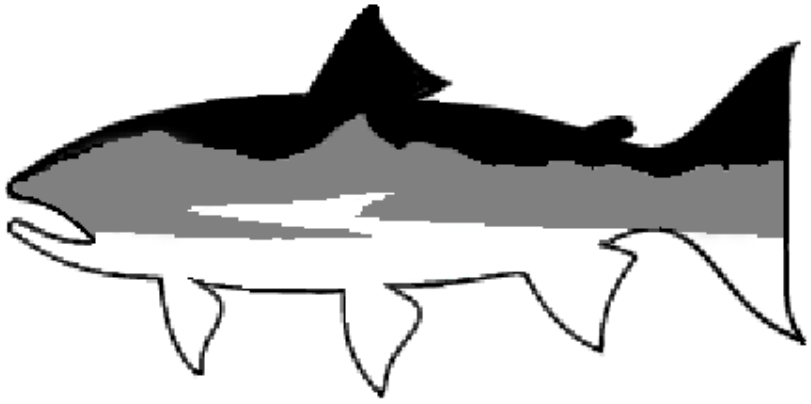
Field Protocol Manual

Aquatic and Riparian Effectiveness Monitoring Program

Regional Interagency Monitoring

for

The Northwest Forest Plan



2023 Field Season

Contacts

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

Christine Hirsch – Program Manager	541.750.7017	christine.hirsch@usda.gov
Mark Raggon – Field Coordinator	541.750.7021	mark.raggon@usda.gov

Acknowledgements

The Aquatic and Riparian Effectiveness Monitoring Program would like to acknowledge the following people for contributing to the field protocols described here. Nate Dachtler, Kirsten Gallo, and Chris Moyer developed the original protocols and produced the first draft of this document. Erik Moberly and Devin Simmons worked on early details of the original protocols. Kris Fausti, Jenni Dykstra, Ted Sedell, Peter Gruendike, Jake Chambers, Steve Wilcox, Heidi Andersen, Hank LaVigne, John Speece, Jeff Metzger, Tracy Pennell, Jared Blake, Alanna Wong, Mark Raggon and Stephanie Miller helped improve subsequent drafts of the protocol. Thanks to all of the field crew members who tested, questioned, and provided feedback over the years. Steve Lanigan (AREMP), Kate Dircksen, Emily Hall, Deanna Vinson and Jeremiah Heitke from the PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Program kindly shared their artistic drawings. Additional thanks goes to Carl Saunders and Andrew Van Wagenen from PIBO for cooperating to standardize a core set of sampling methods for sites with beaver ponds and channel shifts. We would also like to acknowledge the BLM's Aquatic Inventory Monitoring (AIM) group, including Trip Armstrong, Scott Miller, Robin Jones, Ryan Leonard and Jennifer Courtwright for providing guidance incorporating water chemistry techniques.

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

Introduction

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

As natural variance both within and between the watersheds is quite high, it is imperative that errors due to sampling and observer bias are minimized. The data collected will be used as the basis for management decisions throughout the Pacific Northwest. These data comprise one of the largest data sets that exist in the Pacific Northwest, both spatially and temporally. Therefore, it is of the utmost importance to make the effort to produce the highest quality data possible.

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

Locating and Establishing the Start of the Survey

A topographic map of each watershed will be supplied, marked with potential sample sites. The goal is to sample all sites that had been previously surveyed. Contact the field coordinators if extra personnel are going to be needed to finish a watershed.

Navigating with the Garmin inReach

1. From Home screen:
    a. Select Waypoints
    b. Select a waypoint
    c. Select Navigate.

Selection Criteria

Note: A crew leader has the authority at any time to exclude a site if he/she feels it is unsafe for a crew to sample.

Exclude a watershed if:

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

Exclude a site if:

1. The site is not safely accessible, i.e., it cannot be reached without putting the crew in danger. (A long hike into a steep canyon does not automatically qualify as a dangerous situation for the crew.)
2. The site is not wadeable because of depth or current.
3. Travel time (round trip) from road or wilderness camp is over four hours to get to and from the site. The crew should never be in the position of hiking back to camp or their truck in the dark. If the watershed is large and sites are spread out, a crew will relocate camp to be closer to outlying sites to reduce daily travel time.
4. The GPS point (used to identify the beginning of a site) is located on private land.
5. The GPS point for a site is in a lake, wetland or marsh, or on a dam or glacier.
6. The site is an artificial stream or irrigation canal.

Include a site if:

1. All stream channels will be considered, regardless of the presence or absence of flowing water. Use the following criteria to determine whether the site should be sampled;

a. Active scour must be present in the channel, i.e., fine particles have been removed or pushed to the side and larger substrate is visible. Ephemeral streams that flow over vegetation are not sampled.
b. There must be well-defined bankfull indicators present to sufficiently establish survey transects throughout the length of the site, signifying that it is an active channel. An active channel will have some combination of the following bankfull indicators:
    i. Examine stream banks for an active floodplain. This is a relatively flat, depositional area that is commonly vegetated and above the bankfull elevation.
    ii. Examine depositional features such as point bars. The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage. However, depositional features can form both above and below the bankfull elevation when unusual flows occur during years preceding the survey. Large floods can form bars that extend above bankfull whereas several years of low flows can result in bars forming below bankfull elevation.
    iii. A break in slope of the banks and/or change in the particle size distribution from coarser bed load particles to finer particles deposited during bank overflow conditions.
    iv. Locate the elevation where mature key riparian woody vegetation exists. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
    v. Examine the ceiling of undercut banks. This elevation is usually slightly below the bankfull elevation.
    vi. Stream channels actively reform bankfull features such as floodplains after shifts or down cutting in the channel. Be careful not to confuse old floodplains and terraces with the present indicators.
    vii. In the absence of clear indications of bankfull, look for evidence of the previous season's flooding, including: drift debris (leaf mats, thickets of wood). Deposits of unvegetated sand, gravel, or mud. The elevation where deciduous leaves, small branches, etc., are absent from the ground surface because they were carried away by high water.

