EFFECTIVENESS MONITORING FOR STREAMS AND RIPARIAN AREAS WITHIN THE PACIFIC NORTHWEST

STREAM CHANNEL METHODS FOR CORE ATTRIBUTES

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STREAM CHANNEL METHODS FOR CORE ATTRIBUTES

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INTRODUCTION

The Aquatic and Riparian Effectiveness Monitoring Program (AREMP) is a multi-federal agency monitoring program that was initiated in 2000 to assess the condition of watersheds within the Northwest Forest Plan area by collecting information on upslope, riparian, and in-channel attributes within each watershed (Reeves et al. 2004). The program samples watersheds within the Northwest Forest Plan area ("west of the Cascades") on US Forest Service (FS) Regions 5 and 6, Oregon/Washington State Office of the Bureau of Land Management (BLM), and on National Park Service lands.

The PACFISH/INFISH (PIBO) effectiveness monitoring program for aquatic and riparian resources was developed in 1998 in response to monitoring needs addressed in the Biological Opinions for bull trout (USFWS 1998) and steelhead (NMFS 1995) (Kershner et al. 2004). The primary objective is to determine whether priority biological and physical attributes, processes, and functions of riparian and aquatic systems are being degraded, maintained, or restored in the PIBO area. The program samples within the interior Columbia River basin on lands managed by U.S. Forest Service (FS) Regions 1, 4, and 6 and the Idaho and Oregon/Washington State Offices of the Bureau of Land Management (BLM).

The two programs began discussions for combining their sampling protocols in 2003. The goals were:

1) Achieve consistency in data collection between the large-scale aquatic monitoring programs in FS Region 6 and Oregon / Washington State Offices of the BLM.
2) Be able to answer status and trend questions across a larger area and with an increased sample size.
3) Improve sharing of data management techniques, analysis tools / models, and quality assurance testing.
4) Bring both programs in line with the guidelines described in the draft Aquatic Ecological Unit Inventory (AEUI) Technical Guide developed by the Forest Service to provide consistency in physical habitat monitoring methods.

The core set of attributes in this document are collected by both programs and are described in the literature as being important in defining physical habitat conditions and their relationship with aquatic species. This protocol standardization effort describes the minimum number of measurements, the frequency of the measurement, and the location of the measurements to ensure consistent data collection efforts. The actual measurement tools, and techniques for using the tools are left to the discretion of each program. For example, each program has agreed to measure bankfull width at eleven equally spaced transects throughout the reach; however each program has chosen to take the measurement with different tools. In addition, each program has the option of collecting additional data (taking more measurements) as they see fit to meet their specific objectives; these additional measurements are described in the program specific field protocols.

Results from protocol comparison tests (Whitacre 2004), quality assurance tests (Archer et al. 2004, Roper et al. 2002, Kaufman et al. 1999), and unpublished information collected by both programs were used to agree upon a sampling method for each attribute. We also include a core set of summary statistic(s) for each attribute and a description of how they were calculated. Both programs will implement these standardized protocols during the 2004 field season. We acknowledge that this document may need to be updated based on comments from the field crews. We have planned a follow-up collaborative meeting during the fall/winter 2004-2005 to address these changes.

We would like to thank the following authors and acknowledge the original citations for each method, while recognizing that numerous modification have been made.

- Harrelsonn et al. (1994) - Reach layout, bankfull elevation, gradient, and sinuosity.
- Wolman (1954) and Lazorchek et al. (1997) - Streambed particle counts
- Bauer and Burton (1993) and USFS R5 SCI Guidebook (1998) – Pool tail fines
- Kershner et al. (2004) - Defining habitat units
- Lisle (1987) - Residual pool depths
- Hawkins et al. (pers. Commun.) - Macroinvertebrates
- ODFW – large wood

Finally, the protocol and the individual methods were designed and tested specifically to sample a stream reach and to monitor the effects of management activities. Reach lengths are a minimum of 20 bankfull channel widths in length, range from 160 to 480 meters, and are wadeable.

