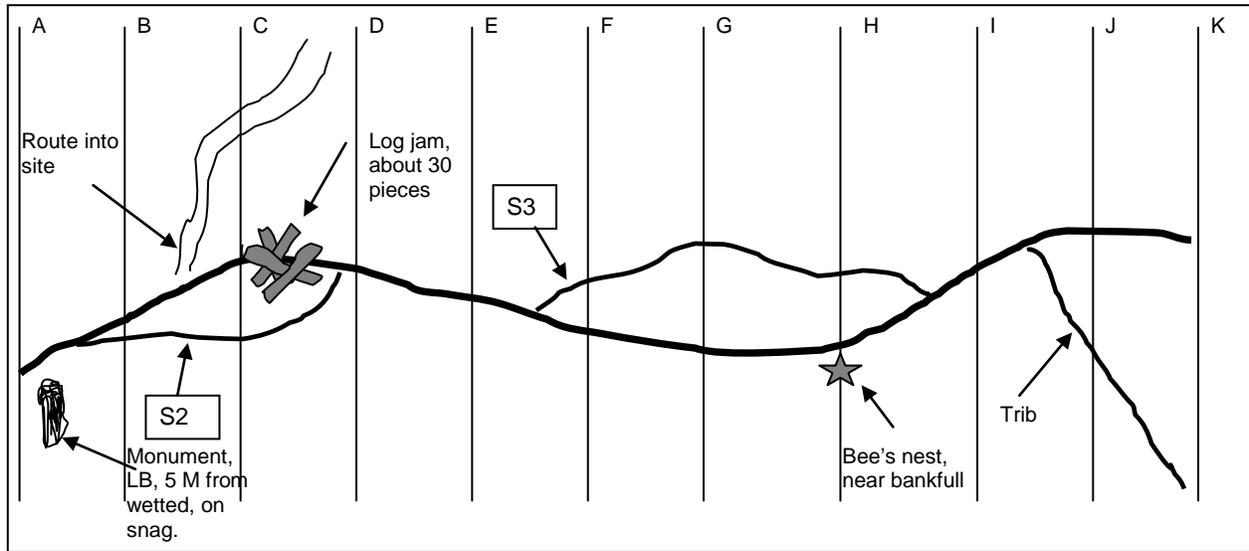


Figure 4. Example of site map for a site **with** side channels.

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 Comments section on the Headings page on the Nomad. 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. Two surveys should never have shared reaches. 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 (Transect F). In order to determine this you will have to measure the 3 initial bankfull widths for the second site and layout the second site up till Transect F. Then layout the first site and flag Transect A of the second site if Transect K of the first site is before Transect F of the second site. However if Transect K of the first site is after Transect F of the second site, drop 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 blocks 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. Collect a point at both the “STOP SURVEY” and “START SURVEY” flagging and make notes in the comments section on the Algiz 7 field computer 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)	Refer to impassible barriers.
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; Figure 5). 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 6; 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 6: 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 $\geq 20\%$ 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 site's average bankfull width. In Figure 7, 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

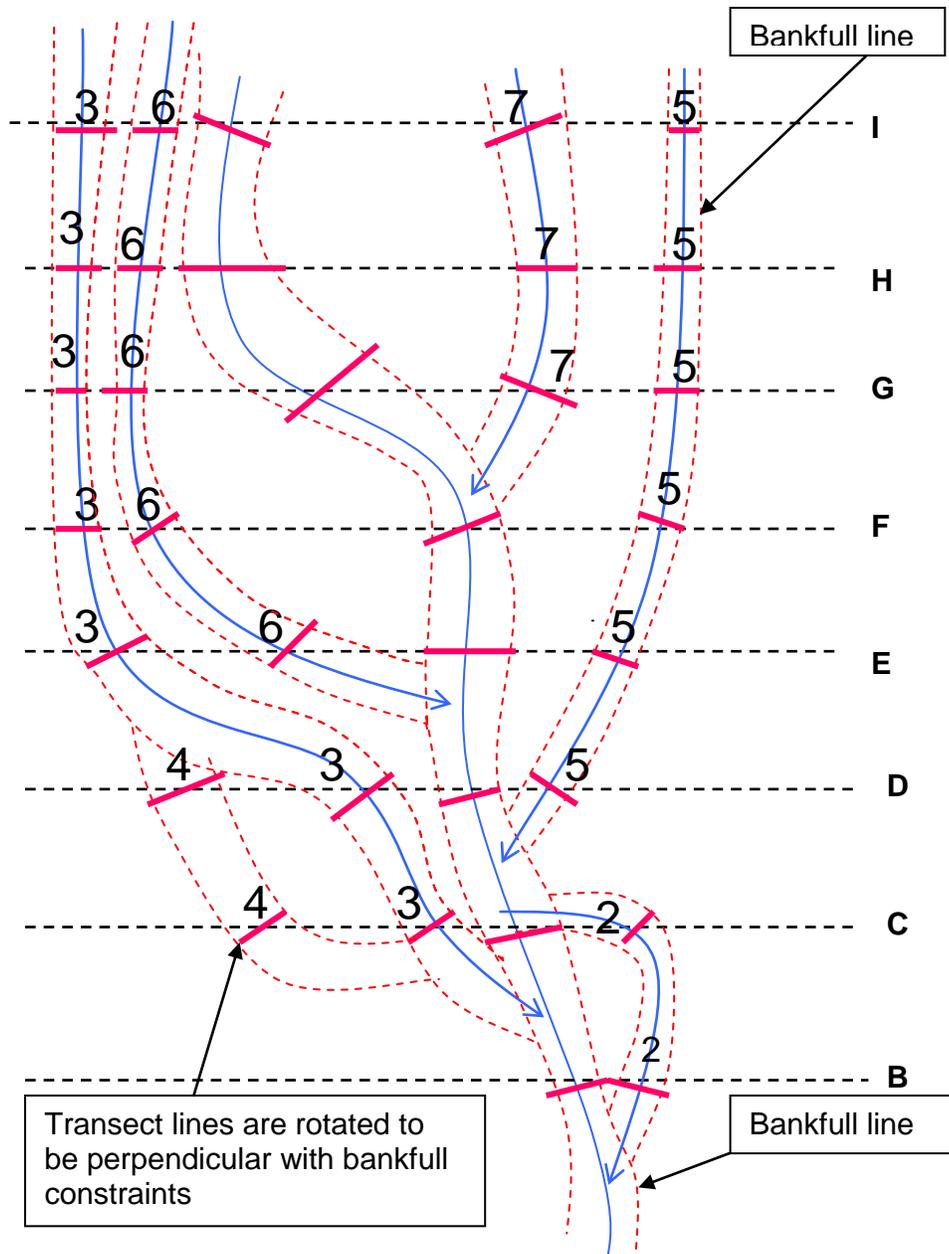


Figure 5. Numbering side channels and rotating transects at each channel. Major transects B - I are represented by the dashed lines and are labeled on the right. Channels are numbered by the order in which they are encountered in the site, while moving upstream. A channel does not need to enter the main channel or have water to qualify (side channel 4), as long as it meets the criteria for a side channel listed previously.