Keep in mind that bankfull height will be more or less consistent throughout the reach. Significant changes in bankfull height among transects should only be observed when there are also significant changes in the physical structure of the reach (e.g., increased or decreased channel constraint or gradient).

The survey crew must be able to physically work and collect a full set of data within the stream channel. Avoid sites choked with willows (or similar dense vegetation) that excessively hinder the crew's productivity or restrict mobility while working in the channel.

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

Record the site UTM coordinates

The EOS Arrow 100 is a high accuracy (sub-meter) GNSS (Global Navigation Satellite System) that utilizes SBAS (Satellite Based Augmentation Systems) to obtain real-time GPS corrections which when used properly can provide accurate spatial locations even in densely forested areas. The Arrow 100 will be used to collect a point at Transect A and Transect K.

To configure the Arrow with an Android device via Bluetooth, go to the Android "Settings" and select the Bluetooth icon. Turn ON the Bluetooth radio button and tap "SCAN" in the Settings menu located next to the search icon. The Arrow will be discovered and listed. Make sure the Arrow device number matches the number located on the bottom of the Arrow 100.

Tap on the Arrow under the "Available devices" and allow a few seconds to pair.

When collecting a point place the antenna off the ground by looping the cord around a branch or placing it on a boulder. Do not lay the antenna directly on the ground to collect a point. On first power up, allow the Arrow to track satellites in DGNSS for at least 10 minutes, prior to hiking towards the stream. Start the receiver at the truck before hiking into forest where the clearest view of the sky is so the SBAS satellites download a "fresh" almanac which increases the tracking performance under tougher environments (forested areas).

EOS Arrow 100

1. Wait until all three lights on the side of the arrow are illuminated. If after waiting for a while and only one or two of the lights are on proceed with the steps below.
2. Select S1 Mobile App > Select a basemap from list icon.
3. Select the settings icon > Connect to Bluetooth GPS > Select the Arrow.
4. Select the plus icon > S1Waypoints > Select the Bullseye.
5. Select the Averaging icon (right of Bullseye) > Select the Attribute icon at the top of the screen.
6. When the attribute screen comes up enter in the name field the following naming convention {creek_code}{site_no}{reach location}. e.g. ORABC####k. Then hit the check mark at the top of the screen.

If the Arrow has no lights on, use the tablet's internal GPS by turning off Bluetooth on the tablet and following steps 4 – 6 above. The newer tablets have a better GPS chip (better accuracy) than the Garmin inReach units.

Monument the Site

Site markers are used to monument the site location. The markers will assist others in finding Transect A of the original site. ***Site markers will not be placed in wilderness areas and National Parks.***

Note: In wilderness areas/National Parks choose a distinctive feature to use as the marker and take a photo of it with someone either pointing at it or temporarily hang a piece of flagging on the feature.

1. Locate a distinct feature near the bottom of the site for Tran A and near the top of the site at Tran K that will be easily identified by the next survey crew.
    a. Something relatively permanent such as a piece of large wood near the stream (e.g. a large spanner log or tree).
    b. Sometimes riparian zones within the sites are characterized by a continuous patch of vegetation; try to pick something that stands out such as a large cottonwood tree or one conifer.
2. Use an aluminum nail to attach the monument. Leave 3-4 inches of space between the nail head and tree so the tree has room to grow and won't pop out the monument over time. Make sure the marker is clearly visible and facing the stream.

Photo Documentation

Each time your turn on the camera confirm the date and time are correct. Hit the Menu button on the camera then scroll to the wrench icon select it and select settings then click the right button (flash icon) to edit date and time.

In the camera screen the most important setting to verify is  , this setting sometimes displays as  . To fix this, with the side menu of camera settings visible on the screen (click OK once if they aren't visible) click the OK button on the camera click the up or down buttons to select  and click to the left to select 

Information about each site will be documented in photographs and in the field data recorders. Ask all other crew members to stay out of the photos. Gear in the photos is OK if it does not move between pictures. Keep gear bundled up to avoid the "yard sale" look. Nine photos will be taken at Transect A and five at Transect K. In addition, photographs should be taken of rare or unique features in the site including culverts, log jams, landslides, beaver dams, or vertebrates that are difficult to identify.

There are three critical components to taking a good photo: lighting, focus, and framing.