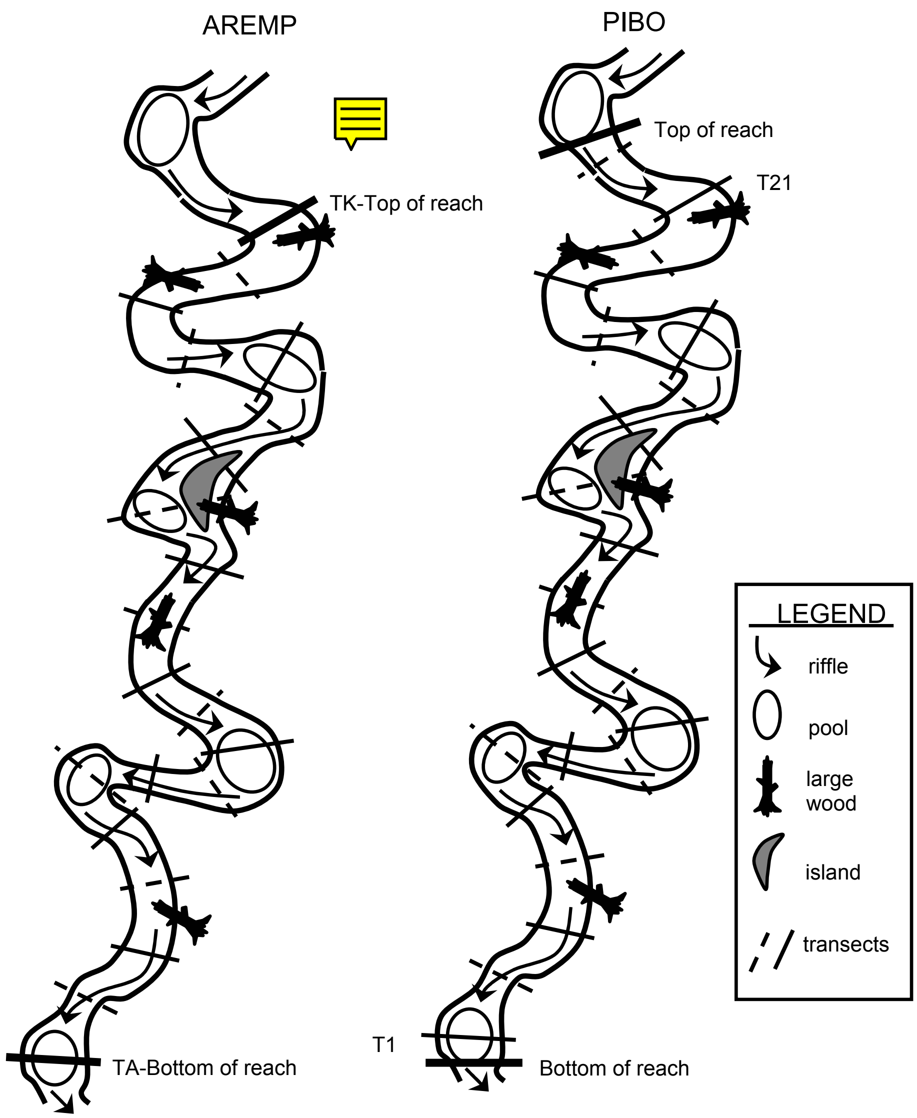

Figure 1. Overview of reach layout showing locations of transects, pools, riffles and large wood.

SAMPLE SITE LOCATION

Determine the Start of the Reach

1. Use the global positioning system (GPS) to record the Universal Transverse Mercator (UTM) easting, northing, and zone at the downstream end of each.
    a. Previously sampled sites: Locate and use the same starting point in the reach using written directions, a topographic map, reach markers, GPS coordinates, and in some cases photographs. It is extremely important that the start of the original reach be correctly located.
    b. New sites: Locate the reach start using the written directions to the reach, GPS coordinates, and a topographic map.
2. Mark the exact start of the reach with flagging.

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. A distinct feature (large spanner, snag, rock or tree) near the bottom of the reach will be used to monument the reach in wilderness areas.

1. Locate a distinct feature near the bottom of the reach that will be easily identified.
    a. Something relatively permanent like 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 big clump of sage or one conifer near the start of the reach.
2. Attach one of the markers to your chosen spot.
3. Take a GPS reading of the reach marker location and record.
4. Next, from the marker location take a compass bearing from the marker to the bottom of the reach and record.
5. Finally, measure the distance from the marker to bottom of the reach and record.
6. Take a picture of the marker location and surrounding distinctive features.

Photo Points to Document the Site

Photo points are used as another tool to monitor change through time and to help locate the start of the reach in future years. Therefore, it is very important to accurately describe the location of each photograph.