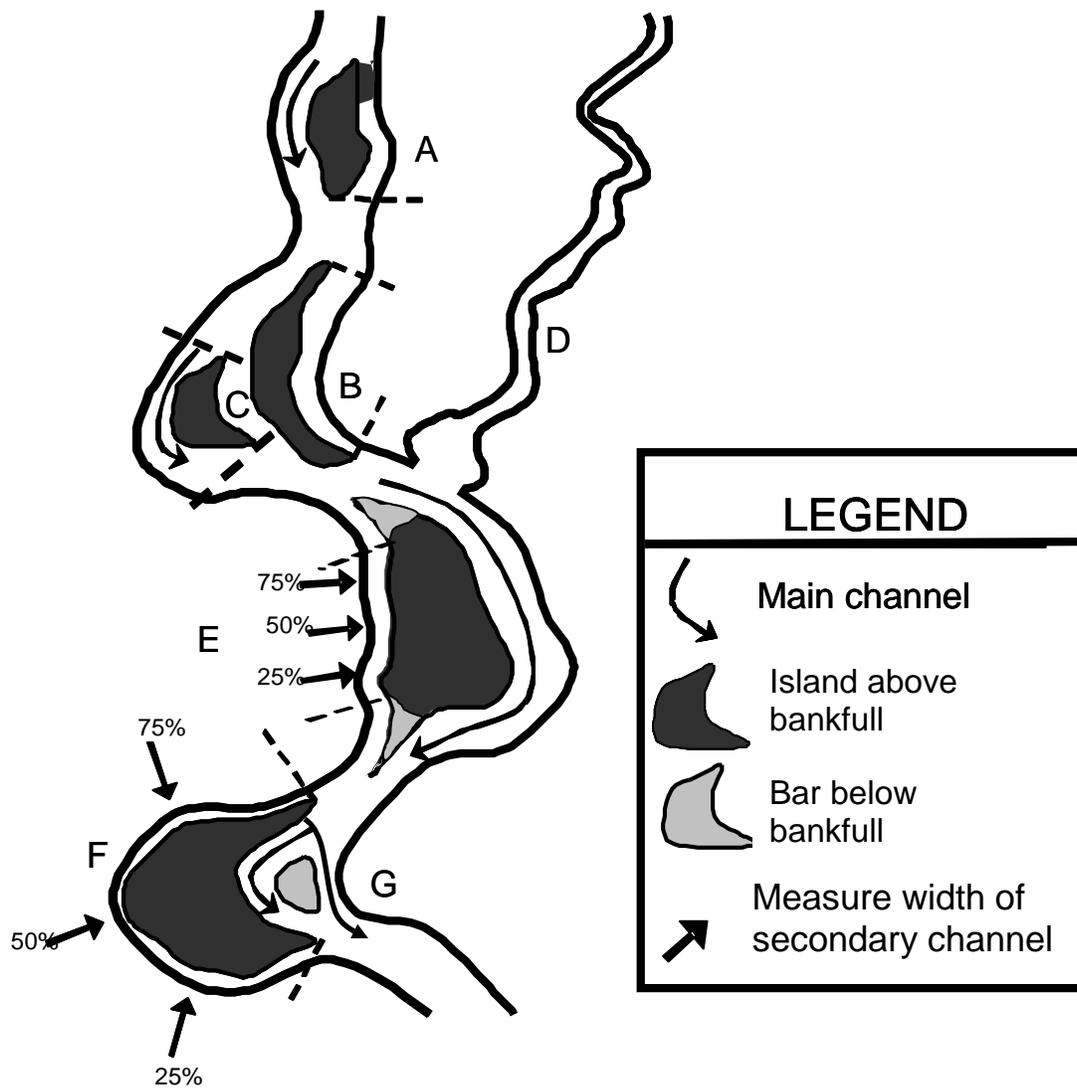


Figure 6. Examples of side channels. Channels B, C, and E are considered side channels ($\geq 20\%$ of the bankfull width category) whereas channel F is excluded as it is too narrow. Channel A is excluded, because it does not have a head (entry point) to the channel. Channels E and F depict where to 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 \geq 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. 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). Mark this center point with an "X" using chalk so this point can be relocated if necessary. Tripod 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, closer to zero is best. 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).

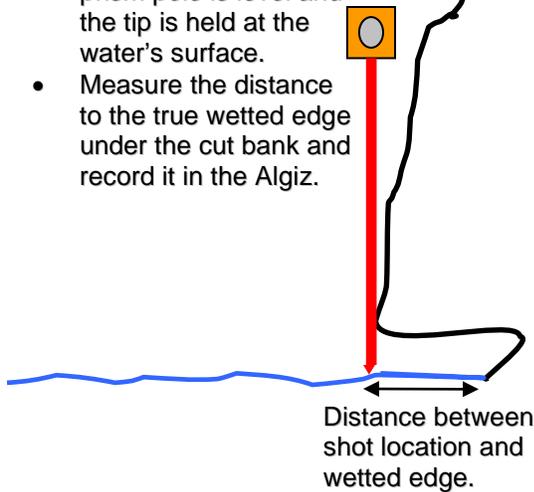
IMPORTANT: Be sure the center tripod pole is firmly placed on a flat surface, and the remaining legs are secured to the ground. A reasonable method is to place a heavy rock around the tip of the tripod legs to keep the whole unit from wobbling. The end piece of the center pole should be fully extended. 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 when surveying hard to reach spots

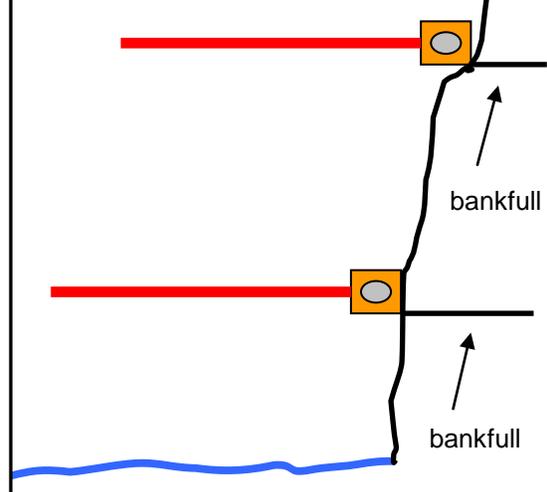
1. Place the point of the prism pole on the substrate at the location you wish to measure with the laser and electronic compass.
2. Use the bubble level to ensure that the prism pole is oriented vertically. If the pole is leaning, it will change the location and elevation of the point that is taken.
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 the shot will have to be deleted and reshot.
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. 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.

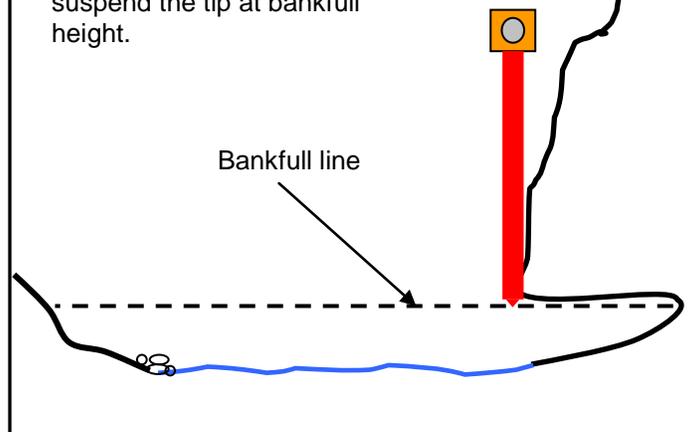
- It is important that the prism pole is level and the tip is held at the water's surface.
- Measure the distance to the true wetted edge under the cut bank and record it in the Algiz.



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.



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.



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 7). 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 8). At each intermediate transect take a point at the Thalweg (in a flowing channel) or in the deepest location (in a dry channel). Do not take a measurement at intermediate transects in side channels. 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 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 field data recorder.