Lighting: optimal photos are captured with mostly uniform lighting, that is, minimal sunspots and shade. Cameras have a tough time adjusting when both extremes are present. Therefore, site photos taken in a shady forest on a sunny day make for terrible

light conditions. Unfortunately, surveyors can do little to fix the amount of sun in a site, but here are some tips to make the best of it:

1. Overcast weather is the best in terms of lighting on a shady stream. If the cloud cover is shifting and there is an overcast moment while on the site, prioritize photos.
2. Sunspots create washed out portions of the photo, shadows create dark spots. Details are lost in washed out portions, dark spots might contain some data that can be enhanced with a photo editor. When in doubt, shoot too dark rather than too light. When in doubt, take multiple shots at different exposure level.
3. Use the exposure level adjustment to tweak lighting level while taking pictures. Turn the camera from Auto to P and adjust the exposure depending on light conditions (-0.7 to -0.3 is a good range to start with).
4. Alternatively, half shutter focus the camera on different spots until best light balance is achieved. Focusing on light spots will darken the photo.
5. Shield the lens from direct light sources.

Focus: optimal photos show sharp detail to the target object

1. Most cameras will allow you to see the point of focus by pressing the shutter halfway down. If the preview of the shot is acceptable, complete the shutter press without moving the camera to take the picture. If the preview is undesirable, release the shutter button, reframe the shot, and press the shutter halfway. Repeat until desirable shot is achieved.
2. Keep the camera as still as possible while pressing the shutter. The photographer should plant their feet, lock their elbows into their torso, and hold their breath immediately before, during, and after the shutter press. This becomes more critical the closer the camera is to the subject.
3. Lighting will greatly impact the camera's ability to focus. The more light on the subject, the easier the camera can focus on it. If conditions are dark, try adjusting the exposure level lower.

Framing: optimal framing will clearly display the target subject and offer a good idea of 3D perspective in a 2D image. Photos must balance between including as many details as possible while allowing the viewer to properly focus on critical features.

When recording photo numbers into tablet, record the top set of numbers from the two sets in the bottom right-hand corner from the camera screen and include the last four digits.

Order of Events for Photographs at Tran A

1. GPS screen showing date and time
    a. At the beginning of each day, open the screen on the inReach unit that displays the time and take a photo of it with the digital camera. This photo serves as a backup in case the digital camera clock varies.

   b. Use the “MACRO” feature for up close shots including the GPS and whiteboard.
2. Close-up of white board with site information
   a. Location (i.e., watershed code name and site number): For Site 3 on Wadeable Creek in Oregon, you would put “ORWAD1003” or ORWAD9003 for QAQC.
   b. Date (Day Month Year): “3 July 2003”
   c. “Transect A LB.”
3. Transect A left bank with whiteboard **ON LEFT BANKFULL**
4. Downstream from Transect A
5. Transect A right bank
6. Upstream from Transect A
7. Transect A left bank to Monument
8. Monument to Transect A left bank.
9. Approach to monument
10. Any other additional photos needed to capture distinctive features

Order of Events for Photographs at Tran K

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

Additional Photos to Take

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

- Features such as logjams, road crossings, waterfalls, deep pools, and beaver dams.
- Land disturbances such as fires, landslides, extensive blow downs, etc.
- Unusual species and species that are difficult to identify; this info should also be entered into the photo log and incidentals form along with the photo number (see the photographs of biota).
- If possible, take a picture of the overall watershed (from a road/clearing).
- Scenic shots and photos of **SMILING** ☺ people working.
- Make sure to use appropriate tags in data forms so we can search our library of 1,000’s of photos.

Site Layout

The site lengths are found in Table 1. In all sites, 11 transects will be laid out and labeled A-K with orange flagging. In addition to the 11 major transects, 10 intermediate transects will be flagged with orange flagging. Side channels and pools will also be identified and marked with pink and blue flagging respectively. Transect A is marked with biodegradable orange flagging.

Following the thalweg (imaginary line drawn to join the lowest points along the entire length of a stream bed in its downward slope, defining its deepest channel) measure the distance between transects using a meter tape. The meter tape should be laid on the surface of the water at the thalweg. If bends are encountered where following thalweg is difficult to maintain, split up the measurements.

Flags will be labeled beforehand but make sure the correct flag is placed at the appropriate transect. Place flags in an obvious area near eye level at each transect location.

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

***Remove all flagging from the site (except for the Transect A flag) after the survey is completed. Keep the flagging to reuse for future surveys.**

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

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

Channel Shift

Assess whether the main channel has shifted since past visits (using photos and reach length) and determine the extent of channel impact.

<u>If New or Abandoned Channel Is <15m in Length:</u>
Determine whether the old main channel qualifies as a side channel (see Side Channel section), and sample accordingly.

<u>If New or Abandoned Channel Is ≥15m In Length:</u>

Measure and record the length of the abandoned channel, length of new main channel in the appropriate fields on the SiteInfo sheet.

Take Tran A photos in the new main channel as usual. Repeat all Tran A photos in the old main channel (left bank, downstream, right bank and upstream) under OptPhotos using Channel Shift as the photo type then select the appropriate keywords. Additionally, take new photos facing downstream where the new and old main channels split (star in fig 1) and facing upstream where they join back up. Label these photos “Split” and “Join” in OptPhotos.

