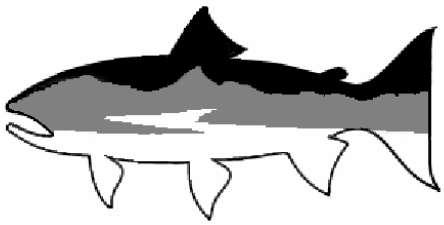
Field Protocol Manual

Aquatic and Riparian Effectiveness Monitoring Program

Regional Interagency Monitoring for the Northwest Forest Plan



2004 Field Season

Contacts

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Acknowledgements

The Aquatic and Riparian Effectiveness Monitoring Program would like to acknowledge the following people for contributing to the field protocols described here. Nate Dachtler, Kirsten Gallo, and Chris Moyer developed the original protocols and produced the first draft of this document. Erik Moberly and Devin Simmons worked tirelessly on many of the details in the protocols. Kris Fausti, Jenni Dykstra, Ted Sedell, Jake Chambers, Amanda Robillard, Dave Piatt, and Kimberly Baker made significant improvements to this and subsequent drafts. Thanks too to all of the field crewmembers that tested, questioned, and provided feedback over the years.

Introduction

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

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

This document is addresses section 11.1 Standard Operating Procedures of the Quality System Management Plan (Palmer, in prep).

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

Locating and Establishing the start of the survey

A topographic map of each reach will be supplied with 80 potential sample sites. Select survey sites in numerical order, omitting sites that cannot be sampled. On the Site Selection Form document which sites were sampled and the reasons for not sampling those which were omitted. It is only necessary to document up to and including the last site sampled.

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

Use the topographic map and GPS unit to find the approximate location of the site from the road. Approaching the site from downstream, use the "Go To" feature of the GPS unit to guide you toward the reach start point. When 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.

Exclude a site if:

1. The GPS point is located on private land.
2. The GPS point is located in a lake, wetland, marsh or on a dam or glacier.
3. The site is located on an artificial stream or irrigation canal.
4. The site is not safely accessible; i.e. it cannot be reached without putting the crew in danger. Long hikes into steep canyons do not qualify.
5. The stream is too small or not physically sampleable. The minimum stream size is 1 meter wide (wetted width) and 0.1 meters deep in riffles.
6. The stream is too large to physically sample and is a safety concern for crews. To qualify, the stream is too swift to safely wade across and/or too deep to gather substrate information.
7. Travel time (round trip) from camp is over four hours to get to and from the site.

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

Record the site UTM coordinate

1. Press and hold the *ENTER/MARK* button for two seconds.
2. On the "Mark Waypoint" screen, toggle to the waypoint number and enter the new waypoint number as follows: a 3 letter watershed code and a 3 number site code. (Example: RCK103) If the site is a QA/QC or trend site, place a 9 or a 6 in front of the site number. (RCK903, RCK603)
3. Hit the *MENU* button, scroll to *Average Position*, then hit *ENTER.* Place the GPS unit at Transect A and start other work, let the unit log at least 250 measurements.
4. Once all the measurements have been recorded, press *ENTER*, scroll to the *DONE* box, and press *ENTER*.
5. Enter the UTM coordinate on the Stream data form.

Monument the Reach

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

1. Locate a distinct feature near the bottom of the reach that will be easily identified.

a. Something relatively permanent such as a piece of large wood in the stream (e.g. a large spanner, snag, or tree).
b. Sometimes reach riparian zones are characterized by a continuous patch of vegetation; try to pick something that might stand out such as a large big clump of sage or one conifer near the start of the reach.

2. Attach one of the markers to your chosen spot.
    a. Use an aluminum nail to attach the marker making sure it is clearly visible and facing the stream.
    b. Place flagging at the top and bottom of the marker.
3. Take a GPS reading of the reach marker location and record. If the marker is less than 10 meters from the GPS location of transect A, use the same GPS coordinates for both.
4. Next, from the marker location take a compass bearing from the marker to transect A Left Bank and record on the Stream Data Form. Record this bearing on the monument and on the Stream Habitat data sheet.
5. Measure the distance from the marker to bottom of the reach and record (this will be done using the laser and prism, taking a point at Left Bank and at the marker and GPS locations).
    - First, take a laser shot of the monument.
    - Next, take a shot of the GPS unit located at Transect A (when getting average waypoint).
    - Finally, a shot of the flag on left bank, independent of transect shots.
    - These points will be labeled as Transect Y.
6. Take a picture of the marker location and surrounding distinctive features. This will include a minimum of three pictures; 1) facing Transect A Left Bank standing at the monument 2) facing the monument standing at Transect A Left Bank and 3) a view of the monument from the route a crew will take to approach the site.

Photo Documentation

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

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

The crews will be responsible for taking digital photos in the field, including the photos taken at Transect A and photos of the monument site.

1. It is possible that due to the position of satellites or the depth of the canyon you are in, you will not be able to get GPS coverage. In this case, walk around close to the area where you will be taking pictures in an attempt to obtain satellites.
2. Turn on your camera and do the following:
    a. Verify the image quality is set on “FINE”. Set the top disc to SETUP and use the navigation disc (on the back of the camera) to choose Image Quality menu option. Under this option, select “FINE”.
    b. Verify the image size is set on “FULL”. Set the top disc to SETUP and use the navigation disc (on the back of the camera) to choose Image Size menu option. Under this option, select “FULL”.
    c. Make sure that the date/time on the camera is in sync with the date/time on the GPS unit.
        i. To display the time on the GPS unit go to the Main Menu, scroll down to Setup, and scroll across to Time. The time displayed is the time to set the digital camera to. To do this put the camera in “Setup” mode with the dial on the top of the

camera. Press the "Menu" button and used the disc to scroll down to "Date." Use the disc again to enter the date and time.

3. At the beginning of each day, open the screen on the GPS unit that displays the time and take a photo of it with the digital camera. This photo serves as a backup in case the time is set incorrectly on the digital camera.
    a. On the GPS unit "Acquiring satellites" page, press the Page button once.
    b. You should now be viewing a screen showing time and date at the bottom with a UTM coordinate of your current position.
    c. Take a picture of this screen, attempting to minimize glare. Look at the picture on the viewfinder to ensure that the numbers on the GPS unit can be read.
4. Take a series of photos at Transect A. The first photo taken should be of the white board, which should then be placed on the left bank. Take the first picture of the left bank (where the white board should be); rotate the camera clockwise 90^{o} to take the next photo, which will be of the downstream view. Repeat 2 more 90^{0} rotations to capture the right bank and the upstream view. Ask all other crew members to stay out of the photos. Gear in the photos is OK as long as it does not move between pictures. Keep gear bundled up to avoid the "yard sale" look.
5. The white board should contain the following information:
    a. Location (i.e., Watershed code name and site number): For Site 3 on the Wadeable Creek you would put "ORWAD03" WAD9003 (6003) for QAQC and trend
    b. Date (Day Month Year): "3 July 2003"
    c. View: "LB Transect A."

Photos to take

Take photos that will help give people who might never visit the area an idea of what it is 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 fire, landslide, extensive blow down, etc.
- Unusual species and species that are difficult to identify; this info should also be entered into the "Comments" section 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 people working are good too.

The Photo Log data form

At the end of each day, enter the appropriate information detailing the site ID (ORWAD10), the UTM coordinate, the time the photo was taken, the photographer, and the photo number. In the comments section, describe the subject of the photo (e.g., transect photo, unidentified salamander) or describe habitat or other distinguishing features for biota.

Site Layout

1. Examine the bankfull indicators (described below) throughout the reach to identify the bankfull elevation. Recognize that all six indicators are rarely present at an individual site.
    - Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the current water level.
    - Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
    - A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.

- Define an elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
- Examine the ceiling of undercut banks. This elevation is normally below the bankfull elevation.
- Stream channels actively attempt to reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators.

2. Measure the bankfull width perpendicular to the channel at the random start location. Round the bankfull width to the nearest integer. This number will be used to determine the location of additional bankfull width measurements.
3. Four additional bankfull widths will be measured, two upstream and two downstream (Fig. 1). For example, the initial bankfull width was 5.3 m (rounds to 5 m), go upstream 5 m and take a bankfull width measurement. Then go upstream from that point an additional 5 m to get the second upstream bankfull width measurement. Repeat this procedure going downstream from the initial bankfull width location to get two more bankfull width measurements. If the situation arises where one bankfull cannot be measured on the downstream end of transect A, take the additional measurement above Transect A.
4. Record all five bankfull widths and calculate the average. Use the average to determine the width category from Table 1 below. The minimum reach length is defined for each width category and is equal to 20 times the bankfull width.

Note: If a qualifying secondary channel is encountered while acquiring the 5 bankfull widths, measure the bankfull width of the secondary channel and add it to the bankfull width of the main channel.

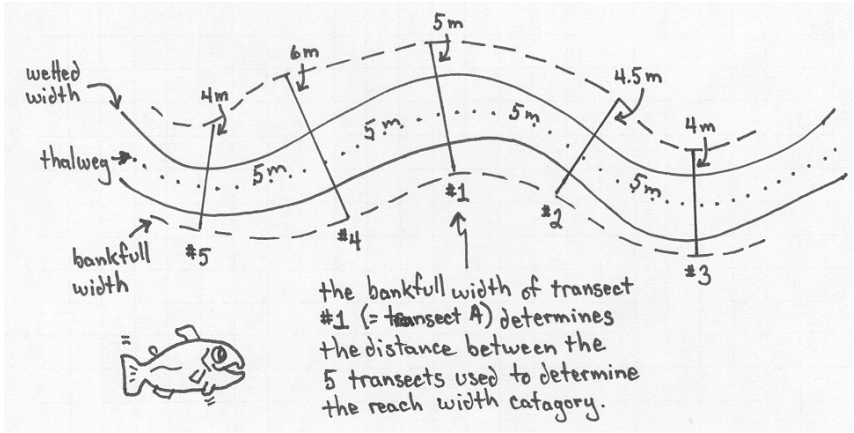

Figure 1: Five measurements taken to determine reach length.

Measurement 1	5.0M
Measurement 2	4.5M
Measurement 3	4.0M
Measurement 4	6.0M
Measurement 5	4.0M
Add the 5 measurements and divide by 5	23.5/5=4.7
Take the average number and find the reach length on Table 1	160M

Table 1

Average Bankfull Width in meters	Width Category	Minimum Reach Length in meters
0 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 to 24	24	480

Transect layout

In all reaches, 11 transects will be laid out and should be labeled A-K. In addition to the 11 transects, 10 intermediate transects will be flagged and used for pebble counts. Secondary channels and pools will also be identified and marked with blue flagging and Transect A will be marked with biodegradable flagging. Site information should be documented on the Stream data form.

Determine the site length as described in the previous section and divide the site length by 20 to obtain the increment between each transect.
From the example in table 2, the distance between transects would be 160/20=8 m.

1. Closely following the thalweg, measure the distance between transects using a meter tape. Place a flag in an obvious area near eye level at each transect location. Label the flags with the corresponding transect name (A, B, C…K). Label the intermediate flags with the letter of the preceding transect and the number 2 (A2, B2, C2…J2). Place an additional flag on the two transects designated for fish displacement and measurement. (these transects will be provided on the biological data spreadsheet in the data recorder).
2. Remove all flagging from the site (except for the Transect A flag) after the survey has been completed.

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 HP48 and the Stream data form comments section.

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

Relocating start of reach
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). Estimate the site length based on the bankfull width and measure downstream that distance from the barrier. Establish the start of the reach at this point and initiate site layout as described in the next section.

Overlapping sites
Always survey the lowest numbered site first. Transect K of the first site will be flagged as transect A for the second site. Drop the second site if the first site will overlap more than 50% of the second site's length (In order to determine this you will have to measure the 5 bankfulls for the second site). Overlap is measured from the site's original GPS coordinate.

Adjusting a transect
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 (avoid moving more than 2 meters up or downstream). However, if the obstruction is large and would block numerous transects, it should be excluded from the survey.

Culvert
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 the shots taken on either side of the culvert as "CULVERT." Under no circumstance should you ever pick up and move the laser without shooting a new origin (AKA "Traverse").

Stop and Start of Survey

Stop and start is a technique intended for small obstructions (ie passable waterfall or single lane culverts) encountered in the reach that interfere with the collection of data or crew safety.

If there is an unsurveyable obstruction within the reach, such as a large log jam, passable waterfall, single lane culvert, stop the survey at the obstruction and restart the survey upstream of it. 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 "RESUME SURVEY." Continue measuring up to the next transect location.
4. Make sure a note has been entered into the HP48, the laser notebook and in the stream data form.