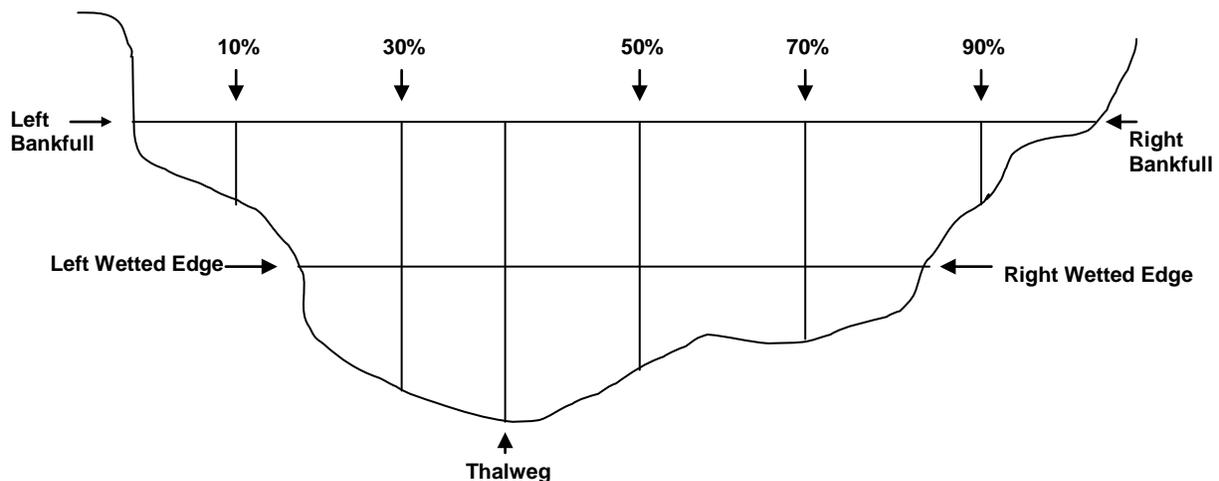


Figure 7. Example of the ten points collected at each major transect.

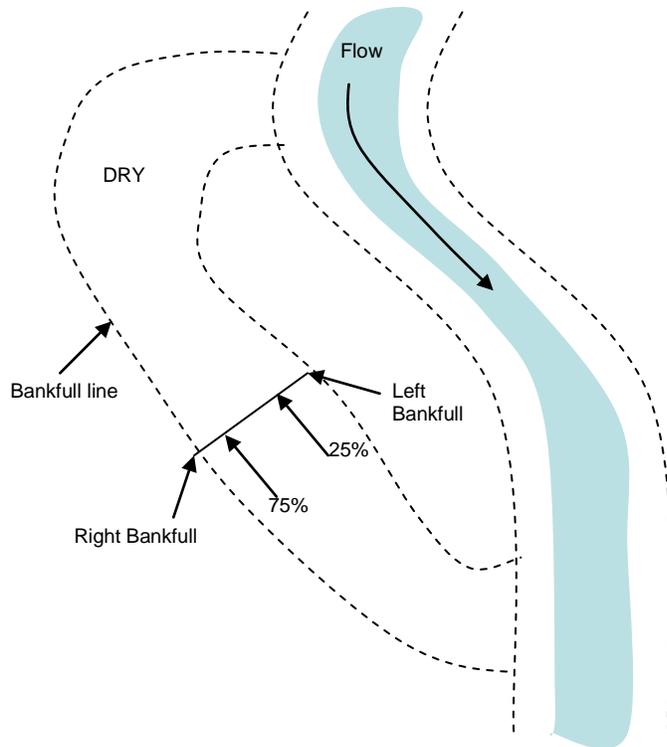


Figure 8. Four points will be collected on all side channel transects. If the channel is dry, place the prism at left bankfull, 25% and 75% of the bankfull width, and right bankfull. If the channel is wet, place the prism at left bankfull, left wetted edge, right wetted edge, and right bankfull.

Order of events for shooting laser and prism

Triangulation of monument location

Monument at A= Y Tran, MA

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 10%, 30%, 50% 70% 90% (wherever they fall in order between left and right bank).

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)

Monument at K = K Tran, MK

Transect K waypoint taken with GPS = Y Tran, GK

Habitat crew must take point and save it on Colorado or Oregon for Crew Leader to download (save as ORRCK1003K) as well as mark point of where GPS was taken with rocks or flagging.

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. These calculations are automatically populated in the Gradient form on the Algiz field computer.

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 9) for gradient measurements.

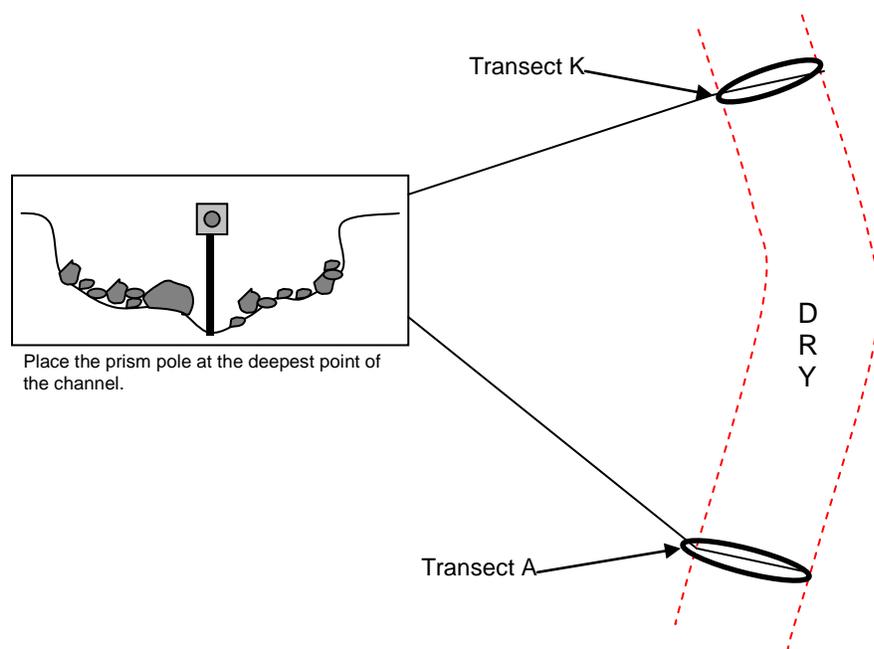


Figure 9. Example of where to place the prism pole in the situation where the stream channel is dry at both Transect A and K.

The following steps outline the process for collecting the appropriate data and how to calculate the elevation change. At Transect A, shoot the elevation of the left wetted edge and label it L1 on the Algiz. At Transect K shoot the elevation for the left wetted edge and label it L2. When the laser survey is complete, re-shoot the left wetted edge of Transect K a second time and label it M1. Then, traverse downstream and re-shoot the left wetted edge of Transect A, and label it M2.

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 $L_2 - L_1 = \text{Value}_1$
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.

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 (think of a spoon).
2. Pools are bounded by a head crest (upstream break in streambed slope) and a tail crest (Figures 10 & 11).
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 (Figure 12).
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.

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 "Pool Tail" 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 "Pool Max" 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 "Pool Head" in the field data recorder (e.g. CD LONG, PH). If the pool is a plunge pool, take the point at the head crest with the prism point at the water's surface.