1. Photos of the reach marker location and the bottom of the reach are required. Additional photos are recommended.
2. For each photo record the picture number, camera location, description, and photo location.
3. Ensure proper lighting when taking pictures. Take pictures with the sun at your back and not looking directly into the sun. Also, try to minimize photographs where part of the frame is in the shadows and part in the sun.

IDENTIFY WIDTH CATEGORY AND ESTABLISH REACH LENGTH

Previously sampled sites: Use the original width category or original minimum reach length.

New sites:

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. It will also be used later to determine which secondary channels to include in the survey.
3. Four additional bankfull widths will be measured, two upstream and two downstream (Fig. 2). 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.
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.
5. In some instances a measurement can not be taken due to dangerous obstacles or a tributary/secondary channel confluence. Skip that measurement. At least three measurements should be obtained.

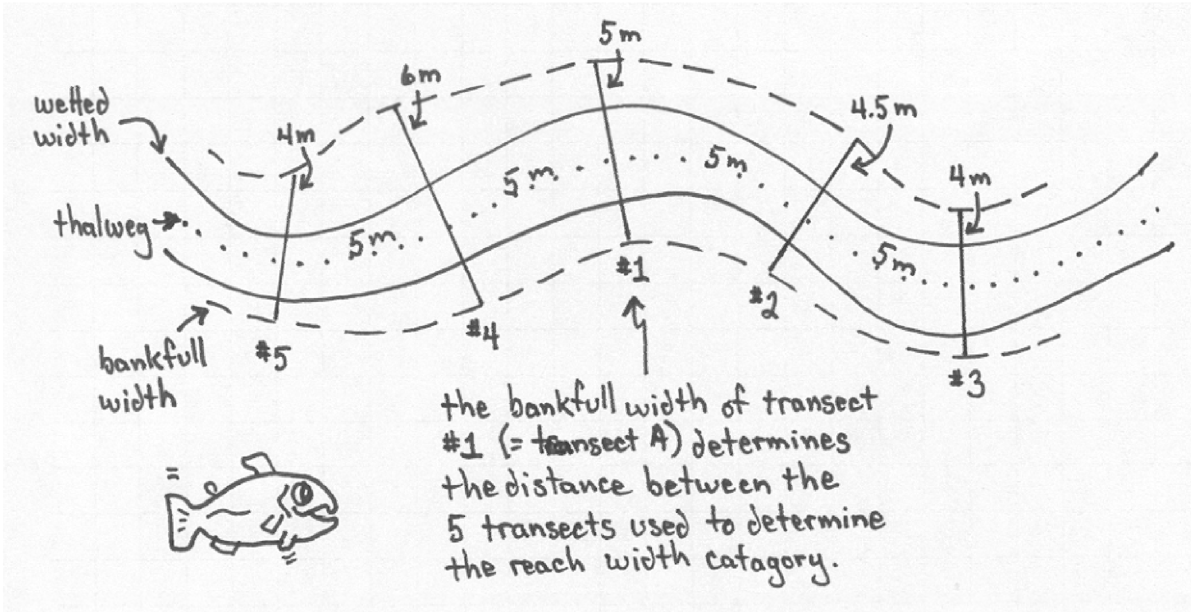

Figure 2. How and where to take bankfull width measurements to determine the width category.

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

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

Table 1. Width categories for determining the minimum stream length.

Measuring Reach Length

The reach length is measured along the thalweg from the bottom of the reach to the top of the reach.

Measuring Valley Length

To obtain valley length, measure the straight-line distance between the points where the thalweg crosses the top and bottom of the reach.

Measuring Change in Reach Elevation

Measure the elevation change from the water surface at the downstream end of the reach to the water surface at the upstream end using a tripod and surveyors' level. Measure the elevation change twice, with the level at a different physical location each time and record to the nearest cm. Record the average if the 2 measurements are within 10% of each other. If not, measure the change in elevation a third time, again re-locating the level. Compare all three measurements, and at a minimum average the two closest readings.

TRANSECT RELATED MEASUREMENTS

Lay out Channel Transects

1. Beginning at the first transect flag, place subsequent transects and their flagging at regular intervals, one "width category" value (see above), as measured upstream along the thalweg.
2. There will be a minimum of 21 equally spaced transects.