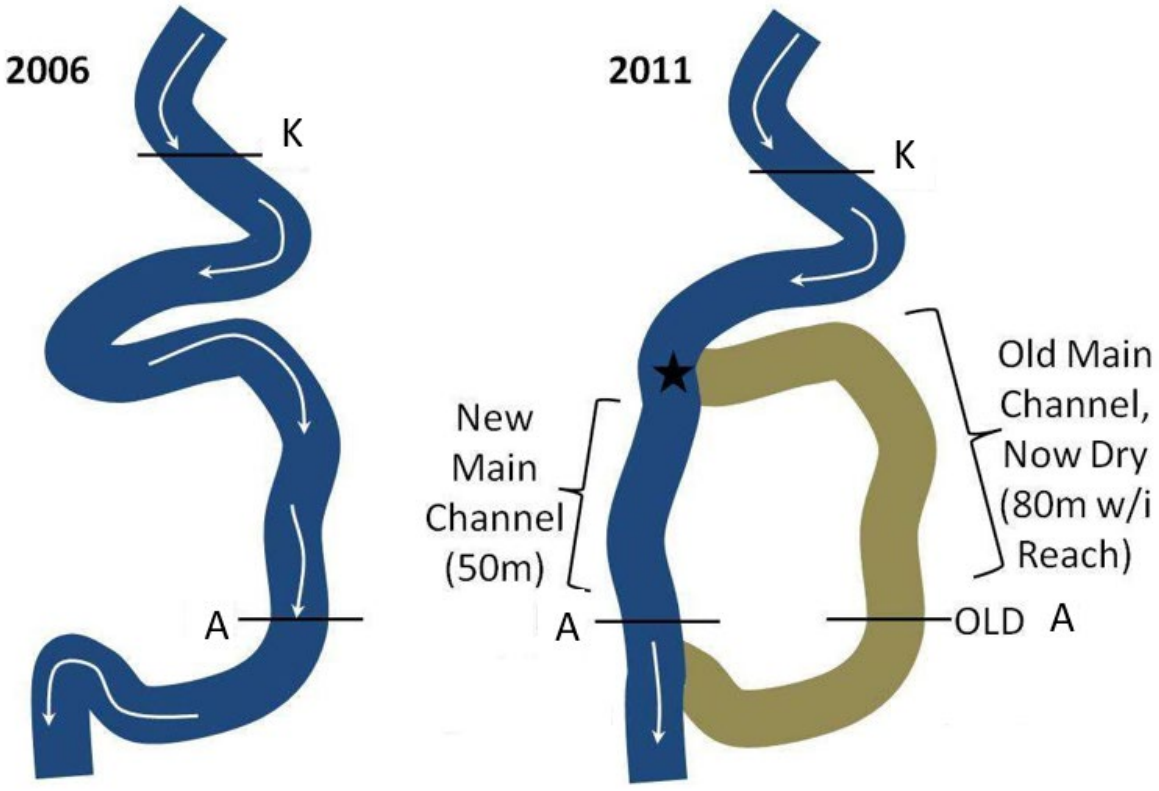


Figure 1: Plan view of example channel shift that impacts location of Tran A. Since 2006, the main channel has shifted, and the old Tran A is now in a dry channel.

If Tran A or K are no Longer in the Main Channel:

Move A/K to new main channel, perpendicular to the valley. Look for a pool tail within ½ a width category (for a 160 meter site, the width category is 8), either US or DS, perpendicular to the old A/K. If there is no pool tail within ½ a width category, establish new A/K to the location perpendicular to the old A/K. Place new A/K monument if necessary and record new GPS point. Repeat all A/K photos in the old main channel (left bank, downstream, right bank and upstream) under OptPhotos using Channel Shift as the photo type then select the appropriate keywords. If the old channel is now a qualifying side channel, sample it accordingly (see Side Channel section).

Other 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 their crew leader notebook and transcribe it to the post-stint data form. Unusual situations include the following; details are presented in Table 2.

Intermittent/Partial Flow

Not all streams will have water flowing throughout the entire reach; there may be sections that are dry while other sections are wet.

Measure all qualifying pools that have water (even a trickle) flowing into and out of them. Don't measure stagnant (isolated) pools.

Collect macroinvertebrates in sites with partial flow. The rule is, if there is enough water in any part of the reach to move bugs into the net, collect them in those areas. If no fast-water habitats occur, take the samples from shallow, slow-water habitat units.

Gradient will either be collected at the thalweg or on the left wetted edge depending on if the transects at A and K are dry or wet. If either Transect A or K is wet and the other is dry, measure gradient at the thalweg of both transects.

At transect cross sections, record the right and left wetted measurements only when the channel or braid connects to the main channel or another braid that eventually flows into the main channel (don't include wetted edges for braids that don't connect to main channel).

If reach has partial or intermittent flow place sonde and collect the water sample where water > 10cm deep and > 1 m^2. If no location exists, do the best you can to take the measurements and record appropriate comments about the quality of the sample. If there is a beaver dam/pool at Transect F place sonde/collect sample at Transect A, if beaver

dam/pool is present at Transect A, place sonde/collect sample below the dam/pool even if it is downstream from the reach.

If a section of the reach is completely dry when measuring large wood, make a comment that says “Dry Channel” for that piece.

Obstructions at the waypoint

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

Impassible barriers

If you encounter an impassible barrier (waterfall, lake or glacier) or private land ***during site layout***, establish the end point of the survey at the barrier (Transect K). Layout the site backwards traveling downstream to Transect A.