Situation	Action
Large Culverts	
Less than 4 times Bankfull width category in length	Stop and start. (Refer to Stop and Start of Survey section.)
Greater than 4 times Bankfull width category in length	Relocate start of reach.
Small, one-lane culverts	If a transect falls on the culvert do a Stop and start. (Refer to Stop and Start of Survey section.) If it does not interfere with data collection refer to note on culverts above.
Greater than 4 times Bankfull width category in length	Relocate start of reach.
Large Logjams	
Less than 4 times Bankfull width category in length	Stop and start. (Refer to Stop and Start of Survey section.) This is only used if the logjam prevents the collection of data. (If a major transect cannot be moved a reasonable distance to avoid the logjams affect on data collection.)
Greater than 4 times Bankfull width category in length	Relocate start of reach.
Impassible waterfall (for crew)	Relocate start of reach.
Passible waterfall (for crew)	If it does not interfere with collection of data (does not prevent layout of at least 2 transects), include in survey. Do this only if it is determined safe for the crew. If not, do a stop and start. If one transect falls on the waterfall, adjust the transect location either above or below the waterfall.
	If the waterfall prevents collection of data, Stop and start. (Refer to Stop and Start of Survey section.)
Dry Channels or subsurface flow	If dry channels or intermittent flows constitute more than 25% of the reach, drop the site. If it is less than 25%, include in the survey. (Skip for aquatic sampling) **Document, Document, Document** when a situation like this arises.

Secondary Channels

A secondary channel is any channel separated directly from the main channel by an island with an elevation above bankfull. All transects (both intermediate and major) that are effected by a secondary channel will be marked with an additional blue flag that is labeled with the channel number (in case of overlapping multiple channels).

1. Only secondary channels that begin and end within the reach will be considered (Figure 2: SC-D is not counted).
2. A secondary channel begins (and ends) at the location where it becomes separated from the main channel by an island that is ≥ the bankfull elevation (Figure 2: see SC-E). SC-G is considered part of the main channel because the island is below the bankfull elevation).
3. The following criteria must be met in order for a secondary channel to be included in the survey:
    a. There must be clearly defined bankfull indicators at some point along the secondary channel.
    b. The bankfull width of the secondary channel must be ≥ 20% of the average of the 5 initial bankfull widths (recorded on Form 1). Measure the bankfull width of the secondary channel at 25%, 50%, and 75% of the way up from the downstream end. Average the result and compare to the average bankfull width from the average of the 5 initial bankfull widths (recorded on Form 1). In Figure 2, SC-B, C, and E would be counted, and SC-F would not as it is too narrow.
4. Do not collect measurements in discontinuous secondary channels, where at any location (normally at the upstream end) the side channel bed elevation is ≥ the bankfull elevation of the main channel (Figure 2: SC-A).
5. Channels that do not meet the above criteria are not included in the survey. Measurements in qualifying secondary channels will include large wood, pebble counts and streambank measurements.

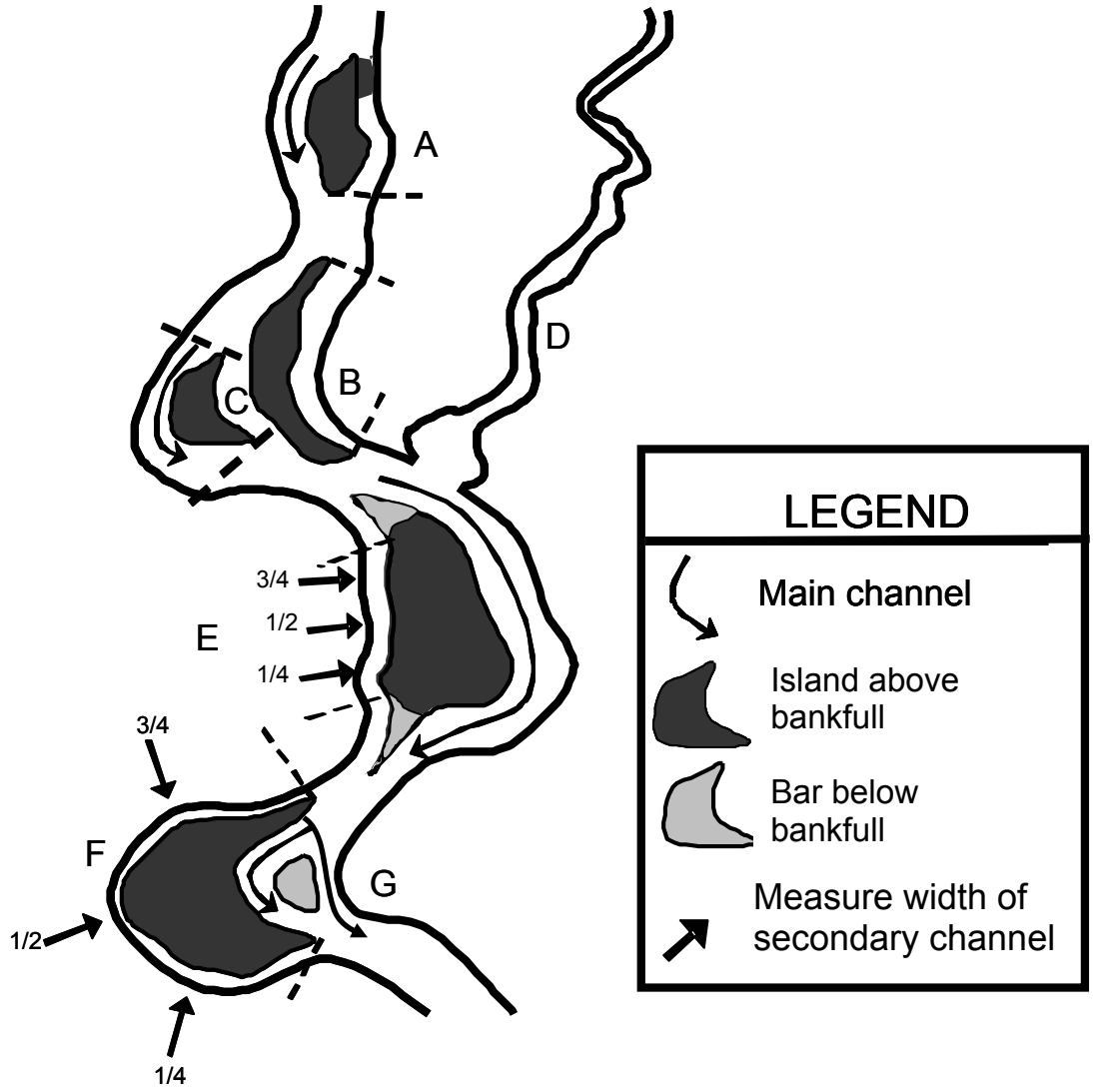

Figure 2. Examples of secondary channels. Channels A, B, C, and E would be considered secondary channels (≥ 20% of the average of the 5 initial bankfull widths) whereas channel F would be excluded as it is too narrow. Channels E and F depict where to take width measurements within potential channels (at ¼, ½, and ¾ of the way up from the downstream end of the portion of the island that is ≥ the bankfull elevation). Channel D would not be included because it began outside of the reach. Channel G is part of the main channel since the island is below the bankfull elevation.

Channel Morphology

GRADIENT

Stream gradient is the average slope of the water's surface measured from the beginning of the reach to the top of the reach. To obtain gradient we use the change in elevation measured between left wetted at transect A and left wetted at transect K.

The elevation change will be measured twice, once upstream (traveling from Transect A-K) and once downstream (traveling from Transect K-A). These two elevation value differences will be averaged and used to calculate the reach gradient. Using the steps listed below, recall the Z-values at both A and K left wetted and calculate the difference to see if the 2 measurements are within 10% of each other. If they are not within 10%, you will measure the change in elevation a third time traveling from Transect A to K. All gradient values collected will be recorded, but no more than 3 gradients will be measured.

At Transect A, write down the Z-value at the left wetted edge on the Stream Data Form in the A(1) column. At Transect K record the Z-Value for the left wetted edge in the K(1) column. Follow these steps to find the Z values in the HP48 (you will need to exit out of the main menu and observe the coordinate file to retrieve the z-coordinates for the gradient calculations, during the laser survey):

1. Observe the (FS) point number for the left wetted edge shot on Transect A or K.
2. Press **[** Purple shift key and the Ed Cord (Edit coordinates)
3. Press **[D]** for the RCL (recall) option on the screen.
4. Type in the point number (FS) that corresponds to the FS number from step 1.
5. Press **Enter**.
6. The next screen displays the northing, easting, and elevation. The elevation is the Z-coordinate.
7. Write the number down in the appropriate column on the Stream Habitat Form and follow the steps below to make the calculations.
8. Press Exit and that will take you back to survey mode.

When the habitat survey is complete, re-shoot the left wetted edges at Transects K and A a second time. You may need to traverse downstream to re-shoot Transect A. In the HP48, label the secondary or tertiary (gradient points) as A *LW and K *LW and insert a note about which point set the gradient is referring too.

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

1. Calculate $K_1 - A_1 = ZValue_1$
2. Subtract $ZValue_1 - [0.10 * ZValue_1]$
3. Add $ZValue_1 + [0.10 * ZValue_1]$
4. Calculate $K_2 - A_2 = ZValue_2$
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 A_3 and K_3 on Stream Data Form and stop.

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

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

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

CHANNEL CROSS SECTION MEASUREMENTS

Channel cross-section measurements provide insight on the relationships of width and depth, streambed and stream bank shape, and bankfull and flood prone area. All are important attributes of channel condition and indicators of health in aquatic and riparian ecosystems. The ratio of bankfull width to depth describes the conditions available for aquatic fauna and flora and of riparian vegetation.

Objective:

- Determine bankfull width-to-depth ratio and entrenchment ratio.

Where to take the measurements:

1. Measure one channel cross-section and flood-prone width in the first riffle that meets the following guidelines:
    a. The channel must be relatively straight and have clearly defined bankfull indicators within the riffle. Do not sample a riffle if the entire length of the riffle occurs at a meander or the bankfull elevation cannot be determined.
    b. Do not sample where secondary channels or human/animal crossings exist or when deflectors such as rocks, logs, other debris, or unusual constrictions make the stream especially narrow, or create exceptionally wide backwater conditions.
    c. There are no minimum length criteria for the riffle.
2. Locate the cross-section in the first riffle, taking into consideration the following channel specific situations.
    a. In riffle/pool channels locate the cross-section where the thalweg crosses over from one side of the channel to the other side. This is referred to as the inflection point and usually occurs midway between two meander bends. If there are multiple inflection points in the first riffle, sample the downstream most inflection point.
    b. In plane bed channels locate the cross-section in the narrowest point of the riffle.
    c. In step-pool channels locate the cross-section at the narrow transition from the step into the head of a pool.
3. Measure bankfull widths perpendicular to the channel. Measure flood prone widths perpendicular to the flood prone constraints. See Figure 3

Sampling method:

1. Determine the bankfull elevation on each bank. Measure bankfull width perpendicular to the channel and record in meters to the nearest cm.
2. Take a minimum of 10 equally spaced depth measurements, using a tape measure stretched across the transect at the bankfull elevation. Calculate the distance between measurements by dividing the bankfull width by 10. Use a random number to locate the first measurement and then make measurements at the interval calculated above (see Table 3 for example).
3. In addition, record the location and depth (from bankfull to the water's surface) at the left and right wetted edges, and maximum depth at thalweg.
4. When the streambank is vertical, take an additional depth measurement 1cm from the bank. This applies to either bank.
5. Only measure to the edge of the bank when an undercut exists. Do not measure beneath the undercut.
6. Measure the flood prone width at the cross section. This is the width of the channel/floodplain at twice the maximum bankfull depth as determined during the cross-section measurement. Record the width to the nearest 10 cm. The cross-section may have to be rotated so that the flood prone measurement is perpendicular to the floodplain constraints. A second meter tape will be stretched across the channel using the thalweg as a pivot point. (See Figure 3).

(It is important to measure at least out to the bankfull width with the string when rotating the flood prone cross section, but it is not always necessary to run the string all the way out to the flood prone constraints. The surveyors string is laid out for the purpose of accurately capturing bankfull location on the flood prone transect as well as giving the prism person a visual guide to follow.)

Note: If the entrenchment site falls on an already existing transect, treat them as two separate transects.

Example: You are measuring a cross-section and it landed right on Tran D, first shoot the cross-section and all of the points described above as Tran Z, then go back and shoot the 5 transect points as Tran D

Bankfull Width	8.0 Meters
Divided by 10	0.8
Pick random # (between 0 & 0.8)	0.3
Increments	0.3 M
	1.1 M
	1.9 M
	2.7 M
	3.5 M
	4.3 M
	5.1 M
	5.9 M
	6.7 M

Table 3: Example of Cross-section increments with random start.