Secondary Channels

A secondary channel is any channel separated directly from the main channel at the upstream end by an island/bar with an elevation above bankfull. Only main and secondary channels will be surveyed.

1. Only secondary channels that begin and end within the reach will be considered.
2. 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 $\geq$ 20% of the average bankfull width (rounded to the nearest integer) from the width category determination. Measure the width of the secondary channel one width category up from the downstream end.
3. In the event that a secondary channel splits into additional channels that are > 2 bf width categories in thalweg length, include only the channel with the greatest flow. Any additional channel divisions will be excluded from sampling.
4. Measurements in secondary channels will include large wood, pebble counts, and bankfull width.

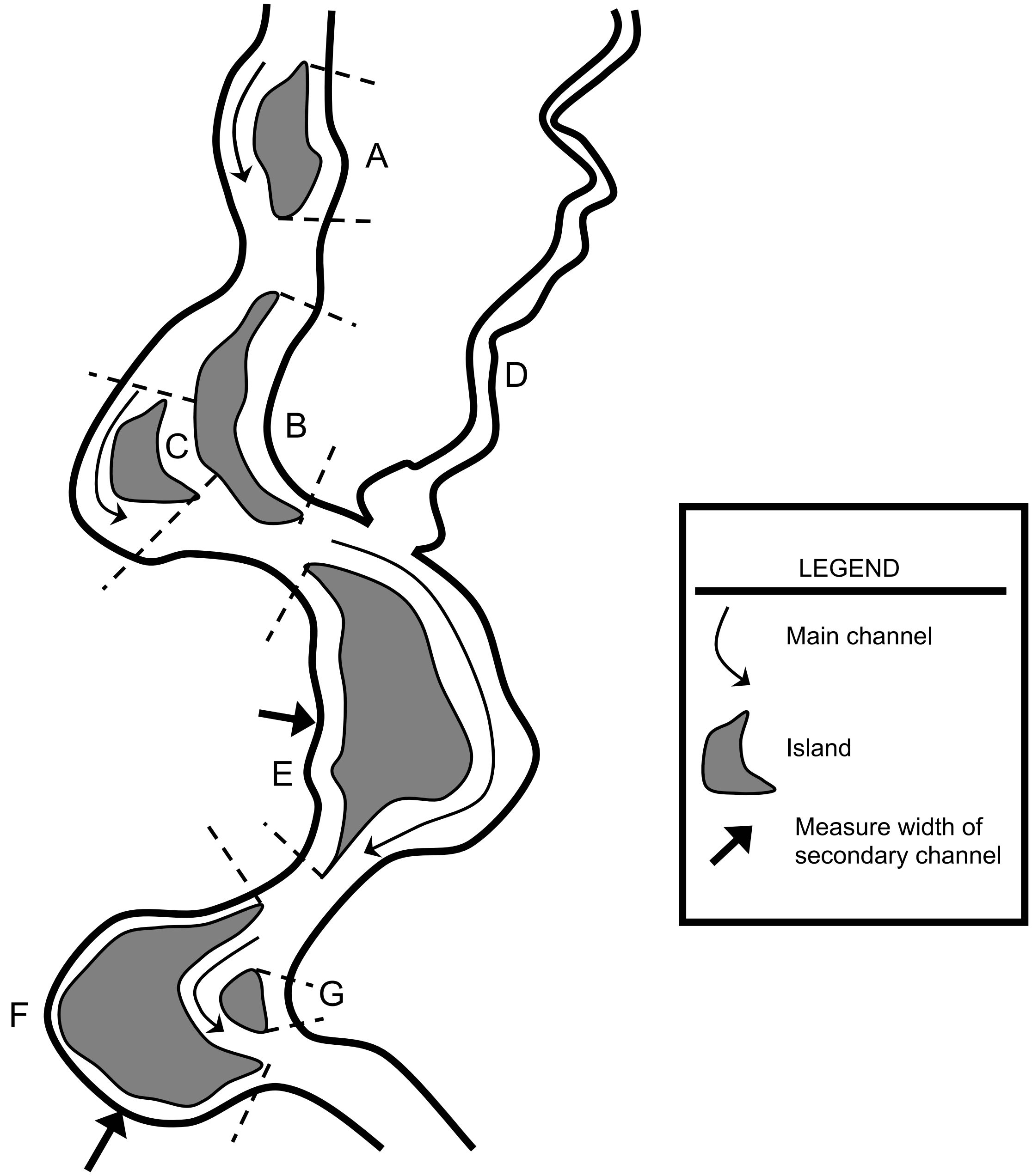

Figure 3. Examples of secondary channels. Channels A, B, C and G would be considered part of the main channel since they are < 2 bankfull width categories in thalweg length. Channel D would not be included because it began outside of the reach. Channels E and F are > 2 bankfull width categories in thalweg length and are considered secondary channels. Secondary channel E would be included in the survey because it also meets the width criteria (>20% of the average bankfull width from width category determination, measured one width category up from the downstream end of the island). Secondary channel F would not be included in the survey because it does not meet the width criteria.

Bankfull Width

Objective:
- Determine the average bankfull width for the reach.

Sampling method:
1. Measure the bankfull width to the nearest 0.1 meters perpendicular to the main stream channel at 11 equally spaced transects beginning with the first.
2. When local bankfull indicators are not present use the height from the water surface to the bankfull elevation defined at channel cross-sections to estimate bankfull.