***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.

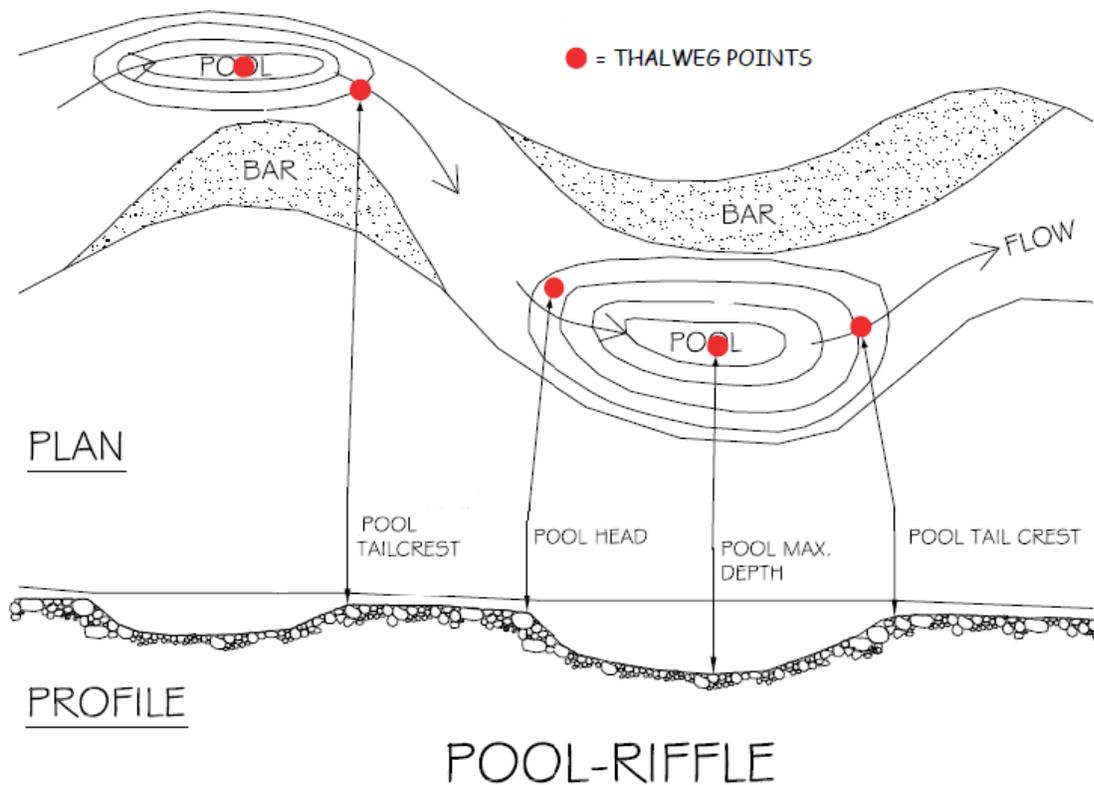
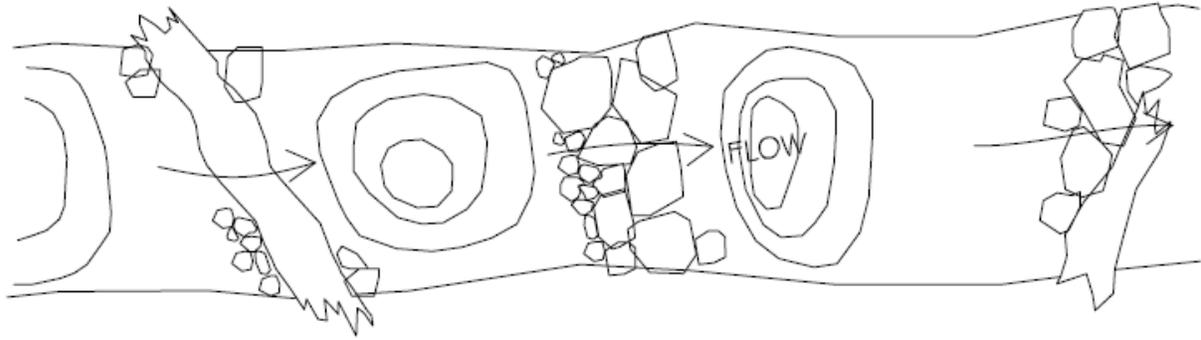
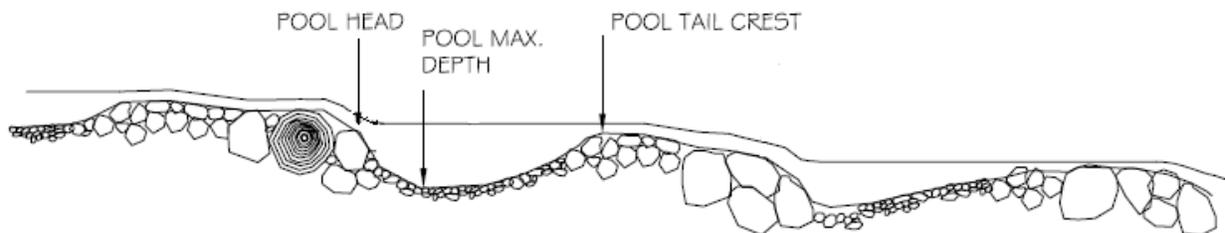


Figure 10. Diagram of pool features in a pool-riffle system including, Thalweg, pool head, maximum pool depth and pool tail crest.



PLAN



PROFILE

STEP-POOL

Figure 11. Diagram of pool features in a step-pool system including pool head, maximum pool depth and pool tail crest.

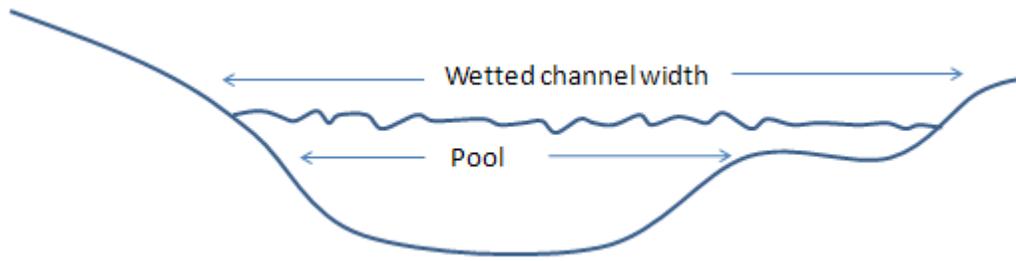


Figure 12. Pool width relative to wetted channel width. The widest point of the pool feature above is approximately 70% of the wetted channel width. Therefore this pool feature would be disqualified as an actual pool.

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	$\geq 4\%$	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. 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 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).

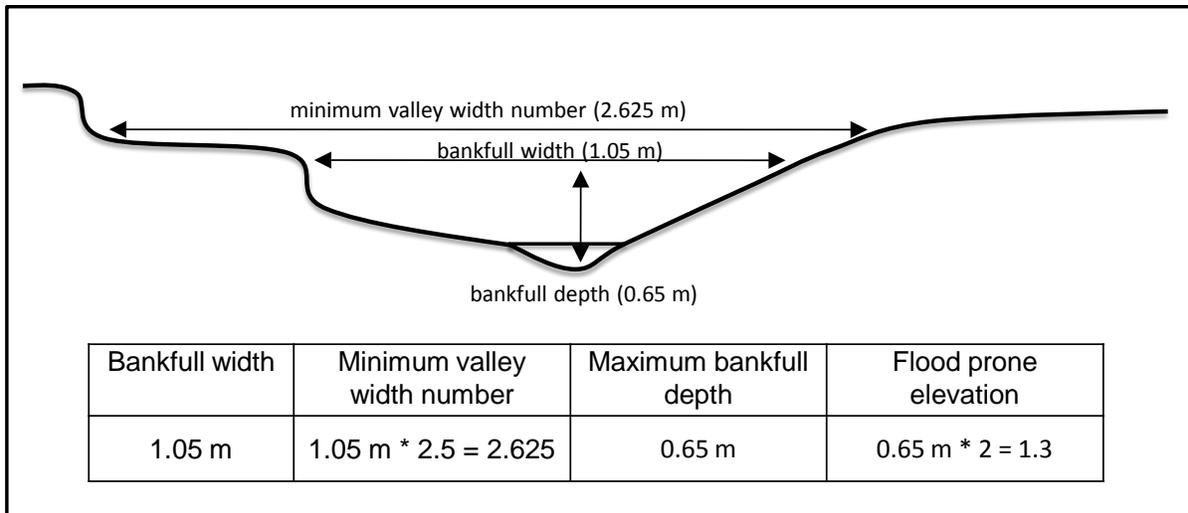


Figure 13. To measure entrenchment, the bankfull elevation and bankfull depth are measured. The minimum valley width number and flood prone elevation are calculated using the bankfull width and depth. This calculation is done automatically in the Entrenchment data form of the FDR.