Small Obstructions

Occasionally logjams or other obstructions cover the stream channel making it difficult to measure cross sections at transects. Cross sections can be moved up or downstream from the transect ½ of the width category. If the width category is 8m, you can bump the cross section up or downstream from the transect 4m. If the obstruction is large and blocks numerous transects, it should be excluded from the survey. Use a stop/start survey in this situation (see below).

Stop and Start of Survey

Stop and start is a technique intended for large obstructions (i.e. passable waterfall or large/long culverts) encountered in the site that interfere with data collection or compromise crew safety. If the length of an obstruction such as a culvert or log jam is greater than four times the bankfull width category (review Table 1) for the site, the site will have to be moved so the obstruction is no longer included in the reach. For example a 160 m reach, would fall in to the 8m width category, therefore if the obstruction is greater than 32m in length the site would have to be relocated to exclude that obstruction from the reach (either upstream or downstream whichever is closest). Additionally, a site would be excluded if multiple start/stops cumulatively add up to 32 m in length as well as if just one obstruction is 32 m in length.

If there is an unsurveyable obstruction within the site, such as a large log jam, passable waterfall or culvert, stop the survey at the obstruction and restart the survey upstream of it. Attempt to measure the length of the obstruction by using the tape. For culverts either walk through if large enough or if the culvert is small go to the upstream side of the culvert, tie the end of the bank tape around a small stick and attempt to float the tape through.

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. Determine if the obstruction is greater than four times the bankfull width category for the site. If yes, relocate the survey to exclude the obstruction. If not go to step 4.
4. Go to the upstream end of the obstruction and, at the first surveyable location, hang a flag labeled “START SURVEY.” Continue measuring up to the next transect location based on the distance from the last transect to the ‘STOP SURVEY” flag.
5. Take photos from Stop and Start survey locations (left bank, downstream, right bank, upstream) and log them into the OptPhotos form.

Table 2—List of unusual situations and appropriate actions.

Situation	Action
Culverts	
Less than 4 times Bankfull width category in length	If it **does not** interfere with data collection (a transect does not fall in the culvert) make a note in post stint form about culvert in reach. If it **does** interfere with data collection, perform a Stop and Start. (Refer to Stop and Start of Survey section.)
Greater than 4 times Bankfull width category in length	Relocate start of site to nearest location where the culvert will be out of the reach. Notify field coordinator prior to continuing survey, move to another site in meantime.
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. (I.e. if a major transect cannot be moved a reasonable distance to avoid the logjams effect on data collection.)
Greater than 4 times Bankfull width category in length	Relocate start of site to the nearest location where the log jam will be out of the reach
Impassible waterfall (for crew)	Refer to impassible barriers.
Passable waterfall (for crew)“WF”	If the waterfall prevents collection of data, Stop and Start. (Refer to Stop and Start of Survey section.)

Side Channels

The main channel has the most amount of flow if flow is similar select the channel with the widest bankfull width as the main channel.

Refer to Channel Morphology, Substrate and Large Wood sections for taking measurements in side channels.

All of the following criteria must be met for a side channel to qualify:

1. A side channel (wet or dry) is any channel separated directly from the main channel or another qualifying side channel by an island with an elevation above bankfull. Only side channels that begin and end within the site will be considered (fig 2; SC-D does not qualify).
    a. A side channel begins (and ends) at the location where it becomes separated from the main channel by an island with an elevation **above** bankfull (fig 2: see SC-E). SC-G is considered part of the main channel because the water is split by a gravel bar which is below bankfull.
    b. Channels that are separated from the main channel by islands lower than bankfull elevation are considered part of the main channel.
2. Only include side channels with a clearly identifiable inlet (head) and outlet (tail) adjacent to an island with an elevation above bankfull (fig 2; SC-A lacks a head). Identification of head or tail maybe unclear as the side channel may either been in process of being formed or disconnected to the main channel (or another side channel) as a result of annually varying stream flows as debris/log jams form or blowout and substrate is transported during high flows.
3. The bankfull width of the side channel must be ≥ 20% of the bankfull width category of the site (Table 3). Measure the bankfull width of the side channel at 25%, 50%, and 75% of the way up from the downstream end and enter these values into the Side Channels form on the tablet. The average will be calculated and the surveyor will have to compare that to the minimum required bankfull width based on the reach length.
4. Do not sample in tributaries. Bump transect either upstream or downstream.

How to layout side channels

1. Place a pink flag next to the orange transect flag in the main channel as well as one in the qualifying side channels and number the pink flags starting with S2 (fig 3; S1 is main channel).
    a. When placing flags in the side channel visualize the main channel transect continuing over the island to the near bank of the side channel.
    b. From the point the transect would intersect the bank of the side channel, orient the transect so that it is perpendicular to the bankfull constraints (fig. 4).
2. Flag the head and tail of each qualifying side channel with pink at the ends of the island with the channel number (S2, S3, etc.) and head or tail written on it.