3. When a qualifying secondary channel is present measure the bankfull width of both channels. Do not include the width of the island that is above bankfull.
4. Large wood or heavy brush may obstruct a transect. Also at some tight meanders the transect may cross a point bar without intersecting the actual bank (located behind the point bar). Do not take a measurement at these transects.

Streambed Particle Size Distribution (Pebble Counts)

Objective:
- Determine the percent fines < 2 mm in diameter (D), D50 (median particle size), and D84 within the reach.

Where to take measurements:
1. Take measurements at 21 transects.
2. Sample the entire bankfull channel width across the transect.

Sampling method:
1. Five particles will be sampled across each transect.
2. Samples will be taken at 10, 30, 50, 70, and 90% of the way across the bankfull channel width.
3. Visually estimate the sample locations prior to walking across the transect.
4. When a qualifying secondary channel is present include the bankfull width of both channels but not the width of the island that is above bankfull.
5. Sample the particle at the toe of the foot/depth rod. Reach down with the forefinger (without looking down) and pick up the first particle touched. Measure the middle width (B axis) of the particle. Visualize the B axis as the smallest width of a hole that the particle could pass through.
6. Record particles < 2 mm as 2 mm. Record the width of larger particles to the nearest mm.

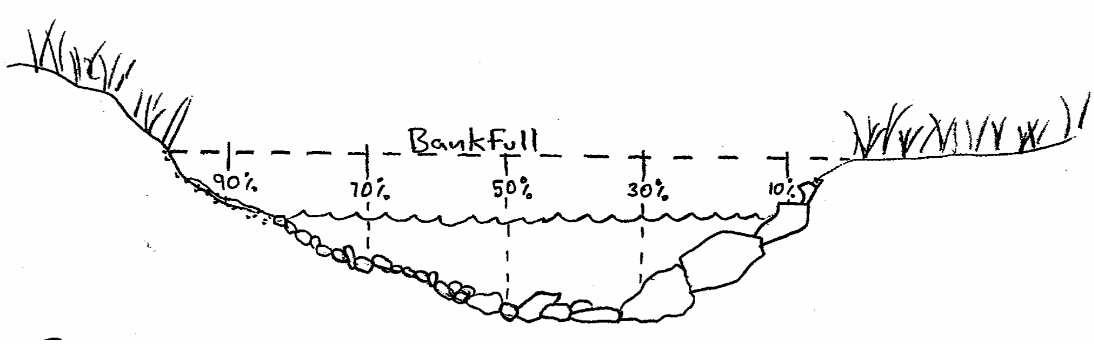

Figure 4. Location across transect for particle count distribution sampling.

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. Pool 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/bars 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 head crest and tail crest.
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.

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.