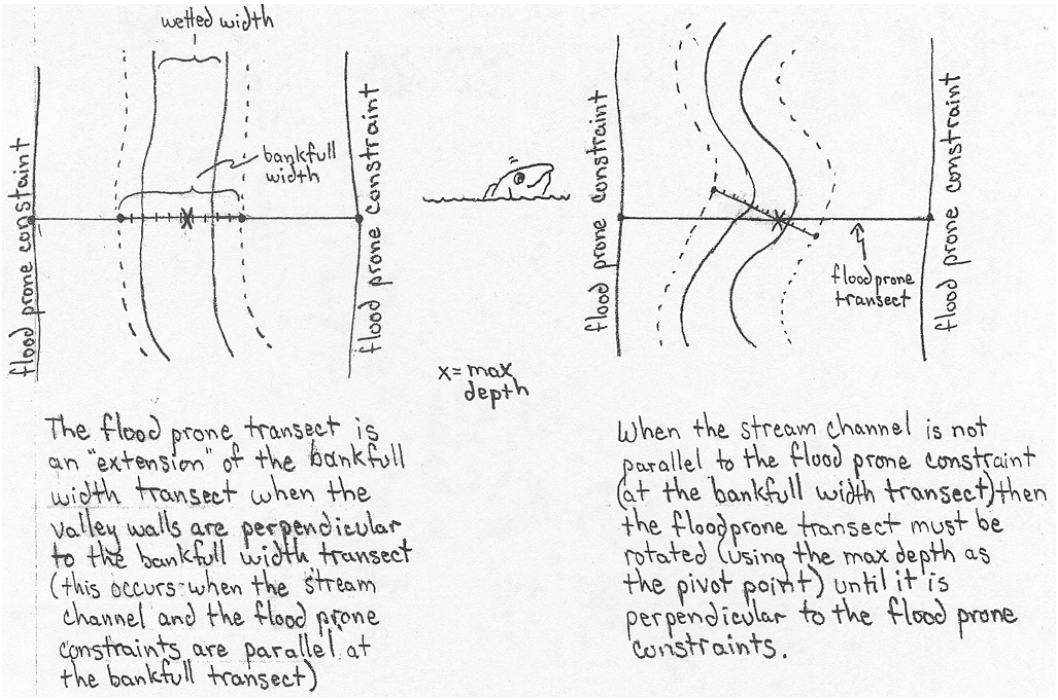

Figure 3: Example of Entrenchment transect rotated to be perpendicular to flood prone constraints (diagram on right).

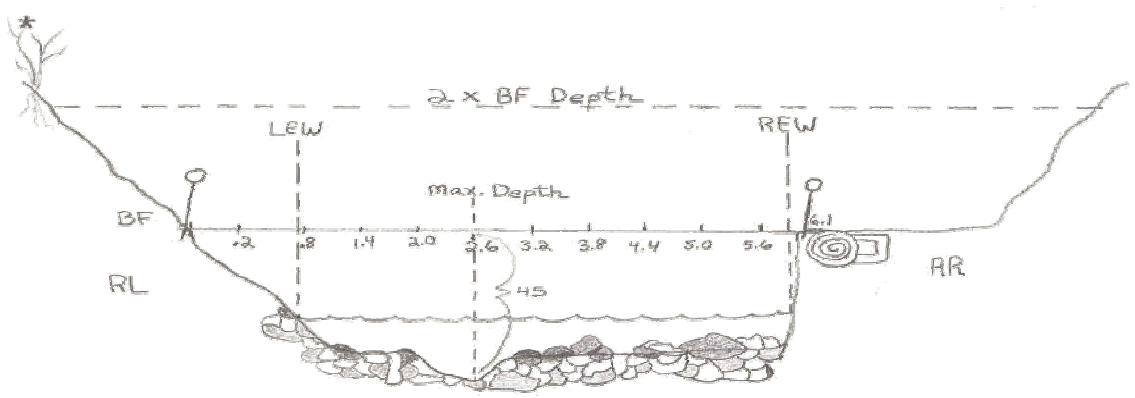

Figure 4. Channel cross section figure and tables displaying the location of the tape; layout of depth measurements along the tape; additional measurements of LEW, REW, and maximum depth; and the location for the entrenchment width at twice the maximum depth.

Bankfull Width

Bankfull width will be measured at each major transect. Using the compass and laser, 5 points will be collected; Left Bankfull, Left Wetted, Thalweg, Right Wetted and Right Bankfull. The thalweg location will be collected at each intermediate transect as well.

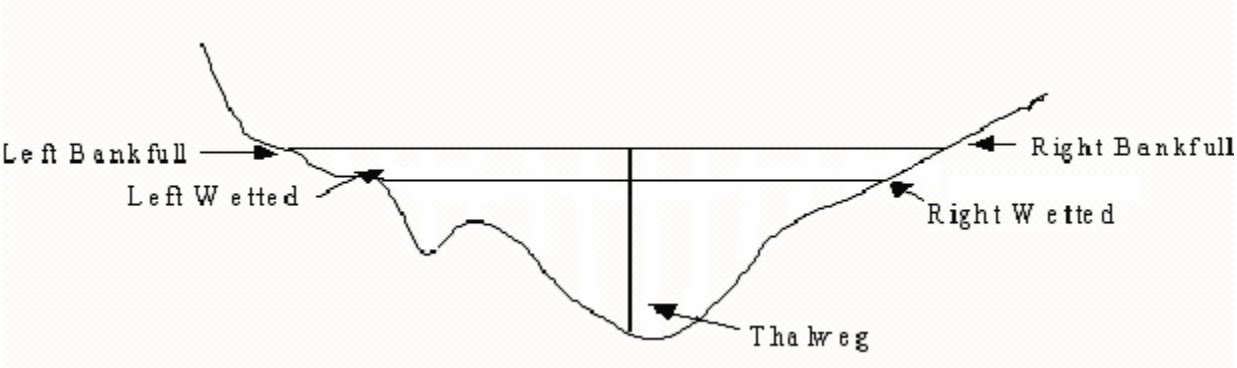

Figure 5: Example of the five points collected at each major transect.

POOLS

Pool Length and Residual Pool Depth

Objectives:

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

Pool Criteria:

Sample every pool within the sample reach that meets the following criteria for low flow conditions.

1. Pools are depressions in the streambed that are concave in profile, laterally and longitudinally.
2. Pools are bounded by a head crest (upstream break in streambed slope) and a tail crest (downstream break in streambed slope).
3. Pools have a water surface gradient close to "0" and are associated with "slower" flowing water.
4. Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
5. Pools span at least 90% of the wetted channel width at any location within the pool.
6. Pool length, measured along the thalweg, is greater than its width, measured perpendicular to the thalweg, at the widest point.
7. Maximum pool depth is at least 1.5 times the pool tail depth.

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

Sampling method:

1. Measure the pool length (nearest 0.1m), maximum depth (nearest cm), and pool tail crest depth (nearest cm) for each pool.
2. Measure pool length along the thalweg between the tail crest and headcrest.
3. The maximum depth represents the deepest point in the pool and is found by probing with a depth rod until the deepest point is located.
4. The pool tail crest depth is measured at the maximum depth along the pool-tail crest and is normally (but not always) at the thalweg.
5. Measure the pool tail crest depth on dammed pools along the top of the obstruction (mostly LWD) if all flow is going over the obstruction. Conversely, measure to the streambed if some of the water is observed flowing under the obstruction.

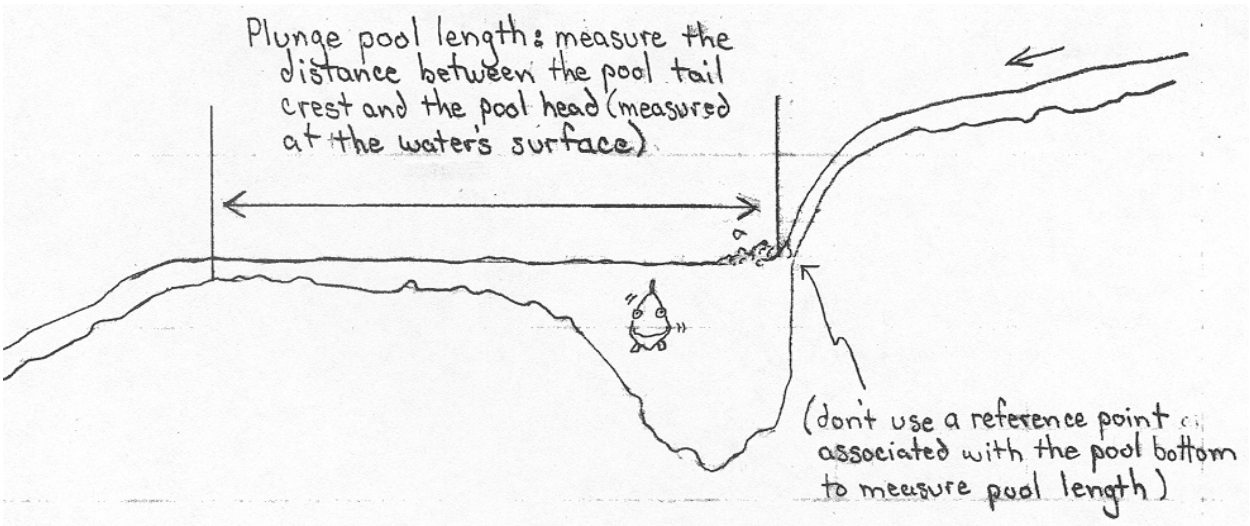

Figure 7: Example of a situation in which you would measure the head of a pool where the surface of the water intercepts the bedrock/substrate.

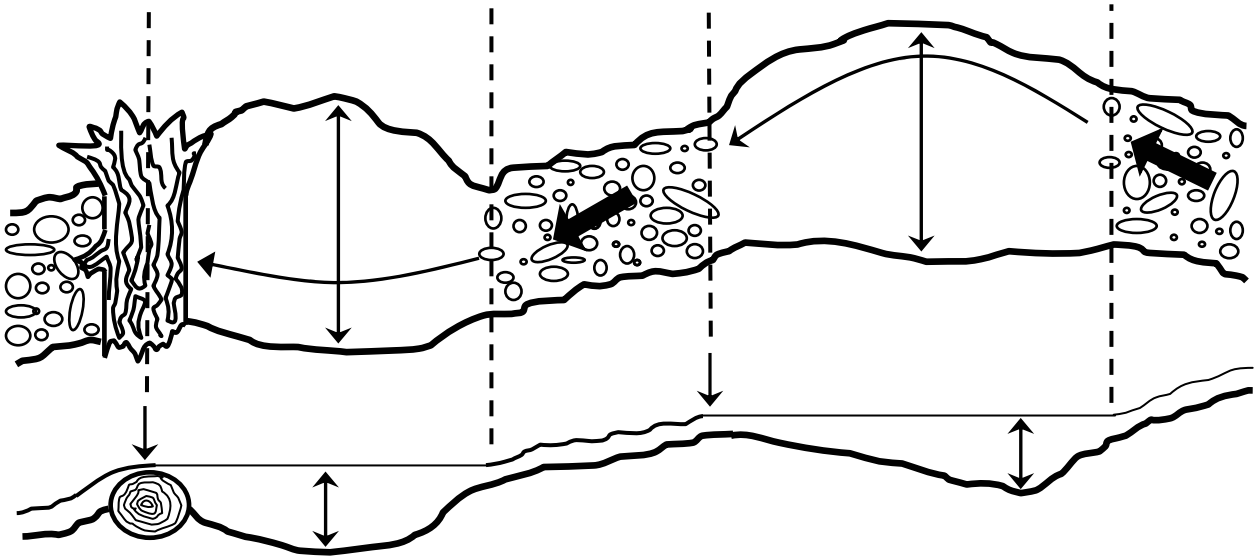

Figure 8: Arial view (top) and profile view (bottom) of an example of when to split pools.

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

Physical Habitat

Substrate – Pebble Counts

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

Pebble counts –

1. Rocks should be measured at the 21 transect locations (Transects A – K).
2. 5 samples will be measured at each transect. Standing at left Bankfull divide the transect (estimate) up into 10%, 30%, 50%, 70% and 90%.
3. Without looking directly at the substrate of your sample location, step forward bringing your meter stick lightly down to touch the substrate. Reach down to the tip of the meter stick and pick up the first substrate that you touch with the tip of your finger. DO NOT LOOK while you are selecting the substrate.
4. Measure the substrate along the intermediate axis with a ruler (scale = mm). The intermediate axis is the median side (B axis) of the rock, it is not the longest side (length-wise) or the short side (depth) of the rock. Visualize the B axis as the smallest width of a hole that the particle could pass through.
5. If the substrate has a smooth dirt feel and is not gritty call it “SILT”. If it is gritty and is < 2 mm call it “SAND.” Anything greater than 2 mm should be measured. Bedrock (BDRK) is defined as a boulder large enough to park a car on (>4096 mm). If in doubt, measure the substrate. If you are unable to access the substrate due to a large piece of wood, use the code “WOOD” on the data

form. Only use the code if you are unable to get under the log*. Do not call it "wood" if it is a piece of bark or a twig.*

6. On larger boulders, you may have to flip the ruler end-over-end several times to get a measurement or use a field tape.
7. If rocks are embedded you may have to feel for the intermediate axis with your hand and use your fingers as calipers. Sometimes sticking the ruler underwater also works.
8. Enter all data on the Substrate data form, starting with Transect A. Write each measurement in the appropriate blank, using either a number or one of the codes (SILT, SAND, BDRK, NOMT). Only use the WOOD code if wood is embedded in the substrate and it is impossible to reach under to select a pebble. **DO NOT** use codes such as "muck", "slime", or "debris." If it is not possible to measure the substrate, perhaps because of a deep pool where the substrate is not visible for an ocular estimate, write "NOMT" for no measurement on the data form.