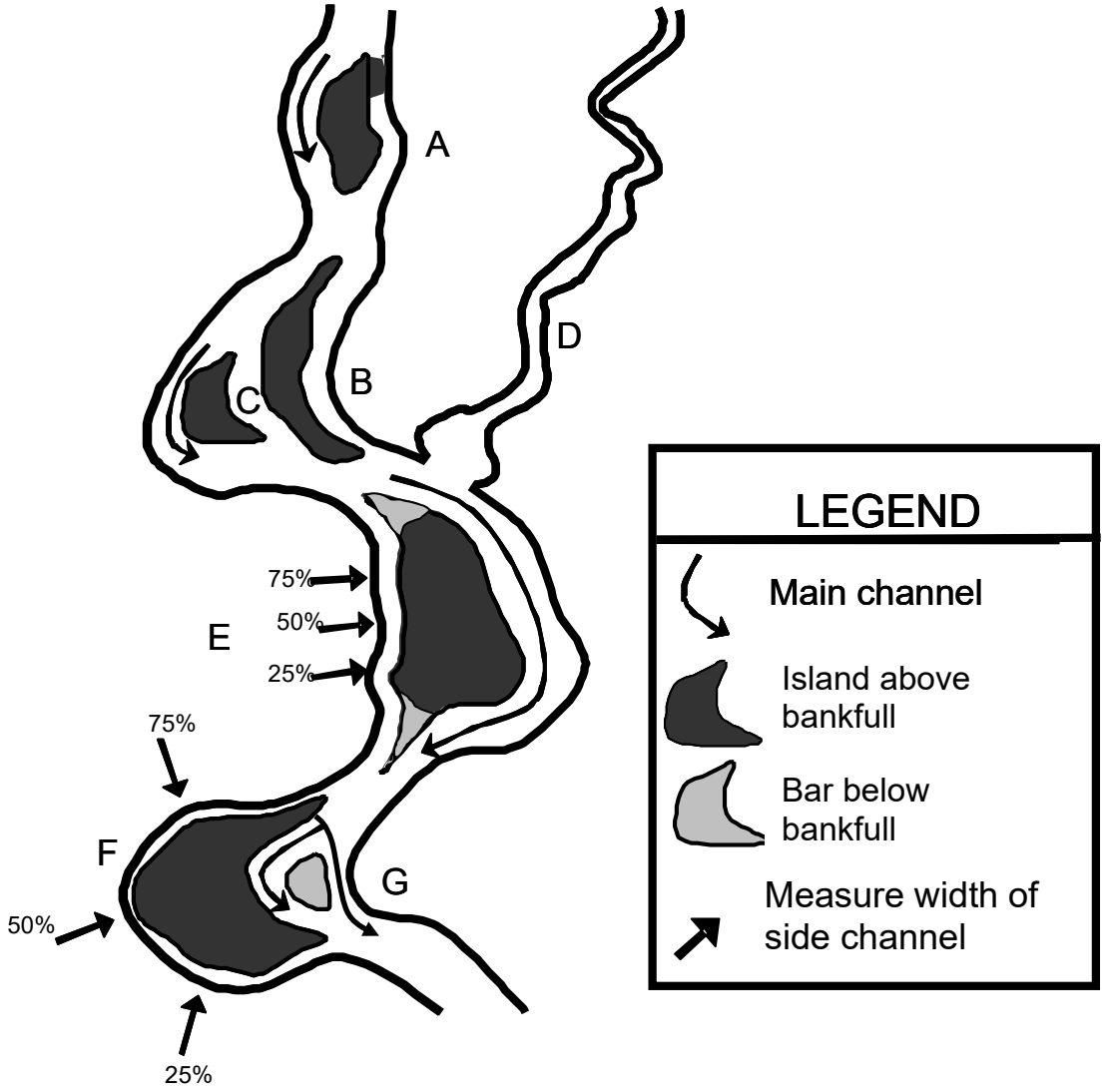


Figure 2— Examples of side channels. Channels B, C, and E are considered side channels (≥ 20% of the bankfull width category). Channel A is excluded, because it does not have a head (entry point) to the channel. Channels E and F depict where to take width measurements within potential channels (at 25%, 50%, and 75% of the way up from the downstream end of the portion of the island that is ≥ the bankfull elevation). Channel D is not included because it began outside of the site. Channel G is part of the main channel since the bar is below the bankfull elevation.

Table 3— Minimum bankfull width for qualifying side channels.