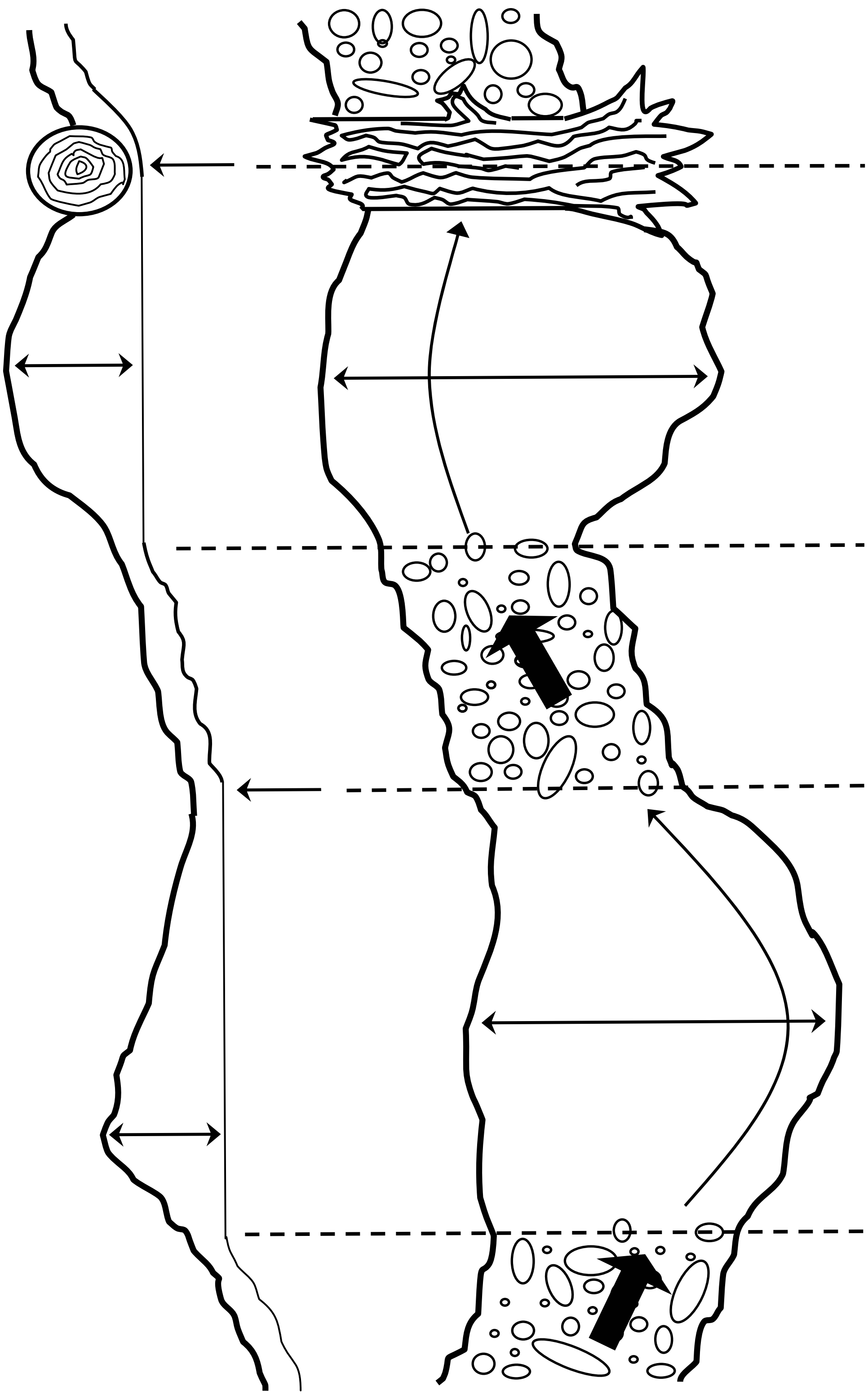

Figure 5. Top and side views of both a scour pool and a dam pool.

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 6).
    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.
    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.