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 20 transect locations (Transects A2 – K; major and intermediate transects) which may extend into adjacent qualifying side channels.
2. Transects shall be divided into five increment points visually estimated at 10%, 30%, 50%, 70% and 90% within the bankfull width starting at left bank (See Figure 14). At each increment point three substrate samples will be collected for a total of 15 substrate samples at each transect. When a single main channel is present, visually locate the 10%, 30%, 50%, 70% and 90% increment points.
3. When side channels are present at a transect, split the five increment points 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, estimate three increment points at 25%, 50% and 75% of main-channel bankfull width and then two increment points at 25% and 75% of the side-channel bankfull width.
4. Without looking directly at the substrate of your increment 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 two more pieces of substrate at the same increment location, reaching to the left for one measurement, then the right for another.
6. Do not record the same piece of substrate multiple times. If the same piece of substrate is encountered when bringing the meter stick down, select another piece either from upstream or downstream (downstream when at Transect K).
7. 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.
8. 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 wood 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.*

9. On larger boulders, you may have to use a field tape or flip the ruler end-over-end several times to get a measurement.
10. If rocks are embedded, you may have to feel for the intermediate axis with your hand and use your fingers as calipers.
11. Enter all data on the Substrate data form, starting with Transect A2. Write each measurement in the appropriate blank.
12. If it is not possible to measure the substrate, perhaps because of a deep pool. Take all of the measurements for that transect either upstream or downstream (don't move flag) to the closest surveyable location that is not on another transect. If a deep pool exists at Transect K, move downstream to collect measurements, do not go above Transect K.

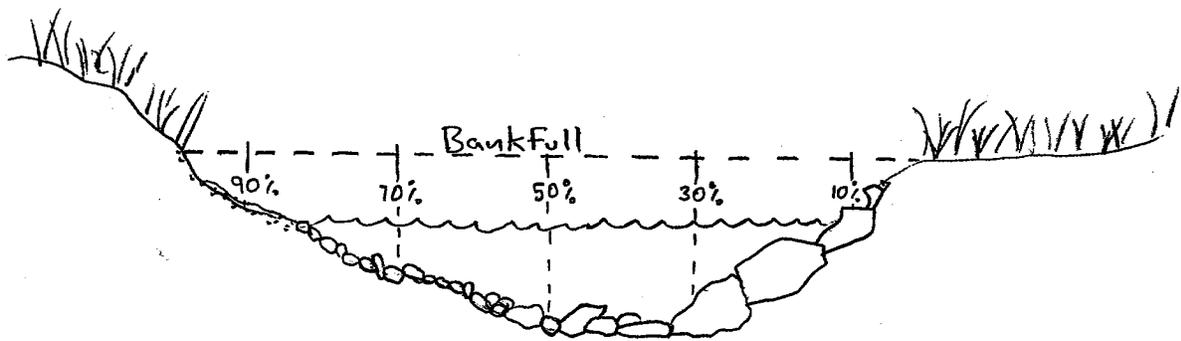


Figure 14. Transect divided for substrate measurement.

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 up to seven measurements (minimum of one) 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 up to 7 measurements per pool. No measurements should overlap.
 - 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)
 - b. Align the grid relative to the left wetted edge so that 7 measurements are equally spaced across the wetted channel, making sure the grid is parallel to and following the shape of the pool-tail crest (Figures 15 & 16).
 1. If the stream size does not permit 7 equally spaced measurements, align the grid along the left wetted edge and record up to 7 measurements based on the wetted area and shape of the pool tail (Figures 17 & 18).
 - c. If a portion of the fines grid lands on substrate 512mm (the size of the grid) or larger in size, on the b-axis, record the intersections affected as non-measurable intersections
 - d. If a portion of the fines grid lands out of the wetted channel (usually for very small streams) record the intersections affected as non-measurable intersections.
 - e. 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.
3. Record the number of intersections that are underlain with fine sediment < 2 mm in diameter at the b-axis.
4. Do not include sediments entrained in algae or other organic matter growing on substrate as fines.

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.

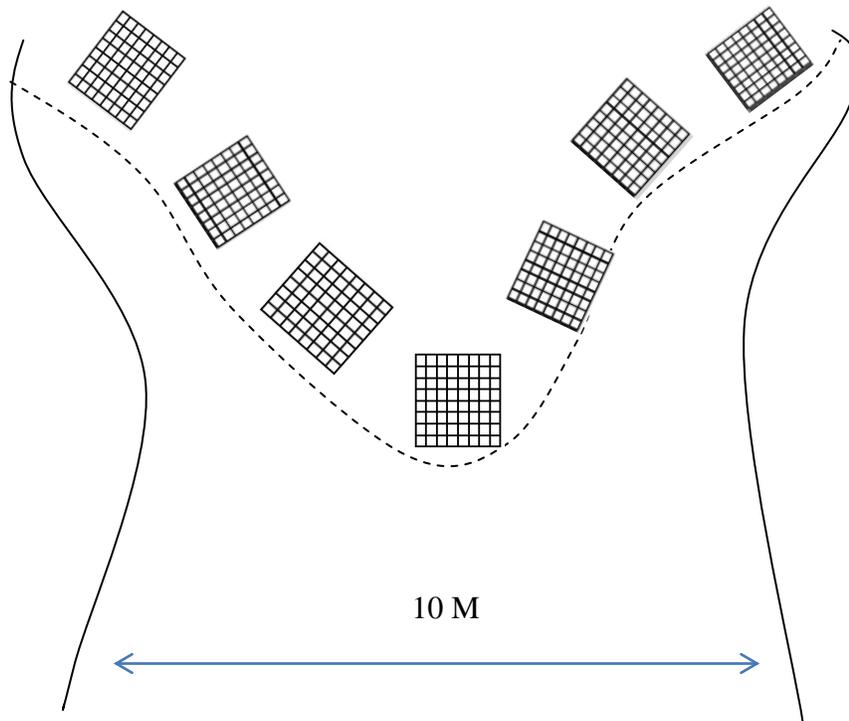


Figure 15. Example of seven equally spaced fines measurements.