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

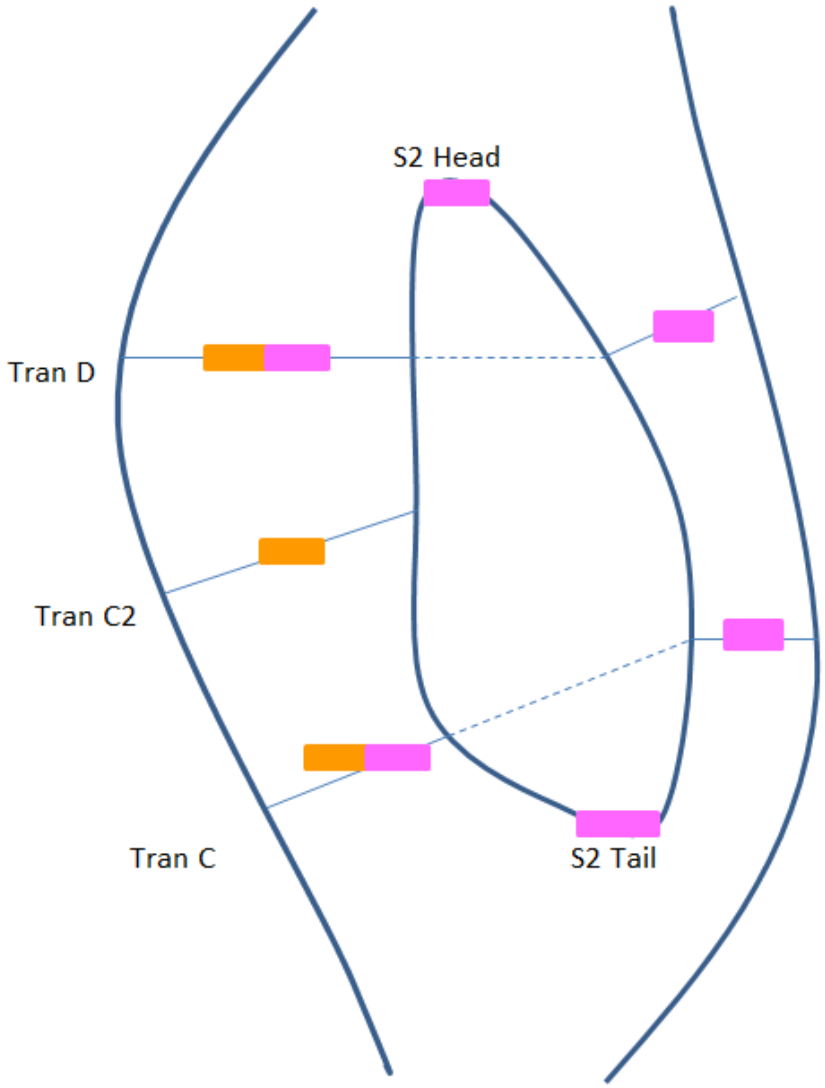


Figure 3— Placement of flags when side channels are present. Orange boxes represent where to place transect flags. Pink boxes represent where to place flags associated with the side channel. Note; no flags are placed in side channel for minor transects.

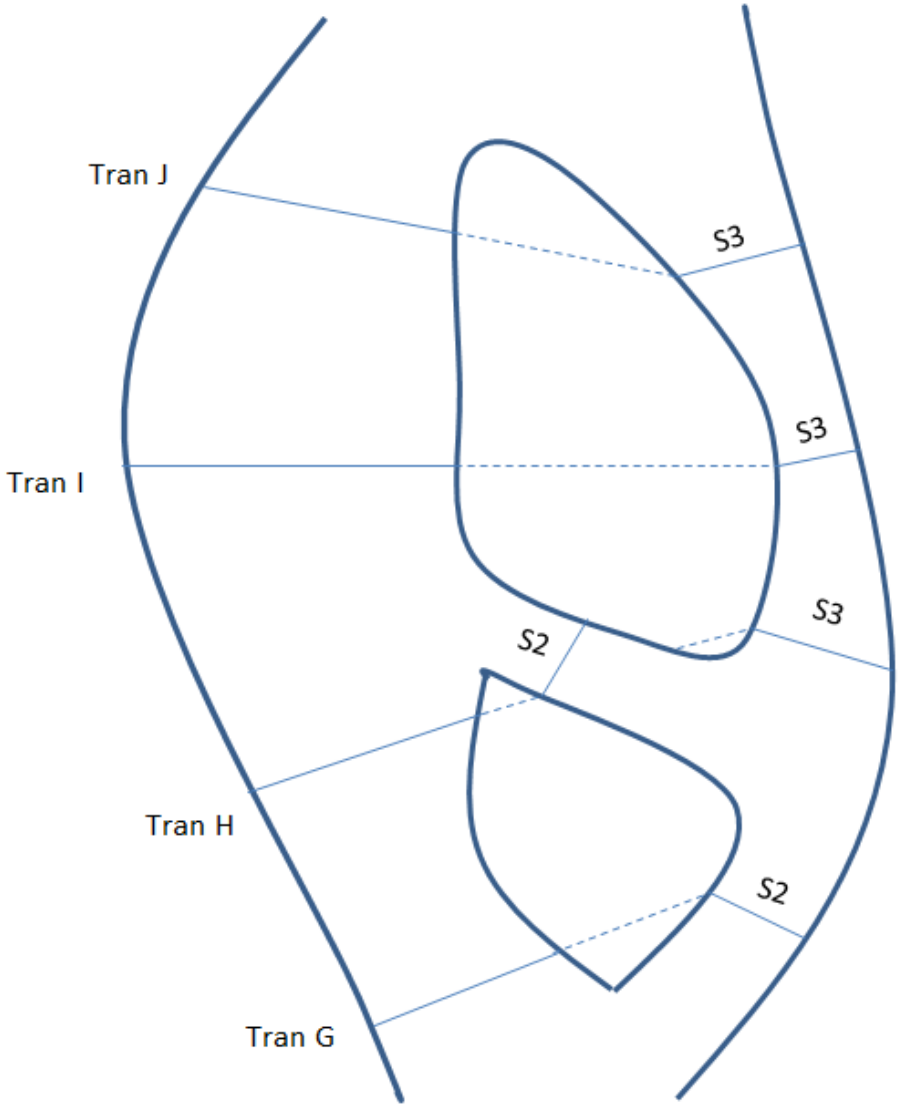


Figure 4— Transects are set up on side channels such that they are projected linearly across the island and turned perpendicular to the bankfull constraints of the side channel. Note; Tran H is projected linearly across the first island (S2) and the same linearity is carried across to the second island (S3). If the criteria for the minimum bankfull width is not met for S2 Flagging and minor transects on main channel were omitted to focus on linearity of placing transects in side channels.