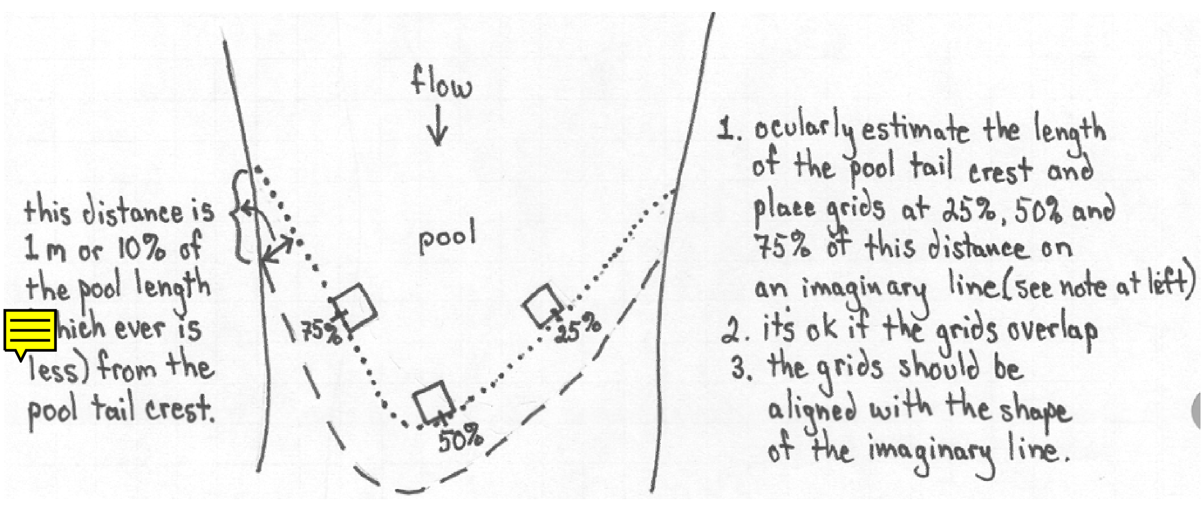

Figure 6. Location and orientation of pool tail fines grids relative to the pool tail crest

LARGE WOOD

Objective:

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

Sampling method:

1. In order to be counted, each piece must meet the following criteria.
   a. Each piece must be greater than 3 meter in length and at least 30 cm in diameter one-third of the way up from the base.
   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 any part is alive (Fig. 8).
   c. Wood that is imbedded within the stream bank is counted if the exposed portion meets the length and width requirements (Fig. 9).
   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. 8).
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 beginning at the downstream end of the reach. 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 11th piece only measure every 5th piece.
   b. For sites estimated to have over 100 pieces, measure the first ten pieces, then starting at the 11th piece only measure every 10th piece.
5. Measure the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.
6. Do not measure (just estimate) standing dead trees, pieces buried in log jams, or pieces that are unsafe to measure.
7. Begin counting from the bottom up when pieces are stacked on each other.
8. For wood in secondary channels, see Fig. 3 to determine what large wood to count.