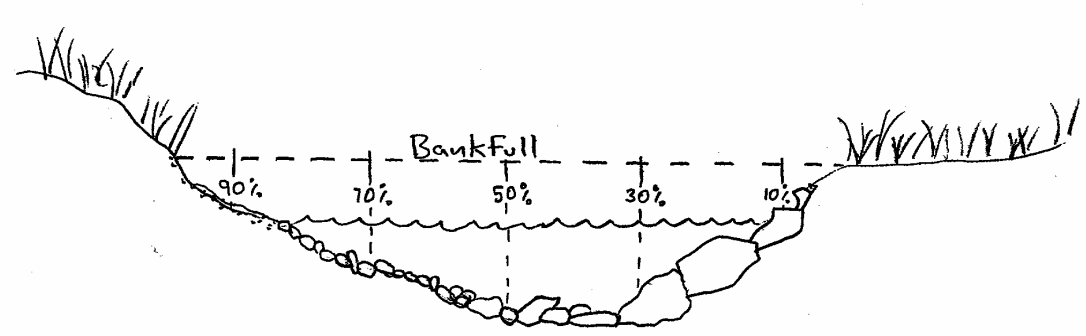

Figure 9: Transect divided for substrate measurement.

The Substrate data form - pebbles

1. To complete the pebbles portion of the substrate form, measurements should be taken at the appropriate transects and recorded in the appropriate location.
2. Take measurements and record at all main and sub-transects.
3. For all measurements, enter either a number (mm) or the appropriate code for type of substrate encountered.

Percent Surface Fines on Pool Tails

Objective:

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

Where to take measurements:

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

Sampling method:

1. Assess surface fines using a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid and there are a total of 50 intersections.
2. Take 3 measurements per pool (See Figure 10).
    a. Place the bottom edge of the grid upstream from the pool-tail crest a distance equal to 10% of the pool's length or one meter, whichever is less. Make sure that the grid is parallel to and following the shape of the pool-tail crest. (It is important to note that the pool tail crest is not always exactly perpendicular to the channel, See figure 10 below.)
    b. Place the center of the grid at 25, 50, and 75% of the distance across the wetted, flowing area of the pool tail.

3. Record the number of intersections that are underlain with fine sediment < 2 mm in diameter at the b-axis. Place a 2 mm wide piece of electrical tape on a ruler and use this to assess the particle size at each intersection.
4. Aquatic vegetation, organic debris, roots, or wood may be covering the substrate. First attempt to identify the particle size under each intersection. If this is not possible, then record the number of non-measurable intersections.

Note: Your total number of measurements should not exceed 50 total measurements per grid. Ie., 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. (I realize this should probably be in italics as a side note and not core (Pibo related).

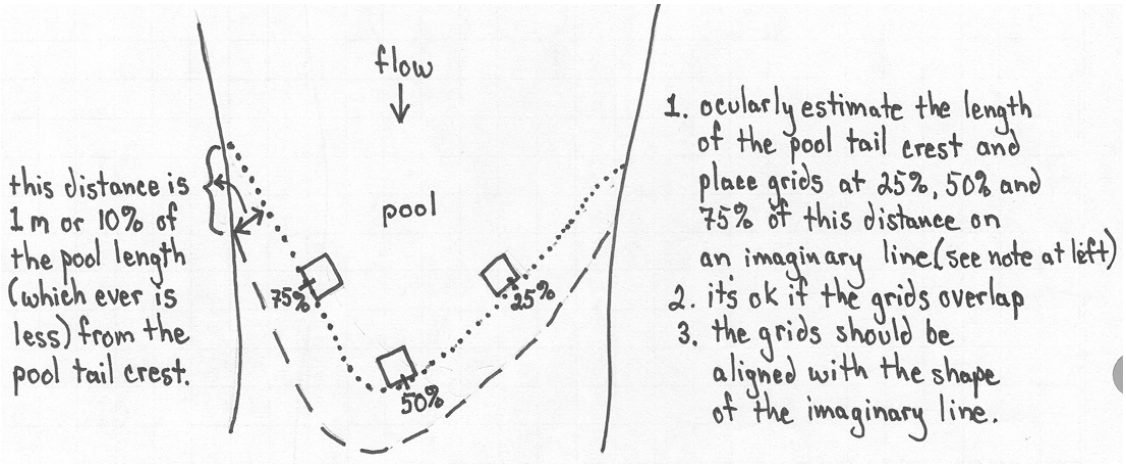

Figure 10: Example of where to place fines grid on a pool tail at 25%, 50% and 75%.

LARGE WOOD

Objective:

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

Sampling method:

1. In order to be counted, each piece must meet the following criteria.
   a. Each piece must be greater than 3 meter in length and at least 30 cm in diameter one-third of the way up from the base, or largest end.
   b. Only include standing trees that lean within the bankfull channel if they are dead. Dead trees are defined as being devoid of needles or leaves. Consider it living if the leaves or needles are green. A tree will be counted if the needles or leaves are brown. (Fig. 12).

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

   c. Wood that is imbedded within the stream bank is counted if the exposed portion meets the length and width requirements (Fig. 13).
   d. Do not count a piece if only the roots (but not the stem/bole) extend within the bankfull channel.

e. Some pieces crack or break when they fall. Count the entire length of the piece when the two pieces are still connected at any point along the break, and only the portion within the bankfull channel when they are no longer connected (Fig. 11).

2. Record the piece number, estimated length (nearest 10 cm), and estimated width (nearest cm) of all pieces in the reach. The same person will make all estimates for a given reach.
3. Also measure the length (nearest 10 cm) and diameter (nearest cm) of the first 10 pieces you encounter. The person estimating should not be made aware of the measured value.
4. A subset of pieces will be measured at sites with more than 10 pieces.
   a. For sites estimated to have between 11 and 100 pieces, measure the first ten pieces, then starting at the 11^{th} piece only measure every 5^{th} piece.
   b. For sites estimated to have over 100 pieces, measure the first ten pieces, then starting at the 11^{th} piece only measure every 10^{th} piece.
5. Measure the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.
6. Do not measure (just estimate) standing dead trees, pieces buried in log jams, or pieces that are unsafe to measure.
7. Begin counting from the bottom up when pieces are stacked on each other.
8. For wood in secondary channels, count only the pieces that are within bankfull.

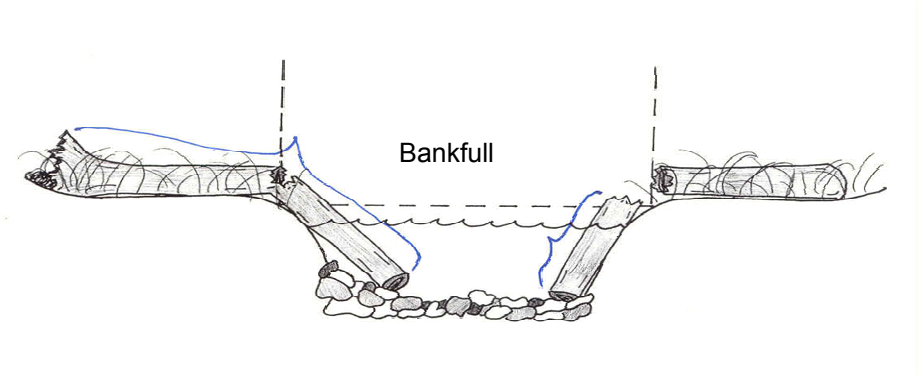

Figure 11: Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

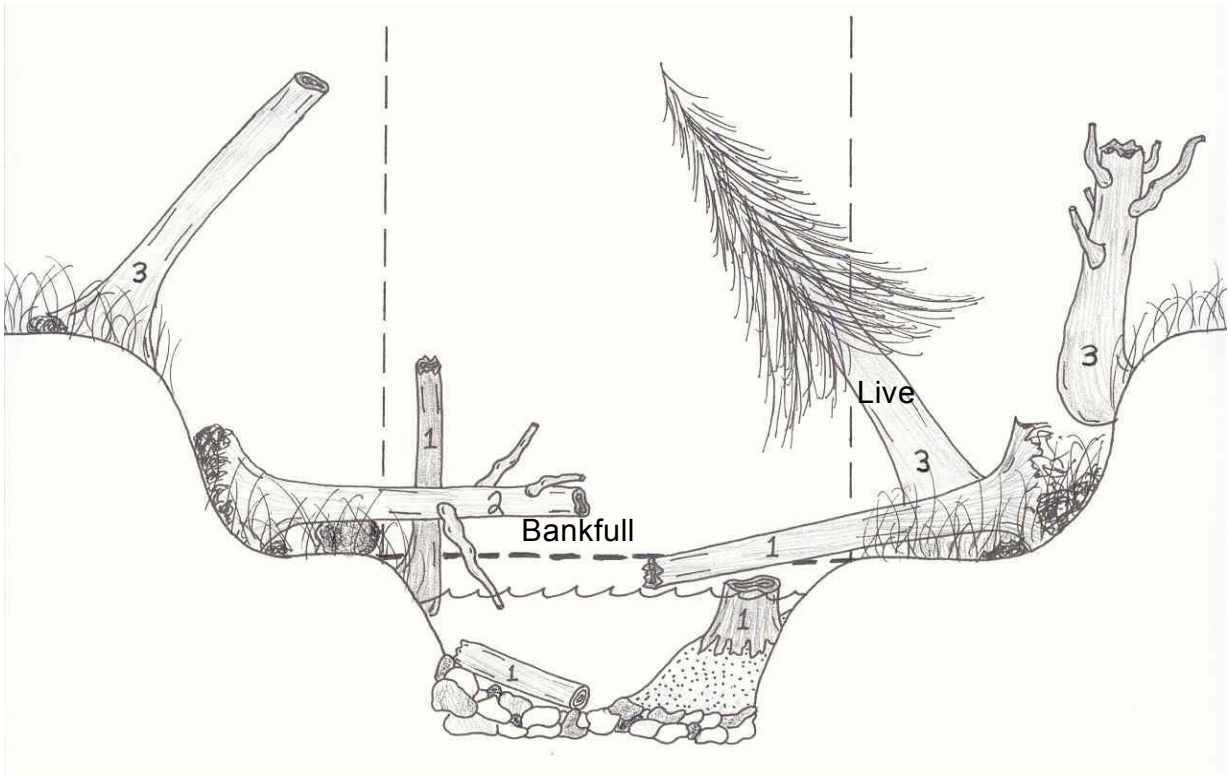

Figure 12: Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

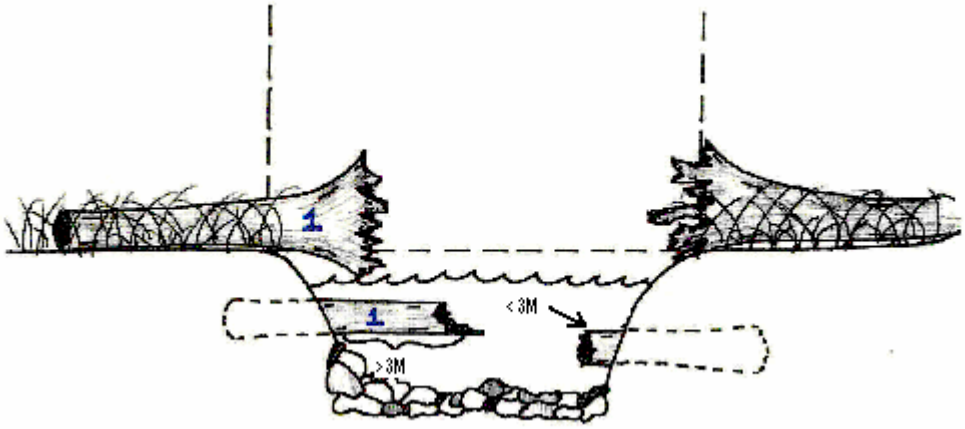

Figure 13: Examples of qualifying large woody debris (1). The pieces on the right side (3) are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

The Wood data form

1. Using the procedure outlined above, the estimator and recorder will complete the large wood survey. The recorder will fill out the data sheet, using the appropriate codes provided in this document and the cheat sheet in the crew notebook.
2. Percent of the wood submerged at bankfull is an estimate of how much of the piece of wood will be underwater when the stream reaches it's bankfull height.

3

3. In the comments section, fill out any info that details any pieces that could not be measured (due to extreme height or unsteadiness) or any other relevant wood information.

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

Code Type	Definition
# Pieces Touching	
S	**S**ingle piece
Acc	**Acc**umulation (2-4 pieces) J Jam (>5 pieces)
Wood Type	
N	**N**atural (broken ends or entire trees)
C	**C**ut end
A	**A**rtificial (part of a man-made structure)
RN	**R**oot wad attached to trunk with **N**atural end (broken or entire tree)
RC	**R**oot wad with opposite end **C**ut
Wood Location	
S	**S**ide of the channel
M	**M**id channel
I	**I**sland
F	**F**ull channel (Completely across the channel within bankfull. Portions may be above the wetted channel)
O	**O**ver the channel (Suspended over the active channel with the ends above the active channel. Include debris with suspended bole but with branches in water).