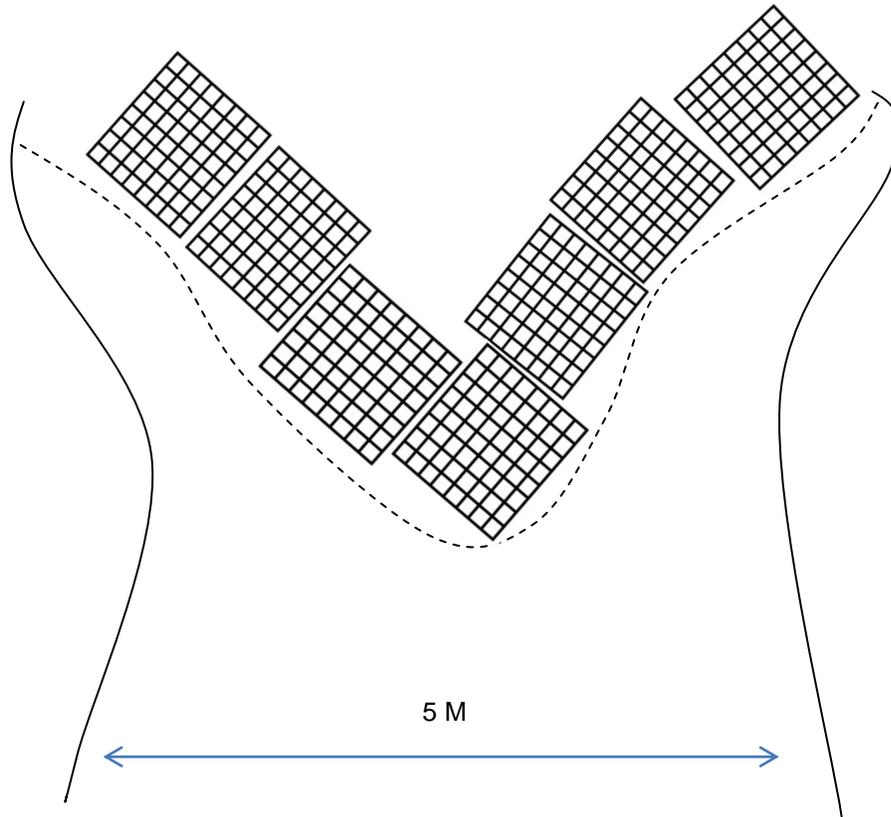


Figure 16. Example of seven equally spaced fines measurements.

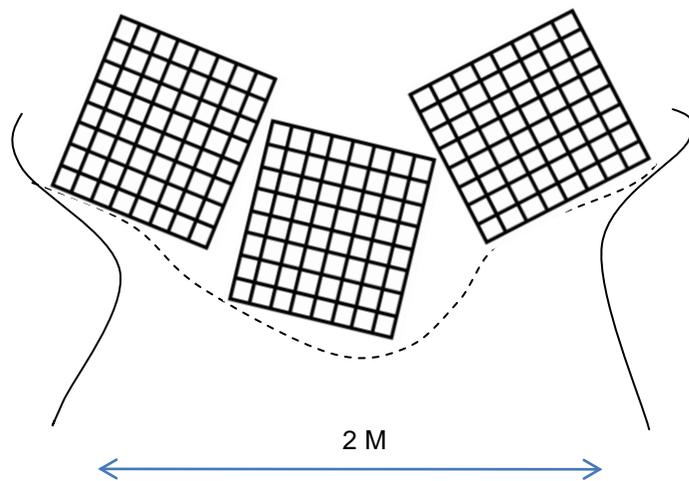


Figure 17. Example of three equally spaced fines measurements

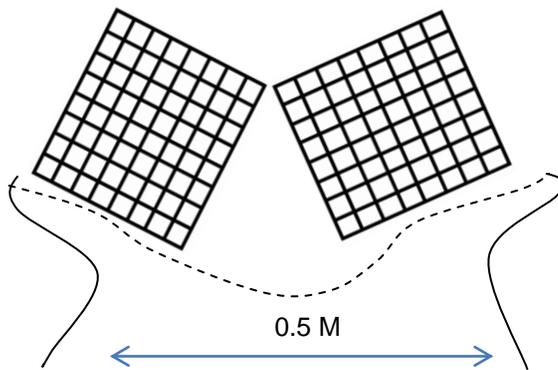


Figure 18. Example of two equally spaced fines measurements.

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 **ALL** of the following criteria.
 - a. Each piece must be greater than 3 meter in length and at least **15 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 (Figure 19).

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 (Figure 20).
 - d. Do not count a piece if only the roots (but not the stem/main trunk) extend within the bankfull channel (Figure 20).
 - 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 21 & 22).
 - f. Only include pieces that begin in the site, if a piece goes below Transect A it does not count (Figure 23).
 - g. When a piece has multiple boles (trunks), include the longest when estimating/measuring.
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 cannot 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. See Table 5 for descriptions of wood types.
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.