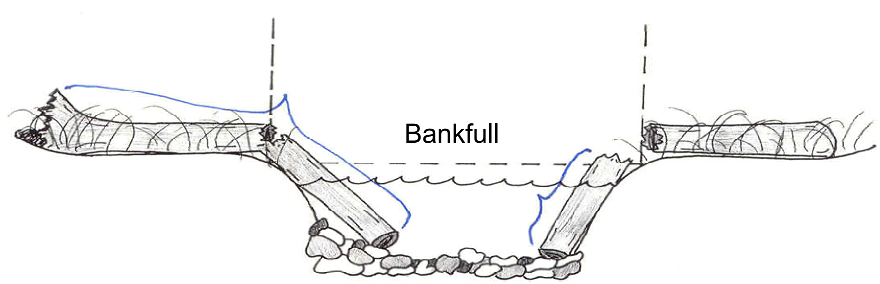

Figure 7. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

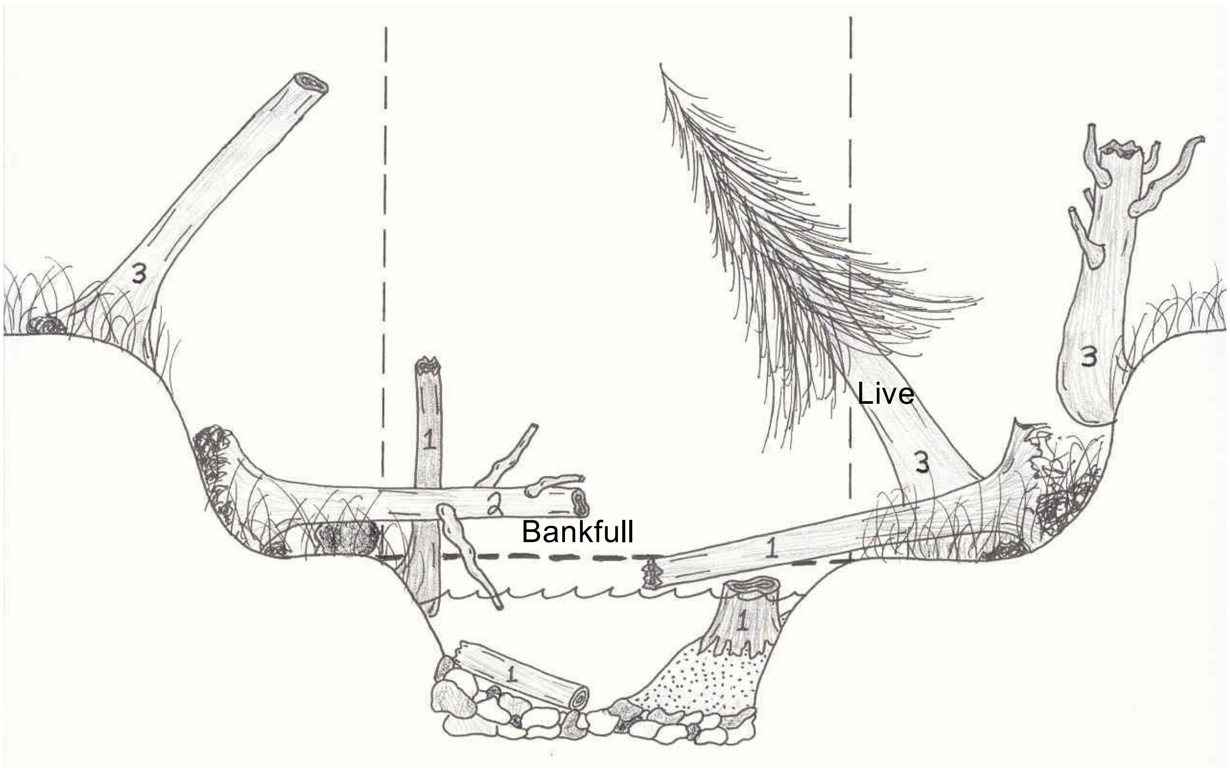

Figure 8. Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

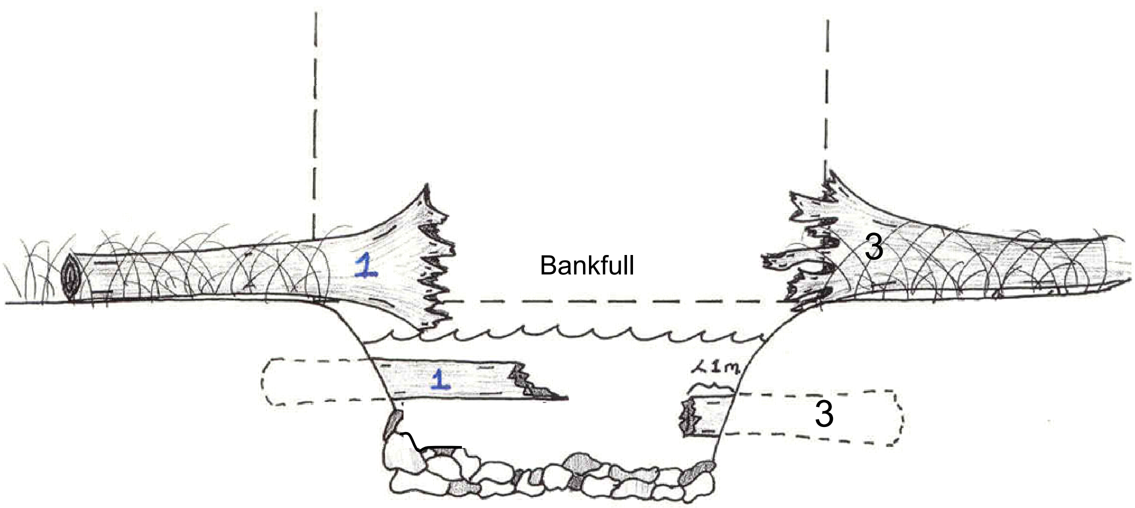

Figure 9. Examples of qualifying large woody debris (1). The pieces on the right side (3) are not counted (3) because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

BIOLOGICAL SAMPLING

Macroinvertebrates

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.

WATER CHEMISTRY

Conductivity

Measure conductivity once at the upstream end of each reach using a hand held conductivity meter. Measure immediately after transects are laid out and upstream of the last transect flag to insure that the channel sediment has not been disturbed. Take the reading in flowing water, near the center of the channel.

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