Biological Sampling

Periphyton

The periphyton protocol used for both field collection and lab analysis is the same as that outlined by the EPA EMAP (Peck et al. 2000). Benthic periphyton samples should be collected at all sites.

At each site, begin at Transect A and proceed upstream, collecting one subsample at each main transect. Subsamples are collected at an assigned sampling location (left, center, or right bank), alternating at each transect (Figure). Record how many samples (should always be 11) were taken from the site and who took the samples on the Biological Stream Data form.

Note: Be certain that the periphyton sample jar is full of stream water before leaving the site. If more water is needed, use the lid of the periphyton jar to fill container (instead of dipping jar into stream) to prevent any loss of sample.

1. Use the Biological Stream Data form to determine whether your starting point on Transect A is on the left, center or right in the stream channel.
2. Choose a rock from each location that is relatively smooth and has adequate exposed surface area.
3. Delineate an area of 12 cm^2 using a template (PVC pipe) provided.
4. Remove all attached periphyton inside the area with a toothbrush. Rinse the toothbrush into the sample jar. Approximately 45 seconds of scrubbing time should be sufficient to remove periphyton.
5. If rocks are not available, use a large bore syringe to vacuum the surface of the sediment within an area of 12 cm2. Add the contents of the syringe to the sample jar.
6. If the substrate at the transect is largely bedrock, place the template on the surface of the bedrock and use the syringe to suck and scrape to collect periphyton from the surface.
7. Subsamples from all transects within a site should be pooled into a single sample jar.

8. During the day, try to keep the sample jar out of the direct sunlight as much as possible to reduce chlorophyll degradation. While in the field, store the jar in the shade, preferably in water near your packs so it is not left behind.
9. Upon returning from the field, measure the water volume in the jar and record.
10. Shake the sample vigorously and pour 50 ml of sample back into the sample jar.
11. Preserve the new sample with 1 ml formalin. Use a plastic syringe to transfer formalin into the sample jar. Close the lid carefully and shake the sample jar. Recap the formalin bottle immediately upon completion.
12. Label the sample jar with the date, watershed code, site number, collector, and the total volume of the sample preserved (should always be 51 ml).

***CAUTION**: Formalin is extremely toxic to all organisms including you. Use extreme caution when handling, use latex gloves and wash hands after use. Do your utmost to avoid spills. If the proper precautions are taken, no harm will come to you or your coworkers. If a spill should occur, use paper towels to absorb the formalin, then place the towels into ziplock bags before disposal. Use soap and water to clean up the spill area.*

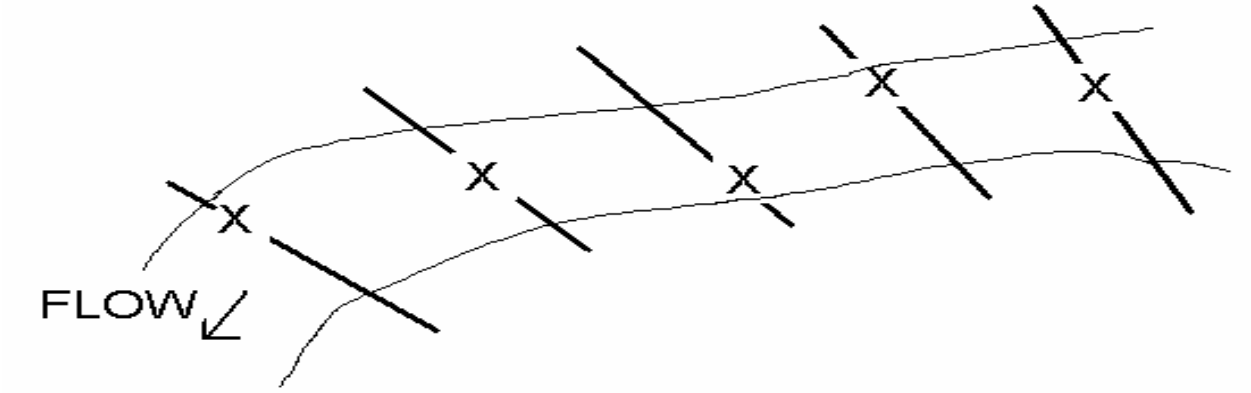

Figure 14: Location (x) of periphyton sample collection. Heavy cross lines represent transects.

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. The sampling protocol is the same for both constrained and non-constrained reaches.

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

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

Sampling method:
These methods were described by C. Hawkins, J. Ostermiller, and M. Vinson (pers. Commun.)
1. Collect samples using a Fixed Area Design (0.72 m^2) from fast water habitats with a 500 μm mesh net. Take invertebrate samples from 4 different fast-water (e.g. riffles, runs) habitat units. Take 2 separate 0.09 m^2 fixed-area kick net samples from each unit for a total of 8 samples. If no fast-water

habitats occur, take the 8 samples from shallow, slow-water habitat units. Combine the 8 individual samples into a single sample that will be used to represent the study area.

2. Place the kick net so the mouth of the net is perpendicular to and facing into the flow of water. If there is no detectable flow, orient the net to most easily facilitate washing benthic material into the net. Collect invertebrates from within the 0.09 m^2 sampling frame in front of the net. Work from the upstream edge of the sampling plot backward and carefully pick up and rub stones directly in front of the net to remove attached organisms. Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations. After removing all large stones, disturb small substrates (i.e. sand or gravel) to a depth of about 10 cm by raking and stirring with your hands. Continue this process until you can see no additional organisms or organic matter being washed into the net. After completing the sample, hold the net vertically (cup down!) and rinse material into the bottom of the cup. If a substantial amount of material is in the net, empty the net into the 14-liter bucket for processing before continuing to the next sample location. Otherwise, move to the next sample location and repeat the above procedure to create a composite sample.
3. Field processing requires a 14-liter bucket, a white plastic washtub, and a 500 μm sieve. Use the bucket to decant organisms from inorganic substrates into the sieve. Use the washtub to transfer stream water into the bucket and then to visually inspect inorganic residue for heavy organisms that were not decanted.
4. Continue this process until all 8 samples have been collected and placed in the bucket. Make sure you thoroughly wash organisms from the net by vigorously pouring water down the net and into the cup. If the net has a cup at the end, remove the cup over the top of the bucket and wash it out.
5. Add water to the bucket and decant invertebrates and organic matter from the sample by stirring the contents of the bucket and then pouring suspended material through the 500-μm sieve. Repeat this process until no additional material can be decanted. Transfer the material in the sieve (invertebrates and organic matter) into the 2-liter sample jar with a small spoon and then wash any remaining material in the sieve into the jar with a squirt bottle. Place the inorganic residue remaining in the bucket into the plastic washtub and cover with water to a depth of 1 cm. Inspect the gravel on the bottom of the tub for any cased caddis flies or other organisms that might remain. Remove any remaining organisms by hand and place in the sample jar.
6. Before preservation, remove and release from the bucket/washtub/sample jar all vertebrates, including fish and amphibians. Also remove and release crayfish.
7. Once all samples have been processed, fill the jar/s with 95% EtOH. Immediately label the jars both inside and outside. Preserve this composite sample in 1 or more sample jars depending on the amount of material collected. If there are multiple jars, label them as 1 of 2 and 2 of 2, etc. and then tape them together.

Vertebrates

Fish and Aquatic Amphibian Sampling

Objective: To determine the species presence/absence within the reach using an electrofisher and to measure the length and volumetric displacement of aquatic vertebrates (or fish and aquatic amphibians) captured from 20% of the reach length.

General Guidelines

Electrofisher Settings

- If the conductivity is less than 100μS, start at 35 Hz, 20% duty cycle and 300V (H-4).
- If the conductivity is greater than 100μS, begin at 30 Hz, 18% duty cycle and 250 V (G-4).

If you see many fish swimming away while the electrofisher is on and fish are not rolling, first increase the voltage, then the frequency, then the duty cycle. **Only increase the settings to the point where fish**

are able to be captured. If it takes more than 20-30 seconds for fish to recover, you are hitting them too hard and should decrease the settings.

Stay within the following ranges:
Frequency: 30-50 Hz (G, H, or I)
Duty Cycle: 18%-35 % (3 or 4)
Volts: 200-500 (never go above 400 in CA)

Methods

1. Before sampling, obtain the conductivity from the YSI and enter it into the data recorder. Do **not sample the reach if the conductivity exceeds 350 µS/cm.**
2. Get the water temperature at transect A immediately prior to electrofishing. If the temperature is greater than 16°C, the temperature must be checked every 30 minutes to make sure that it never exceeds 18°C. **Also do not sample if the temperature is 18°C or greater.**
3. Fish and amphibians will be captured and measured between two randomly selected transects. Obtain two random letters from the data recorder. The vertebrates captured in the longitudinal transect upstream of these two transects will have length and displacement measured.
4. Reset the timer on the electrofisher and begin sampling. Beginning at transect A, conduct one pass with an electrofisher focusing on good habitat such as pools, around wood, undercut banks, etc. Keep in mind that the objective is to document the species present at the site, not to capture every single fish or amphibian.
5. Capture each fish or amphibian in the net and identify it to species. Note that a species has not been captured unless it is netted and properly identified. Document the number of fish and amphibians shocked (even if not captured) and the number and species of all vertebrates captured in the data recorder.
6. When you reach the random measuring transect, place all captured fish and amphibians into a bucket. Do not keep them in a bucket for longer than ten minutes and be careful not to overcrowd them. Measure the fork length of all fish, the snout-vent and total length of all salamanders, and the snout-vent length of all frogs captured in the measuring transect (Do not measure the total length of frogs). Place each fish or amphibian into a graduated cylinder with a known volume of water and record the volumetric displacement of each fish or amphibian to the nearest ml. If no species are captured in the first measuring transect, measure all species netted in the next transect and continue until you capture at least one species to measure (Again no data is data).
7. When you have finished measuring all captured species in the first measuring transect, continue upstream with the electrofisher counting and identifying all netted species until you reach the second measuring transect. Bucket and measure all specimens as before on this transect.
8. When you have complete one pass with the electrofisher throughout the reach, obtain the temperature at transect K and document the total effort in seconds from the timer on the electrofisher.

Example: Transects C and F were selected as the displacement and measuring transects. Measure all fish captured between transects C and D (CD Long) and transects E and F (EF Long) If Tran K was chosen as a random measuring transect, conduct measurements on JK long
Important: If no organisms are captured on the "measuring" segment, measure the organisms on the next segment that organisms are captured. If none are captured within the total reach that is okay it is still data.

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

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

Photographs of Biota

Follow these general guidelines when taking photographs of animals.

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

Only take a few pictures of the representative sample of species found within your watershed. For example, we don't need 400 brook trout photographs within a watershed.

Fish

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

Aquatic Amphibians

1. Place specimen on its abdomen at the top of the fish board and capture the full length of the amphibian.
2. Also, take any pictures on the ventral and lateral side that may help further identify the individual (same as fish).
3. Take a picture of any distinguishing feature about the specimen.
4. Take a picture if you can't identify the species or family.

Terrestrial Amphibians

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

Water

Water Chemistry

Water temperature, dissolved oxygen, conductivity, specific conductance and pH will be logged at five minute intervals for two hours at each site using a YSI meter. Place the meter at the upstream end of the reach unless a tributary enters the reach. If a tributary enters the reach, place the YSI two bankfull widths downstream of the tributary junction.

The YSI meter and probe module is an extremely precise and delicate piece of equipment and should be handled with care. Always store the probe with the calibration/transport cup on, filled with ½ inch of distilled or tap water. When it is in the stream, it should be protected by the probe sensor guard. **Do not touch the pH bulb or the DO membrane with your hands or any other object.**

1. Calibrate the YSI for pH and dissolved oxygen in the morning prior to going out into the field. (For information on calibration, refer to Appendix G on page 45.)
2. Remove the calibration/transport cup and replace it with the probe sensor guard.
3. At transect K, place the probe into the center of the stream, away from the banks in an area such as a riffle or pool tail crest where the water flowing past the probe is representative of the water in the stream. Avoid placing the probe in a turbulent area or pool. (In turbulent areas such as those with white water, the DO will be elevated, and pools do not have adequate mixing to replenish the DO probe or ensure a uniform temperature throughout the pool.) Place rocks onto the cord to hold the probe in place.
4. Turn on the YSI and allow it to warm up for **ten** minutes.
5. Record the current time (military time), temperature, pH, conductance, specific conductance and dissolved oxygen in the data recorder.
6. To begin logging:
   a. In the upper left corner of the "Run" screen, scroll to "Start logging" and press ↵
   b. On the "Enter Info" screen, scroll to the file name, press ↵and enter the file name as follows: state code (two letters), watershed code (three-letters) and the site number (two characters). If the site is a QA/QC or trend site, leave out the state code and include a 9 or 6 before the site number. **Example:** ORRCK03 (RCK903, RCK603)
   c. When you are finished entering the filename press ↵, select "OK", and press ↵
   d. The YSI will begin logging data every five minutes. Allow the YSI to log data for at least two hours.
7. When you are finished logging data, select "Stop logging" and press ↵ Turn off the YSI and replace the probe sensor guard with the transport/calibration cup and ½ inch of distilled, filtered or tap water.