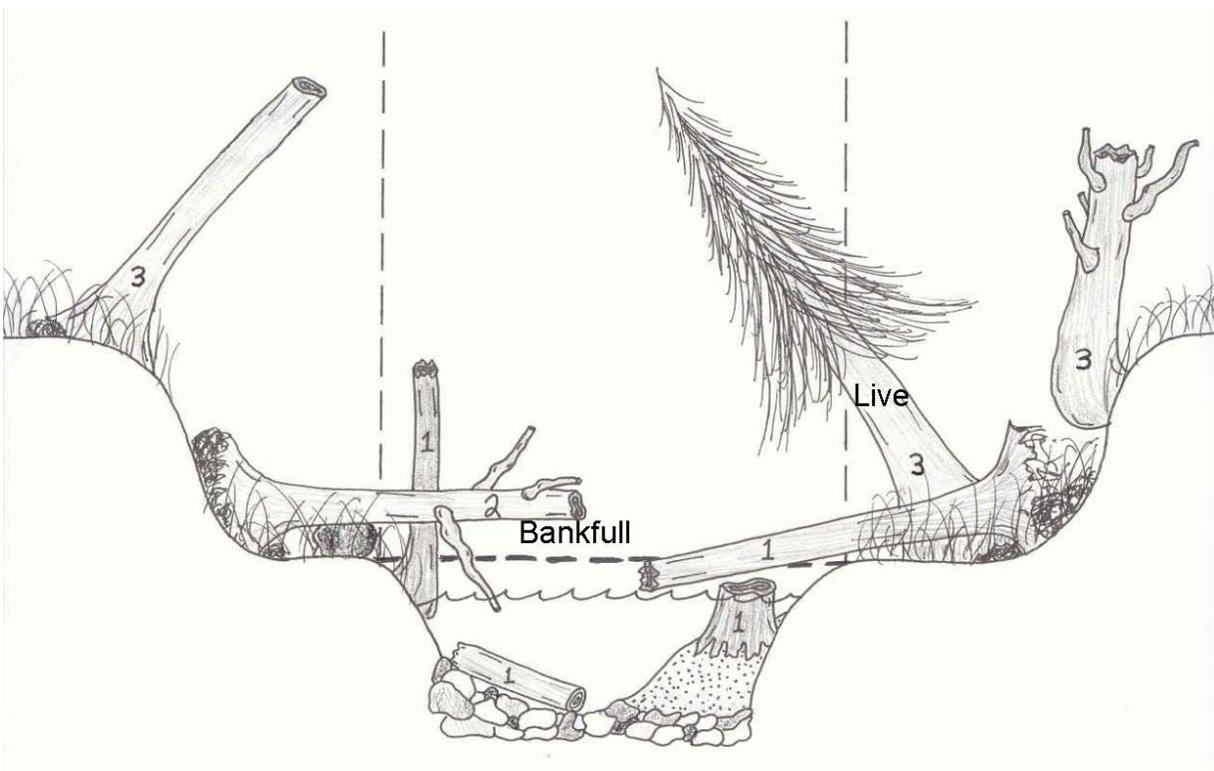


Figure 19. Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

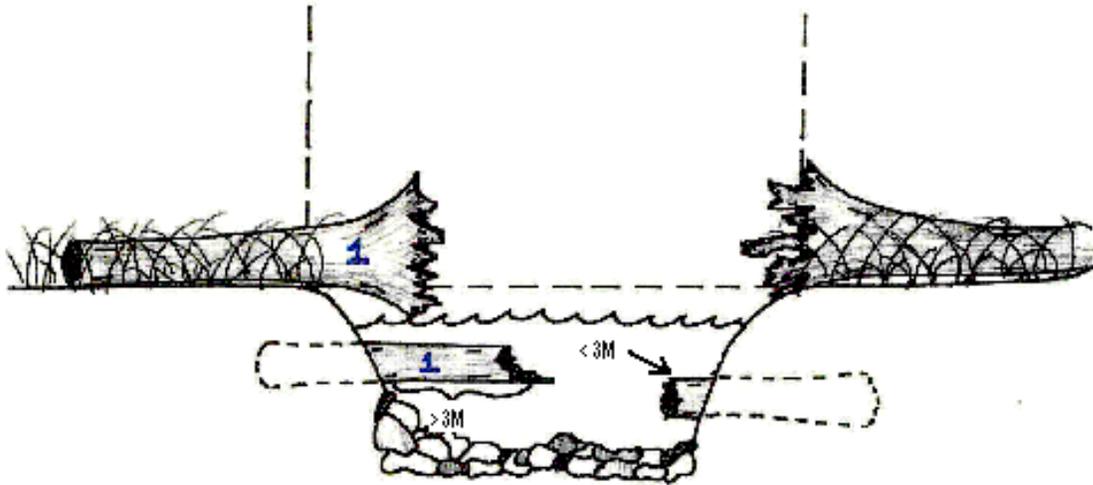


Figure 20. Examples of qualifying large woody debris (1). The pieces on the right side are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

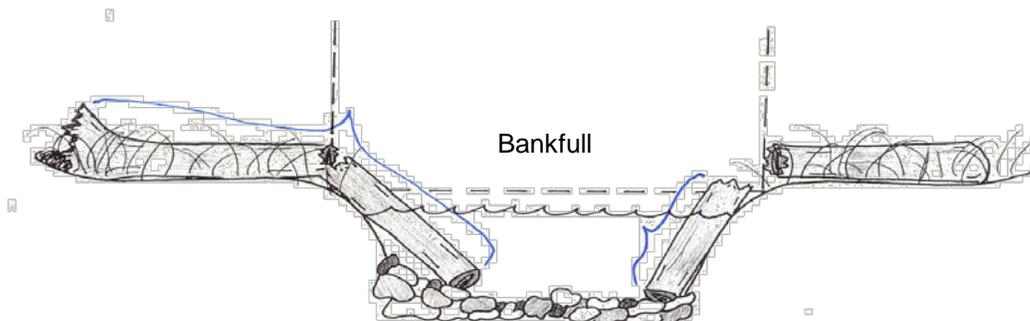


Figure 21. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

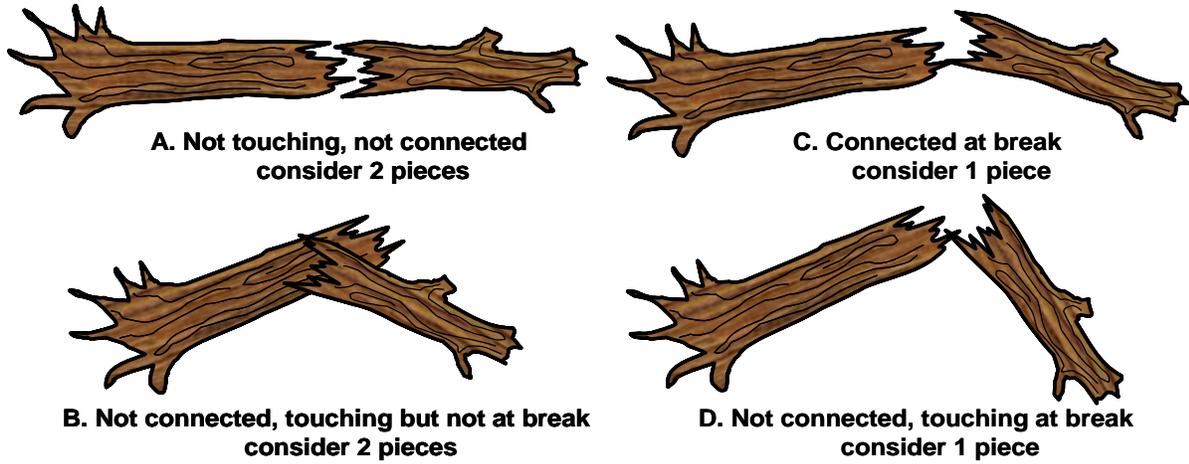


Figure 22. Variations of touching vs. not touching along the break.

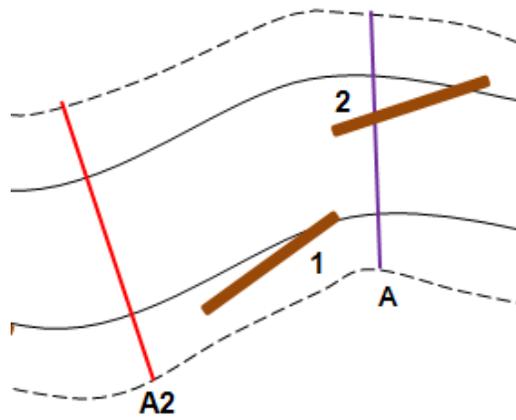


Figure 23. Example of pieces going out of a site at Transect A. Piece numbered 1 would count while piece number 2 would not.

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

Code Type	Definition
# Pieces Touching	
S	Single piece
C	Complex (> 1 piece)
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

If you do not encounter any wood on a longitude, check the box on the data form indicating there is no wood in that longitude (remember to uncheck box for the next longitude you encounter wood in).

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 when possible. 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. **Collect benthic invertebrates at the start of the survey.**

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 reading the 2 pairs of random numbers on the data logger. The first number in each pair 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. 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.), move to nearest possible sampling location.

Field Sampling method:

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

Field processing method:

1. Field processing requires a squirt bottle, white plastic washtub and a 500 μm sieve. Make sure you thoroughly wash organisms clinging to the sides of the net by vigorously splashing water down the net and into the cup. Then transfer the contents of the cup into the washtub using the squirt bottle to ensure the cup is completely empty.
2. Wash off any sticks and small rocks with the squirt bottle into washtub. Add water to the tub 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 by washing material from the sieve into the jar with a squirt bottle. 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, fill jar with water so contents are submerged.
3. Examine the contents for non-native snails, mussels, or crayfish as described in the Invasive Species section below.
4. Remove and release from the washtub/sample jar all vertebrates, including fish and amphibians. Any fish or native crayfish found make a comment in the Biological Comments page in the Headings section.
5. Store any collected Alderflies *Megaloptera* in a separate container as they will prey upon other macroinvertebrates in the sample.
6. At camp, fill the jars with 95% EtOH. **CLEARLY** label the jars using a pencil and the labels provided. Preserve this composite sample in one 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.

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 invasive plant is encountered, take photographs and collect specimens. Place specimens 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 invasive 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.
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.
6. If non-native species are found, finish decanting and preserving the eight original subsamples, and collect more samples at various locations in the site until more of the non-native specimens are found.

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.

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 the area downstream to the next 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 (i.e., 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 zigzag 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, take photographs and collect specimens. Place specimens between two sheets of paper in a plant press (see Appendix C 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.