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

Placing and Retrieving Thermographs

Thermographs are to be placed in each watershed prior to the field season. Temperature data will be collected hourly from June 1 through September 15. All thermographs should be removed from the watersheds by October 15.

Thermograph location and placement:

1. The thermograph should be placed in the lower-most, accessible point of the watershed on federal land, with these exceptions:
    a. If the federal landholdings are discontinuous, place the thermograph on the lower-most continuous portion of federal land that will be surveyed, downstream of all survey sites and tributaries with survey sites.
    b. If the HUC is a composite watershed (a drainage basin that has water input from outside the basin) and the mainstem will not be sampled, place the thermograph in the largest tributary that will be sampled at it's lower-most point on federal land.
2. Launch the thermograph on the day of placement. Make sure it begins logging prior to placement in the stream.
    a. Program the thermograph to log temperature hourly for 331 days
    b. Label the file with watershed name, code and year.
    Example: ORSES_E_Fork_Smelly_Creek_2003
3. Secure the thermograph in the steel pipe to a steel cable with a bolt.
4. Place the thermograph in deep, flowing water (not a pool), ideally in the thalweg or other area which will remain underwater throughout the summer. Avoid high-traffic locations.
5. Secure the thermograph under rocks and attach the cable to a tree or other anchor point. Bury the cable under rocks or wood.
6. Document the time and water temperature using a NIST-approved thermometer at the exact time the thermograph is logging a temperature. Make sure the thermograph has stabilized in the water for 5 to 10 minutes prior to the scheduled logging time.
7. Document the location:
    a. Flag a tree 5 meters upstream or downstream of the anchor so that attention is not brought to the cable. You may want to place an inconspicuous marker at the base of the anchor point.
    b. Get a GPS waypoint at the thermograph location, labeled with the serial number of the thermograph.
    c. Write detailed notes on the location of the thermograph relative to the anchor (distance and direction) and stream channel, what it is attached to (tree, size, type, bank, etc.) and where the flag is relative to the anchor. Draw a map of its location.
    Example: Thermograph mid-channel, under .4m boulder, 1.5m from/attached to .3m Douglas Fir, right bank. Flag on willow, upstream 6m, right bank.
    d. Take photos of the thermograph location, anchor (up close, from the flag, including the flag), the flag (from access direction 15 meters away) and any other photos that will facilitate finding the thermograph.
    e. Mark the location on the field map.
    f. Write parking and walking directions to the site.
8. Download all waypoints from the GPS unit and photos from the camera.
    a. Using Photoshop place arrows on one or two photographs pointing out the location of the thermograph, anchor and flagging.

Thermograph Retrieval:

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

General Procedures for using the Compass, Laser Rangefinder, and HP48

1. First and foremost, the laser and the electronic compass are very expensive ($ 5,000 for both). Therefore, always treat them with care. When moving it in the field, walk slowly and cautiously so you do not drop the laser and smash it into bits on the rocks.
2. The laser and its components are water resistant, which means you can use it in the rain, but do not submerge the unit underwater or drop it in the creek. The compass is not water resistant and needs a zip-lock bag placed over the top in the event of rain or snow.
3. Read the laser user's manual and consult it at any time you have questions.
4. The laser requires a direct line of sight. If shrubs or branches are in the way, it is usually best to have someone either hold them out of the way or cut them out of the way with the Swedish safety brush axe (AKA Sandvik). Make every effort to avoid your or another crewmember's anatomy when wielding the Swedish safety brush axe.
5. If you are shooting a point and are unsure whether the laser hit the target or a branch, either shoot the branch or the person holding the prism to determine what the approximate distance to the prism should be and re-shoot the point, before classifying the point on the HP48.
6. Try not to bump the laser so that it is no longer level. If the laser is not level, re-adjust the tripod legs without moving the center post.
7. If multiple channels (or gravel bars) are located within bankfull of the main channel, take the required 5 points (LB, LW,TH,RW, RB) but include additional measurements on each side of the gravel bar at the wetted edges. Be sure to label these as right and left wetted. Take a thalweg measurement only in the main channel (the one with the most flow).
8. **Data files should be downloaded each night. The fewer mistakes that are made in the field, the fewer corrections that will have to be made in the evening. If mistakes are made, it is very important for you to make notes about it in the HP48. Correcting errors without notes is difficult and time consuming. Make sure to document all problems, missed increments, or mislabeled points as soon as the error is discovered.**

Cable connections

The compass comes equipped with two cables, one that connects it to the HP48, and the other that connects it to the laser. The cable running to the HP48 has one round end and one box-type end, and the cable that runs to the laser has two round ends. The HP48 cable should be attached to the bottom left side of the compass when looking at the compass display, and the laser cable should be attached to the bottom right side of the compass. If the cables are on the wrong side on the compass, the data will not be transferred to the HP.

Taking notes

Use a Dura-rite notebook to keep notes about the laser operation at each site. Notes should include:

1. Site number, date, laser crewmembers, and their tasks.
2. File names with the transects and habitat information included within the file.
3. For sideshots or traverses write down X, Y, Z coordinates used each time a new file needs to be setup and include a tally for the number of origins. Writing down the traverse coordinates for each origin will allow the laser operator to return to the previous origin if an error occurred while traversing. Use the purple shift key and Ed coord as described in the Gradient Section above in the HP48.
4. Anything unusual with the laser or the files, such as presence of side channels, undercut banks, or other features in the site that may or may not have been captured by the habitat mapping.
5. These notebooks can be used for anything of interest pertaining to the field season, e.g., landslides, problems with equipment, flora and fauna observations, past management activities, roads not on a map, etc.

IMPORTANT: Notes may be stored in the site file by pressing the NOTE button on the HP48. Use this function to record problems, errors and all comments about the stream, habitat and data. The notes will appear after downloading the data at the point they were entered into the HP48.

Using the Laser

Initial laser setup

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

Adjusting the prism pole to survey hard to reach spots

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

1. The prism pole (Rod Height (HR)) can be adjusted to prevent moving the laser unit. **Remember to change the target height on the HP 48 data processor each and every time you change the height of the prism.** If the rod height is not changed, the data will be incorrect and will require editing at a later date.
2. In the case of an undercut bank, it is important to capture the wetted edge at the point where you can see the wetted edge and shoot the point on the surface of the water only. Make a note of the undercut bank in the HP48, and measure the distance of the undercut that is wetted.

In very tight situations, you may have to invert the prism pole or remove the prism from the pole and place the prism in the desired location. In this case, the rod height should be set at 0.08, the distance from the edge of the prism to the center of the glass.

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

Using the compass

The compass is a precision instrument that calculates heading based upon the earth's magnetic field. The compass is equipped with a calibration feature to account for variations in the magnetic field. **ALWAYS** calibrate the instrument each time you start a new site or the laser or HP 48 is changed.

Keep the compass away from magnetic interference including ferro-magnetic materials (e.g. iron, steel, portable radios, metal watch bands, belt buckles, bank pins, and etc.) and strong magnetic fields (overhead power lines).

Powering on and off

The compass is powered pressing the **ON** button located in the lower right hand corner of the compass face. Simultaneously pressing and holding the two upper buttons power **OFF** the compass. The compass may power itself off after a period of inactivity to help conserve battery life. Simply press **ON** to restart the compass. It will *not* power back on when a new measurement is taken.

First, perform a field calibration on your compass (see Calibrating the compass in Appendix B), *and then* enter your local magnetic declination before you begin logging the data. Otherwise, the accuracy of your measurements could be compromised. Once on site, the laser operator should be the one conducting calibration and making sure all necessary equipment is attached properly. Failure to do so could result in inaccuracies.

Instrument tones
During operation, numerous tones and beeps may be sound. The sounds are indications of what the instrument is doing. Table 1 explains the different audio tones produced by the Mapstar compass and the meanings of those tones.

Appendix A

Compass Operational Information

Compass keys

The "**FWD**" and "**BACK**" menu keys will scroll through the top-level menus until the "**ENTER**" button is pressed to advance into a submenu (Figure 1). Once in the submenu the **FWD** button moves from option to option and pressing **BACK** once will display the previous option while pressing **BACK** again exits the submenu and returns to the top-level menu. **EDIT** ↑ or **EDIT** ↓ scrolls through the predefined settings. These keys also provide a means for entering numeric settings into the compass.

Edit mode

The compass has an edit mode that will allow numerical values to be changed in the compass. When an option can be edited, the left digit will be flashing. The following are how the edit keys work:

- **EDIT** scrolls through each digit that can be edited from left to right,
- **EDIT** ↑ increases the digit value,
- **EDIT** ↓ decreases the digit value,
- **EDIT** ↑ and **EDIT** ↓ may also toggle the left digit between + (indicating positive values) or – (indicating negative values),
- Pressing **FWD** saves the edited value and moves to the next option. Pressing **BACK** twice will save the edited value and return to the top-level menu.

If a value is entered that exceeds the limit of the compass a tone will sound and the value will be reset.

Appendix B

Set-Up and Calibration of the Compass

STEP 1

Calibrating the compass

The compass should be calibrated prior to use at each site to account for varying magnetic conditions. The quality of a calibration is dependent upon various factors:

- The intensity and stability of the ambient magnetic field
- The physical stability of the compass during calibration
- The number of calibration points used (preset)
- The amount of data taken at each calibration point (preset).

To calibrate, make sure the compass is as level as possible and all the instruments (laser and HP) are securely attached. The laser operator should conduct the calibration. All other people, equipment, etc. need to be several feet away from the compass so as not to interfere with the calibration. To initiate the calibration routine:

1. Begin by aiming roughly West or Northwest and then turn the power **ON**.
2. Press **FWD** or **BACK** until the calibration menu is reached (the symbol looks like a little meter). Press the **LEVEL** button to use the level aid tone. Move the compass in the direction displayed to level the instrument, attempt to achieve < 1.0 degrees of tilt when leveling.

3. Press **ENTER** to display the calibration screen and the unit will emit a low-pitched aiming tone.
4. Rotate the compass in the clockwise direction at approximately the same rate as the second hand on a clock. You will hear a series of high-pitched tones as the calibration points are collected. It is okay to hear an occasional single medium-pitched tone during the calibration.
5. Continue collecting all of the calibration data.
6. Once the compass is rotated 360 degrees and all data has been collected, the compass will be silent while the calibration log is created (**CtabL**). It is finished when two good tones are heard and **CdonE** is displayed on the screen.

Failed calibrations rarely occur, but if one does, try leveling the instrument and checking for magnetic interference. Then attempt to calibrate the compass again. If the error persists, contact your supervisor so that Laser Technology can be contacted.

When calibrating in a high wind, the instrument may be shaking enough so that the tilt and stability requirements cannot be met, so it may be necessary to shelter the compass from the wind during calibration.

Pressing **EXIT** at any time before a calibration has been completed will abort the calibration.

Step Two

Setting The Magnetic Declination Offset

To set the magnetic declination offset:

1. Use **FWD** or **BACK** to scroll to the North menu (reads N R>> and SEL on the screen).
2. Press **ENTER** to advance into the submenu. A small "**d**" appears at the bottom of the screen to indicate the declination entry.
3. Four zero's (0 0 0 0) or the last declination should appear. The first zero use EDIT mode to change the value +/-. The last 3 digits are for the declination value displayed on your map. (Example: 17.5)
4. Press **EDIT** to skip to the 2nd "0" and start entering the declination value.
5. Use the **EDIT** ↑ or **EDIT** ↓ buttons to edit a declination value.
6. Press **SELECT** three times to return to the main menu.

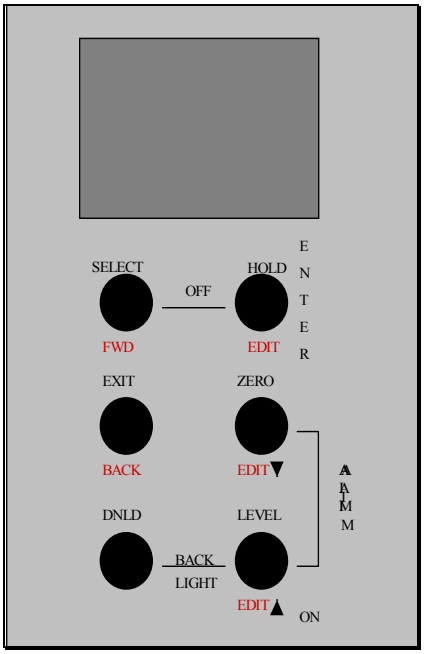

Figure 1. The Mapstar compass button panel showing the navigation keys. Note the different options for each button.

Table 1. Mapstar compass audio tones and their meanings.

Tone	Meaning	Explanation
Double high pitched beep	Good tone	A valid azimuth has been held. A calibration point has been logged. A calibration has been successfully completed.
Single low pitched beep	Bad tone	An azimuth could not be held due to an error. You are trying to edit a value outside of an acceptable range. A calibration has failed.
Persistent steady tone	Aim assist tone	Rising – the instrument is nearing the aiming point. Failing – the instrument is moving away from the aiming point. Silent (after hearing the tone) – the instrument "on target.
Persistent multi-tone beep	Level assist tone	Falling – the instrument is moving closer to level. Rising – the instrument is moving farther off level. Silent (after hearing the tone) – the instrument is within the tilt limit.

Measurement limits

The instrument can express measurement units in either degrees or grads. For our purposes *the degrees option should always be used*. To change units:

1. Use **FWD** or **BACK** to display the system menu then press enter to advance into the submenu.
2. Press **FWD** repeatedly until the screen displays **SEL**:
3. The units symbol will be flashing. Degrees are represented by **°** and grads by **G**. Press either **EDIT** button to switch between the two units.
4. Press **FWD** to move to the next system option, or press **BACK** twice to back out to the top-level menu.

Appendix C

Compass trouble shooting

Warning and error conditions

If the compass detects a problem during measurement, warning or error messages will appear. Warning messages will not prevent a measurement from being taken. They appear at the bottom of the screen as a number with the warning symbol to the right.

The warning/error symbols appear as a dark triangle with a light exclamation point in it. The numerical warning codes and their meaning are presented in Table 2. Additionally, error messages will occur. Error messages indicate when the instrument is unable to calculate azimuth due to excessive interference. An error message interrupts the measurement cycle and overwrites the measurement in the display area. Error messages and their meanings are presented in Table 3. A low-pitch beep will sound if an error message is displayed while attempting to take a measurement.

Table 2. Mapstar compass warning messages and their meanings.

Code	Warning Message
1	User-defined tilt limit exceeded
2	Instrument unsteady
3	Compass core is unsteady
4	Warnings 1 and 2 present
5	Warnings 1 and 4 present
6	Warnings 2 and 4 present
7	Warnings 1,2, and 4 present

Table 3. Mapstar compass errors and their meanings.

Code	Meaning
E01	15.1 degree tilt limit exceeded
E02	Instrument shaking excessively
E03	E01 and E02 present
E04	Compass core overloaded by strong magnetic interference
E05	E01 and E04 present
E06	E02 and E04 present
E07	E01, E02, and E04 present
E60-E65	Huge problem, contact Laser Technology of problem persists

Appendix D

Using the Laser Rangefinder

Powering on and off

1. To turn the laser on, press the button closest to the back (where the function screen, battery tube cap, and wire are located) of the laser on either side.

2. To turn the laser off, simultaneously press the middle and front buttons on the left hand side of the laser.

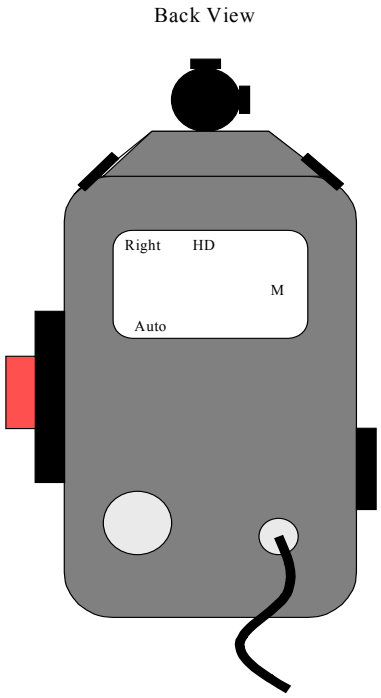

Figure 2. LTI 200 LCD screen showing the correct settings for using the laser.

Using the laser

Once the laser is turned on, the following should be visible on the LCD screen (Figure 2):

- "**Right**" in the upper left corner of the screen,
- "**HD**" in the upper center of the screen,
- "**Auto**" in the lower left corner of the screen, and
- "**M**" in the right central portion of the screen.

It is very important that these indications are present as absence of or different messages will produce data not suitable to this project.

To take a measurement, press the rear right button once to turn the laser dot in the scope on (if not already present) and then press the button again to take the measurement. A beep will sound when the measurement is taken. A number will be displayed in the center of the LCD screen; this is the horizontal distance to the target. Watch the horizontal distance to ensure the readings are logical, when the prism person is moving throughout the stream.

The button panels

The primary button panel is indicated in the upper left hand corner of the LCD screen (Figure 2; "Right" indicates the right panel is primary and the left is secondary; this is the common setup.) Specific button functions are affected by the length of time the button is depressed. A "short" press means the button is pressed and released immediately and a "long" press means the button is depressed for about two seconds before being released.

For simplicity, the buttons on the primary panel will be called "A", "B", and "C" (Figure 3). A is the button to the rear of the laser, B the middle button, and C the button to the front of the laser. The secondary button panel will follow the same button sequence, but be known as "A2", "B2", and "C2". (The button functions are described in Table 4).

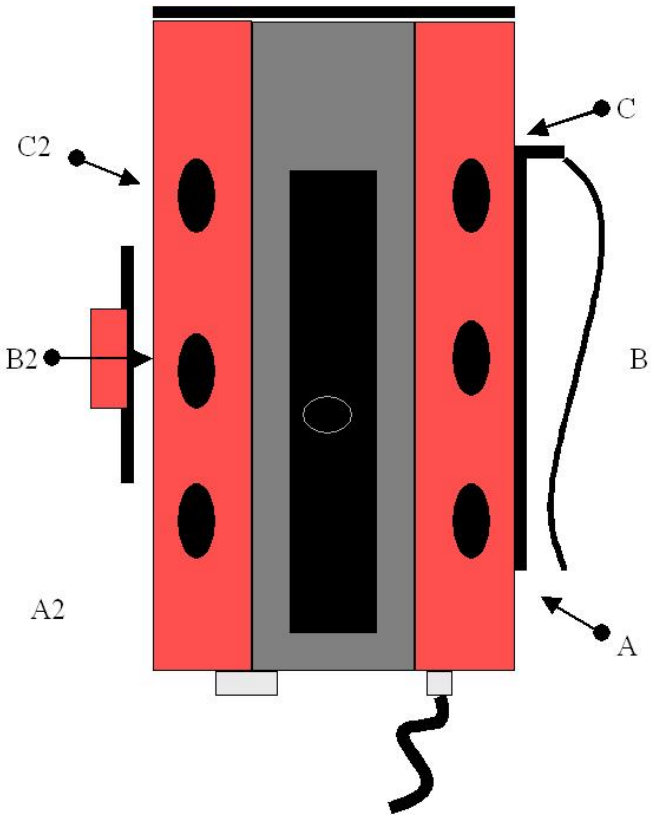

Figure 3. Button panels for the LTI 200 laser rangefinder.

Table 4. Laser button functions for the LTI 200 laser rangefinder.

Button	Function
A	Powers on the laser. Turns on the red dot in laser scope. Fires the laser. Selects the option listed in submenus (HT, GATE, MULTI, SYS). In system setup functions, selects or toggles values. In edit mode, accepts a manually entered value.
A2	No function in measurement operations. In system setup functions, invokes optional “edit mode” so a value can be entered Once in edit mode, advances to the next digit.
B	Moves “forward” in the menu. In edit mode, the first press restores the edit value, the second press abandons the edit.
B2	Adjusts the brightness of the dot in the sighting scope. When press simultaneously with C2, turns off power. In edit mode, increments the digit value.
C	Moves “backward” in the menu, selects the previous option or backs out of the menu. In edit mode, first press restores the edit value, second press abandons the edit. Long Press: clears out the current measurement value.
C2	Turns the screen backlight on or off. In edit mode, decrements the digit value. When press simultaneously with B2, turns off power.

Selecting the measurement units

The laser can express both English and metric units. Units are indicated in the right-hand central portion of the LCD screen. A displayed “M” means the units are set to metric, while a displayed “F” means the units are in feet. Metric units should always be used and are set as the default. The following procedure should be used only if the units were switched, and will return the operator to default settings for this protocol.

1. Use “B” or “C” as needed to display the SYS indicator.
2. Press “A” to select the SYS option.
3. Press “B” until the UNITS indicator at the bottom center of the LCD screen begins flashing, and SEL shows in the numeric display area.
4. Press “A” to toggle between the F (feet) and M (meters) indicators.
5. Press “B” to select the M indicator. The D (degrees) or G (gradient) indicator will begin flashing.
6. Press “A” to toggle between D and G.
7. Press “B” to select D. The % indicator flashes, and OFF should show in the numeric display.
8. Press “C” twice to accept the new settings and back out to the main display.

Important: Changing the units in the laser will not change the units on previously stored data. Those points must be shot again.

Using the filter option

In brushy areas, the laser will often reflect off of unwanted targets giving incorrect values. To avoid errant points, the filter option may be used. With the filter option on, the laser will only reflect off of highly reflective targets, such as the prism, rather than leaves or brush. The filter does not work when a clear line of sight is present. To use the filter:

1. Press C to get to the SYS option.
2. Press A to select the SYS option. The filter indicator will blink, and ON or OFF will be shown in the center of the screen.
3. The A button will toggle between ON and OFF.
4. Press C to save the desired settings and back out to the main display. The FILTER indicator will be displayed on the screen.

Appendix E

Laser Troubleshooting

Error conditions

The central area of the screen is also where error codes are displayed. If an error occurs, a low-pitched tone will sound and an error code will be displayed. Most errors are trivial and require repositioning and/or shooting the point again. Error codes and explanations presented in Table 5.

Table 5. LTI 200 Laser rangefinder error codes and their meanings.

Code	Explanation
doF	Display overflow. Distance or measurement angle too large.
EoF	Editor overflow.
E01	Failure to lock on target. Reposition and retake measurement.
E02	Target lost during measurement. Reposition and retake measurement.
E03	Unstable aim. Steady the instrument and retake measurement

E04	Invalid tilt sensor reading. Contact Laser Technology if persists.
E05	Tilt reading outside limit on height measurement. Reposition or retake measurement.
E06	Tilt calibration error. See company manual and contact your supervisor.
E52	Temperature too hot. Stop operation.
E53	Temperature too cold. Stop operation.
E60, E61, E62	Calibration or code memory checksum failure. Contact Laser Technology.

Appendix F

TDS Software

If the TDS software is not running on the HP 48, press the following keys in sequence: α α T D S 4 8 ENTER. This should bring up the main menu.

Opening a new file

Open a new file at each new site location. All points taken in the site should be stored in a single file. The following steps are the procedure for opening and naming a new file.

1. Press G Open/Edit a Job.
2. Press G Create new job.
3. Under Job name, type in the two character state code and the site ID (e.g. In Glade Creek, Oregon on site 14 the label would be ORGLD14).
4. Be sure that Raw data is turned ON.
5. Start point should be 1.
6. Change the northing, easting, and elevation coordinates to 100.000 for each coordinate.
7. Press the CREAT key (A on the button pad).
8. For the description for point 1 type in ORIGIN 1, then ENTER.
9. You should now see the current job info screen. Press EXIT.
10. To return to the main menu, press EXIT.

Shooting points - SIDESHOTS

1. From the main menu, press J Traverse/Side shot.
2. Be sure you are on the correct foreshot number (FS). FS is the next shot to take in sequential order. Occupy point (OC) only changes when you traverse (create a new origin point).

On your first shot of the day the OC will be "1" and the FS will be "2", which is the GPS location or the monument site on Transect A. All subsequent shots (FS) will proceed in numerical order from 2 until you have taken your last shot at Transect F or K. When you create another origin point the OC will change once you have traversed. Example: The survey proceeds through all the points up to Transect B, the OC = 1 and the FS = 97. When you shoot a traverse at FS = 98, at this point, the OC changes to 98 and the FS = 99.

3. Aim the laser to the center of the prism and shoot the point.
4. Check the distance on the laser display to determine whether you have hit the prism. If you are not sure you hit the prism, take another shot. If you did hit the prism, press SIDES.
5. Enter the description. For the Left Bank on Transect A, type A*LB then press ENTER. For a pool tail crest on the AB longitudinal, type AB*FT. For an increment shot on Transect C, simply type C. The HP48 carries the descriptor from the previous shot. If you do not need to change the descriptor, press ENTER. A complete list of codes is presented in Appendix 2.
6. Enter rod height and press ENTER. If you do not need to change rod height, simply press ENTER.
7. You are now ready to shoot the next point.

Hint: Signal to the prism person when you have the shot, so he/she can move to the next point while the laser operator classifies the shot. Develop a set of hand signals for distinguishing codes between the prism person and laser operator in the field for pool codes.