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	<i>Potamopyrgus antipodarum</i>	POAN
	Zebra mussels	<i>Dreissena polymorpha</i>	DRPO
	Quagga mussels	<i>Dreissena rostriformis bugensis</i>	DRRO
	Rusty Crayfish	<i>Orconectes rusticus</i>	ORRU
	Red Swamp Crayfish	<i>Procambarus clarkii</i>	PRCL
	Ringed Crayfish	<i>Orconectes neglectus</i>	ORNE
	Bullfrog	<i>Rana cotesbeiana</i>	RACO
	Northern Crayfish	<i>Oronectes virilis</i>	ORVI
	Nutria	<i>Myocaster coypus</i>	MYCO
Aquatic plants	Yellow Flag Iris	<i>Iris pseudacorus</i>	IRPS
	Hydrilla	<i>Hydrilla verticillata</i>	HYVE
	Parrot Feather Watermilfoil	<i>Myriophyllum aquaticum</i>	MYAQ
	Eurasian Watermilfoil	<i>Myriophyllum spicatum</i>	MYSP
	Variable-leaf milfoil	<i>M. heterophyllum</i>	MYHE
	Yellow Floating Heart	<i>Nymphoides peltata</i>	NYPE
	Giant Salvinia	<i>Salvinia molesta</i>	SAMO
	Giant Reed	<i>Arundo donax</i>	ARDO
	Brazilian Elodea	<i>Ergeria densa</i>	ERDE
	Didymo	<i>Didymosphenia geminata</i>	DIGE
	Flowering rush	<i>Butomus umbellatus</i>	BUUM
	Kudzu	<i>Pueraria lobata</i>	PULO
	Common reed	<i>Phragmites australis</i>	PHAU
	Curly-leaf pondweed	<i>Potamogeton crispus</i>	POCR
	Water primrose	<i>Ludwigia spp.</i>	LU
Terrestrial animals	Feral Swine	<i>Sus scrofa</i>	SUSC
Terrestrial plants	Japanese Knotweed	<i>Fallopia japonica</i>	FAJA
	Cultivated Knotweed	<i>Polygonum polystachyum</i>	POPO
	Giant Knotweed	<i>Polygonum sachalinense</i>	POSA
	Giant Hogweed	<i>Heracleum mantegazzianum</i>	HEMA
	Old Man's Beard	<i>Clematis vitalba</i>	CLVI
	Garlic Mustard	<i>Alliaria petiolata</i>	ALPE
	Himalayan blackberry	<i>Rubus discolor</i>	RUDI
	English Ivy	<i>Hedera helix</i>	HEHE
	Salt Cedar	<i>Tamarisk ramosissima</i>	TARA

Photographs of Biota

Follow these general guidelines when taking photographs.

- Use a small object for scale (e.g., pencil, ruler).
- 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.

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).

Appendix A – 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 the major transects will be surveyed identically to the regular field protocol, without using the compass and laser. Contingency data forms titled “Depth, Width, Pools, SC Width and SC Depth” 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 data forms are provided on the desktop of the Algiz as a separate excel file.

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 “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 “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.
- Using a meter stick take depth measurements at the same ten locations across each transect (LB, 10, LW, 30, 50, TH, 70, 90, RW, RB). Place the meter stick at the correct location and record the height from the substrate to where the meter tape crosses the meter stick (to the nearest cm) on the “Depth” datasheet. Label each measurement in the provided cells in the 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 32).

- 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 “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 32).
- Record the longitude location (AB, BC, etc.) of the pool in the line column in the datasheet.

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.

Side Channels

Survey side channels identically to the regular field protocol. Contingency datasheets titled “SC Width, SC Depth” have been created. Collect measurements as explained in the Transects section of the Contingency Protocol.

Appendix B - Invasive Species Disinfection Protocol

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. 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. AREMP 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:

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

Disinfection Equipment Provided:

Field Crews	QAQC and Thermograph Crews
<ul style="list-style-type: none"> • Large Tupperware bin (stored at Warehouse) • Sparquat 256 • Stiff brush to remove mud from gear • Rubber gloves and eye protection • “Quat Check 1000” Test Papers to check solution effectiveness 	<ul style="list-style-type: none"> • Large Tupperware bin • HPDE bottle with Sparquat 256 • Large water container – clearly labeled as Sparquat (to store diluted Sparquat solution) • “Quat check 1000” Test Papers to check solution for effectiveness • Funnel to pour diluted Sparquat solution from Tupperware bin to large water container • Stiff bristle fingernail brush • Rubber gloves and eye protection

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.
3. In Corvallis: Crews will disinfect waders, boots and nets using Sparquat 256.
 - a. Mix a Sparquat and water solution by diluting Sparquat 256 with water using approximately 6oz (roughly ½ cup) of Sparquat to 1 gallon of water in a large Tupperware bin.
 - b. Fully immerse boots (laces as well), waders, nets and net handles for at least 10 minutes.
 - c. The solution can be used by multiple crews as long as it maintains its effectiveness (see testing solution effectiveness section below).
 - d. Once the solution is no longer effective dispose of the solution down a drain that runs to a water treatment plant. **DO NOT DUMP THE SOLUTION NEAR A STREAM OR OTHER WATER SOURCE.**
 - e. Rinse gear with water.
 - f. Remove gear from tub and lie out or hang up outside for 10-15 minutes to remove any excess water. Hang equipment in cages over the break and allow it to dry for the entire duration (6 days) between field stints.

QAQC and Thermograph Crews

Quality control and Thermograph Crews will travel to multiple watersheds during a work stint, sometimes visiting multiple watersheds in one day. These steps need to be completed before entering and working in a new watershed.

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. Between watersheds: Be sure to decontaminate gear at least 100 meters from a water source.
 - a. Mix a Sparquat and water solution by diluting Sparquat 256 with water using approximately 6oz (roughly ½ cup) of Sparquat to 1 gallon of water in a large Tupperware bin.
 - b. Fully immerse boots (laces as well), waders, nets and net handles for at least 10 minutes.
 - c. After disinfection, pour solution from the Tupperware bin into a large clearly labeled water container for storage. This solution can be used multiple times as long as the solution maintains its effectiveness (see testing solution effectiveness section below).

- d. Once the solution is no longer effective dispose of the solution down a drain that runs to a water treatment plant. **DO NOT DUMP THE SOLUTION NEAR A STREAM OR OTHER WATER SOURCE.**
- e. Rinse gear with water.
- f. When possible, gear should be hung to dry overnight.

Testing Sparquat Solution Effectiveness:

The solution can be used for multiple disinfections as long as it maintains its effectiveness. To test solution effectiveness:

1. Take one cup of the Sparquat solution and pour into a bucket.
2. Add 5 cups of water.
3. Mix.
4. Test the diluted solution with “Quat Chek 1000” Test Paper.
5. Match up the color of the paper with the ppm’s on the color chart.
6. For optimal disinfection, the diluted solution should have a concentration of between 600 and 800 ppm.

Notes on Sparquat:

Sparquat 256 is a liquid disinfectant that contains didecyl dimethyl ammonium chloride, n-alkyl dimethyl benzyl ammonium chloride. These chemicals can be potentially dangerous if they come into contact with skin, eyes, or are swallowed.

Use protective, unlined rubber gloves and eye protection when handling the Sparquat solution and take extra precautions when handling undiluted chemicals. Have eye wash and clean water available on-site to treat accidental exposure.

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. To be safe, it is best not to transport wood between any 6th field watersheds.

Appendix C– Procedure for Pressing Plants

Collect a specimen when a plant is identified as a potential invasive species and cannot 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. 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 24). 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.

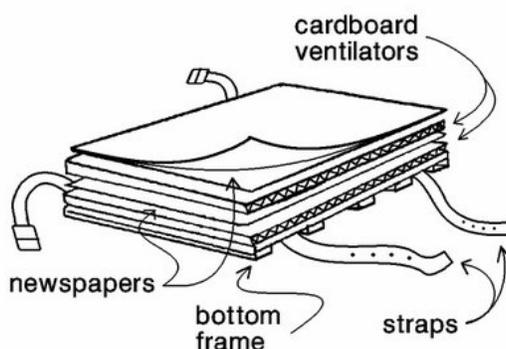


Figure 24. Schematic of a plant press for preserving plant specimens in the field.

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.

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, Interagency 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.

NOTES