Editing the rod or instrument height

1. In the shot screen, replace the FS number with the point number that needs to be changed.
2. To change instrument height, arrow down to the HI field, and type in the correct height.
3. Reshoot the shot.
4. Press SIDES.
5. Change rod height, then press ENTER.
6. Press YES to overwrite the point.
7. The HP will return you to the original shot screen. Type the FS number you are on, and resume shooting points.

Moving the laser – TRAVERSE

1. Have the prism person choose a good location with a clear line of site upstream and downstream to place the laser.
2. Take a shot to the new point.
3. Press TRAV.
4. Type the new origin number in the descriptor field (see Appendix 2).
5. Enter the rod height, then ENTER.
6. Next, keep a tally in the field notebook for the number of origins (traverses) in each site and compare it to the actual number when downloading. Be sure to record the X,Y and Z coordinates in the notebook for each traverse, stop/start survey and gradient shots especially if you think errors have occurred.

Editing points

(A quick way to get to the editing menu; hit the purple shit key and then “edit coord” key.)

1. To change a point descriptor, Exit into the main menu.
2. Press “G” Open/Edit a Job.
3. Press “J” Edit coordinates.
4. Use Pt+ to increase point numbers incrementally, use PT- to decrease point numbers incrementally, or RCL to go to a specific point.
5. Arrow down to the descriptor field and type in the correct code.
6. Press STORE, then press YES to overwrite the point.
7. Press EXIT twice to return to the main menu.

Appendix G
Downloading and Editing Data

GPS and Camera

1. At the end of the day, download the track log with the software provided on the laptop. Use the icon on the desktop entitled “GPLdown.exe” to launch the software. Plug the GPS unit into the laptop and push the download button. Create a folder with the days date under C:/Crew #/ GPS_camera/Stint#/. An example filename for the tracklog would be 2003-06-08. In this folder is the track log file entitled track.csv. Be sure to clear the tracklog and prepare it for the next day.

2. Attach the USB cable to the camera, remove the lens cap, turn the camera on and plug the USB cable into the laptop. Locate the photos on the camera card and copy them into the folder with the .csv file extension from the GPS download folder (i.e., in the date folder, as above). When you

are done, locate the icon on the task bar that allows you to unplug the USB cable from the laptop safely (the green arrow icon). Review the photos and make sure that the comment sheet is filled out correctly. When you are sure you have downloaded and recorded all of the pictures delete them from the camera so that you do not download them again the next night.

Downloading the YSI

1. Connect the YSI to the laptop using the cable that is labeled YSI.
2. Turn on laptop and open EcoWatch.
3. Click on the yellow folder (Upper left corner) and navigate to the appropriate folder for downloading. Then click close.
4. Turn on the YSI, and press **ESC** to access the main menu.
5. Select "File"
6. Select "Upload to PC"
7. Select the file you want to download
8. On the laptop in the EcoWatch window, select the "Dynamite" icon from the toolbar
9. Select **"**COM 1"
10. The file will upload into the directory and open in the Ecowatch Program as a .dat file.
11. Check the data to make sure it appears correct and the YSI is functioning properly.

Downloading the HP 48

1. Turn HP48 and computer on.
2. Connect the HP48 to the laptop.
3. Plug the hardware key (dongle) into the large port in the back of the computer.
4. To log onto the computer, *fsguest* is the username, *fsguest* is the password (no italics), and Domain is *Local workstation*.
5. Click on the **Link32.exe** icon on the desktop. If the software does not open, make sure the dongle is plugged into the appropriate port, then click the *Search for hardware lock again* button.
6. Select *Send/Receive* in the **Transfer** menu.
7. For **Which Data Collector or Total Station Used**, ensure that *TDS Data Collector – HP48* is entered. The output file should be **sequential**. Be sure that the **Get File Name from Data Collector or PC** file is checked. In the **Store In** box, select the *Choose Directory* button and navigate to the Crew#/SurveyLink/Stint#folder on your C-drive.
8. To prepare the HP48, press [*F*] to enter the main menu, then [*S*] *File Transfer*. Set file type to RAW. Type [*A*] to send the data.
9. Select the file to be downloaded then press [*A*] for *SELECT*.
10. On the laptop press the *Receive* button on the transfer screen.
11. When the file transfer is complete, hit the *Close* button on the transfer screen.
12. Open the file you just saved.
13. Make corrections as necessary.

Editing data files

To change instrument height or rod height:

1. Highlight the line above the line that needs to be changed, and select **Insert Line** from the **Edit** menu.

It is important to insert the line above the point you want to fix.

2. Click on the HI/HR tab then enter the correct instrument and rod heights then select *Store*. Select *Done* to exit **Edit** mode.
3. This procedure changes all points below this line to the next instrument height. THEREFORE, if you need to change only one point, you will have to insert lines *above and below* the point with the unique instrument or rod height.

Changing point labels

1. Highlight the appropriate line, and then edit the note. Type the entire descriptor; the laptop doesn't know the codes. Click on *Store*.
2. To view the descriptor file on the HP, from the main menu, press [H] Open/Edit

Making a scatter plot of the file

1. Select **Generate Coordinates** from the Conversions menu. A conversions screen will open. Select the name of the file to convert. The **Output** file should be sequential. Ensure that the **Convert File** box is NOT checked. **Click *OK***.
2. In the Conversion menu, select **Convert File Format**. A convert screen will appear. Select Coordinate File. Output file type should be ***ASCII 2***. The output file should be named the same thing as the original file, with the .asc suffix. Save the output file in the same TDS crew download folder. Click on the ***Convert*** button.
3. In the Start menu, open Microsoft Excel.
4. In excel, open the ASCII file just created. The Text Import Wizard will open.
5. Click the circle to the left of **Delimited**. Select *Next*.
6. Check the box next to **Tab** to turn it off, and then check the box next to **Comma** to turn it on. Click on *Finish*. This should produce a spreadsheet with 5 columns containing the point numbers, the X, Y, Z coordinates, and the descriptors.
7. Click on the graph button, select *XY plot,* click *Next* and highlight columns B and C. Click *Next* twice and then *Finish.* A graph should appear. This graph should appear as a bird's eye view of the reach.

Making a longitudinal profile graph

Right click on the tab at the bottom of the Excel screen that labels the currently open "sheet". Select *Move or Copy*, check the box next to **Create a Copy** and select *OK*. This should create an identical "sheet".

1. Highlight columns B and C then delete them.
2. Highlight the new column C, open the **Data** menu, select **Sort**, make sure *Expand the Selection* is selected, click **Sort**, and sort by column C. Select *OK*.
3. Column C should now be ordered by longitudinal, then origin number, then Transect. Delete all the rows with information pertaining to origins, monuments, and transects.
4. Highlight column A, go into the **Data** menu, and expand the selection to sort by column A. This will put all the points into the order in which they were shot.
5. Highlight all the values in column B (not the entire column, just the values). Click on the Chart **Wizard** button, **Line Graph** option, then **Finish.** This will create a graph of the longitudinal profile of the stream. It will look like a cross section and will show the elevation gain of the stream (the first z-value should be 100, because the initial origin was created in the file as 100,100,100). If there are any odd points or elevation gains and/or losses make note of what may have happened. Also make a note if a significant "jump" in the profile was due to a waterfall(s) or other gradient changes, such as culverts or debris slides.

Deleting files on the HP48

****Important: Delete files ONLY if the file has been downloaded to the laptop, stored in the Aquatics folder on the network, been checked for errors, and the Data Manager has given the okay to do so!!!***

1. From the main menu, press **G Open/Edit a Job.**
2. Press **L Delete job.**
3. Use the arrow keys to scroll to the file you want to delete, press **SELCT**.
4. Press **YES.**

Editing the data file in Survey Link

Use the Electronic Protocol for further discussion on how to edit a data file in the Survey Link software on your laptop. The appendix also includes information on problem solving and how to fix errors.

Appendix H

YSI Meter Calibration and Maintenance

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

Calibrating pH (daily)

1. Rinse the YSI probe module and calibration cup **three** times with distilled water. Open the cap and pour one inch of water into the cup. Replace the cap and rinse, swirling the water inside the cup and around the probes **for at least 10 seconds** during each rinse. Shake the excess water out of the cup between rinses.
2. Pour a ½ inch of pH 7.0 buffer solution into the cup and rinse **one** time with the buffer solution.
3. Fill the calibration cup with the pH 7.0 buffer solution to the pH line on the side of the cup. Replace the cap and gently turn the probe on its end.
4. On the YSI meter, note the temperature of the solution then press escape to get to the main menu. Scroll to “Calibrate” and press ↵
5. Select “pH”. Select “2-point” calibration.
6. The YSI will prompt you to enter the first pH. Look at the temperature-pH chart on the label of the buffer solution bottle to determine the correct pH at the current temperature. Enter it into the YSI and press ↵
7. The parameters will be displayed and “continue” will be highlighted in the upper left hand corner of the screen. Wait a few minutes for the temperature and pH to stabilize. The pH has stabilized when it has not changed for 30 seconds. If it drifts in one direction it is not stable, but if it fluctuates back and forth between two values it is stable. If it takes a very long time for the pH to stabilize or if it continues to drift, the probe probably needs to be cleaned or is not working properly. When it is stable record the values of the temperature and initial pH on the calibration log. Press ↵to calibrate. “Continue” will be highlighted in the upper left corner. Record the final pH value on the log sheet. Press ↵
8. Rinse the probe **three** times with distilled water and **once** with ½ inch of pH 4 buffer solution. Fill the calibration cup to the pH line with pH 4 solution.
9. The YSI will prompt you for the next pH value. Look on the chart of the pH 4 buffer solution to find the proper pH value. Repeat the same process (steps 6 and 7) as with the pH 7.
10. Rinse the probe three times with distilled water when finished calibrating pH.

Calibrating dissolved oxygen (daily)

1. Make sure the YSI has been turned on for at least 10 minutes.
2. Remove the entire calibration cup from the probe module. Shake the excess moisture off of the probes and, using a clean cotton swab, gently dry off the thermister and the DO membrane. When calibrating DO, inspect the membrane and make sure it is in tact and there are no air bubbles inside the membrane. If there is a large (greater than 1/8 inch) bubble in the membrane, the membrane will need to be replaced.
3. Pour ½ inch of water into the calibration cup.
4. Being careful not to wet the probe, place the probe module on its end into the cup and screw the cup onto the probe ½ turn so that the cup remains **loosely** fitted onto the module. Make sure the thermister is not submerged and the DO membrane remains free of water.
5. Wedge the probe into a place where it will not be disturbed for at least 10 minutes. Make a note of the time. The probe should be in the shade, out of sunlight, where the temperature is stable.
6. On the “Calibrate” menu of the YSI select “Dissolved Oxygen (DO)”. Select “DO%”.
7. The barometric pressure should appear on the “DOsat” screen by default. Press ↵to confirm it. Record this value in the calibration log.

8. When ten minutes has passed since the probe was last disturbed, record the initial DO value on the log sheet. Press ↵to calibrate the probe and record the final DO value on the log sheet. Press ↵to continue.

Storing the probe module

The calibration/storage cup should be screwed on snugly with approximately ½ inch of water (distilled, tap or filtered) inside to keep the DO membrane and pH probe moist, but not submerged in water. It is very important that the probes stay moist. If there is no other water available, stream water can be used temporarily. However, do not store the probe overnight in stream water and be sure to rinse the probe well if stream water was used. If the calibration cup leaks, the O-ring may need to be replaced.

Cleaning the probes (as needed)

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

1. Rinse all three probes thoroughly with distilled water using the squirt bottle, paying close attention to the inside of the conductivity probe and around the pH bulb.
2. Using the bottle brush included in the maintenance kit, scrub the inside of the conductivity probe using 15 to 20 strokes.
3. Wet the end of a cotton swab and use it to gently wipe the pH bulb, DO membrane and thermister. Do not touch the bulb or membrane with anything other than a cotton swab, and be very careful not to force the swab around the sides of the bulb. Wipe the outside of the probes.

Calibrating specific conductance (monthly)

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

Changing the DO membrane cap (monthly)

1. Unplug the probe from the YSI.
2. Thoroughly clean the probe module.
3. Unscrew the DO membrane cap from the DO probe and discard it.
4. Rinse the probe with distilled water.
5. Using the sanding disk in the maintenance kit, gently wet-sand the gold cathode with a twisting motion two to three times to remove any tarnish or silver deposits. Clean the silver anode by wrapping the sandpaper around the anode and twisting to remove the dark build-up on the anode.
6. Rinse the probe well and wipe thoroughly with a wet paper towel making sure all grit has been removed. Rinse the probe again with distilled water
7. Prepare the electrolyte solution according to instructions on the bottle. Try not to shake up the solution just before use as it may cause air bubbles to form.

8. Carefully fill the new membrane cap at least ½ full with electrolyte solution trying not to form air bubbles. Tap the side of the cap gently to release any air bubbles in solution.
9. Tip the DO probe down and gently screw the membrane cap onto the probe moderately tight. Do not touch the DO membrane with your hands. A small amount of electrolyte solution should overflow.
10. Rinse the probe thoroughly and replace the storage cup with about ½ inch of water. The membrane should sit for 24 hours before use.

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