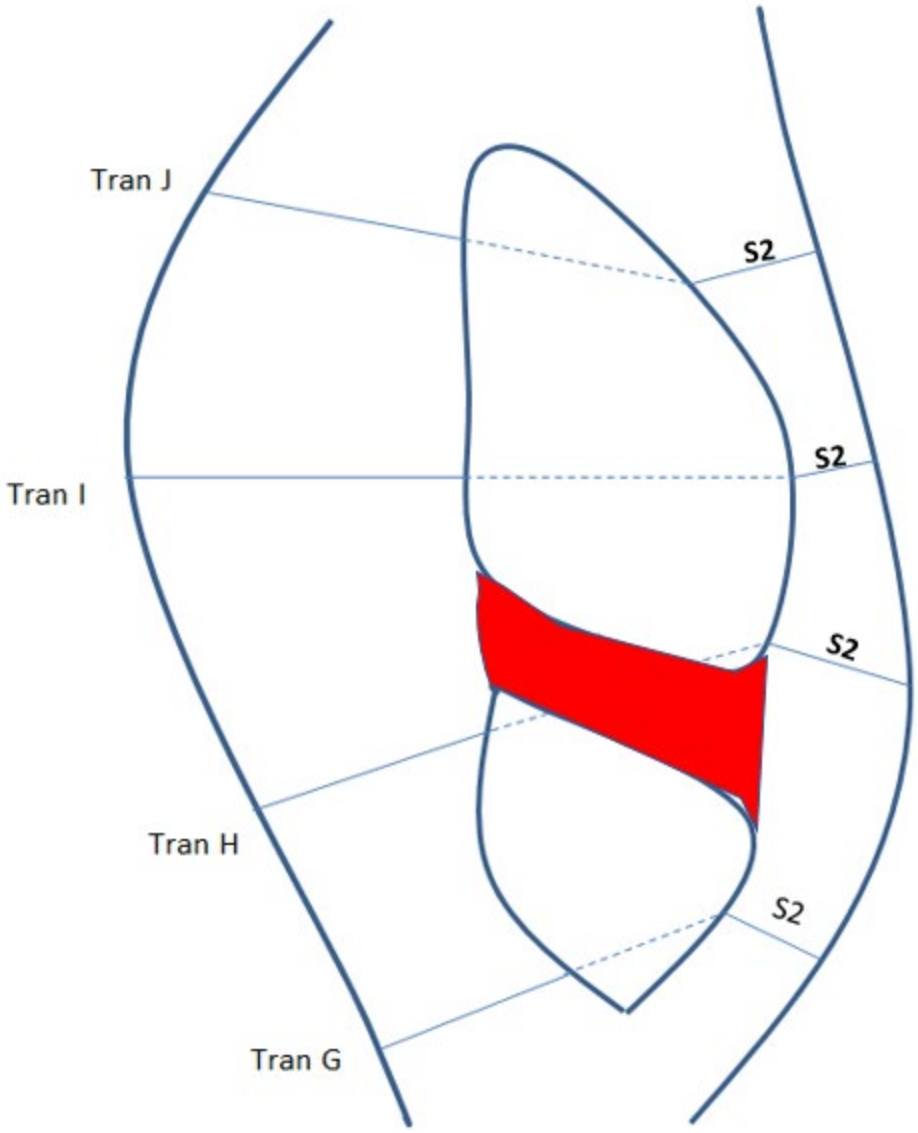


Figure 5— Scenario depicting if the minimum bankfull width for S2 from Figure 4 is too small (bankfull width of the side channel must be ≥ 20% of the bankfull width category of the site) resulting in new designation of S2 including S3 from Figure 4. The red area is omitted from any surveying or measurements.

Channel Morphology

Cross sections will be setup for each major transect. At each cross section, record bankfull and wetted widths along with depth measurements relative to bankfull. The depth measurements are relative to the bankfull line and are measured at left wetted, thalweg, right wetted and points calculated by the data form at 10%, 30%, 50%, 70%, and 90% from left bankfull (fig. 6).

If the main channel is **dry**, collect depth measurements at six points along the transect, including points estimated at 10%, 30%, 50%, 70%, and 90% from left bankfull and the deepest point in channel (where thalweg would be if water was present).

If the channel has braided into other mini channels separated by bars – record these as multiple wetted widths and depths on the data form.

For side channels, record the bankfull width whether wet or dry. The location of the depth measurements will depend on if the side channel is dry or wet. Collect depth measurements at left wetted and right wetted if the side channel is wet. If the side channel is dry, measure depths at 25% and 75% from left bankfull (fig. 7).

Cross Section Transects

- Cross sections are perpendicular to bankfull (not flow).
- Cross sections don't have to be in exactly in line with the transect flags, they can be moved up or downstream from the transect flag ½ of the width category. If the width category is 8m, the cross section can be moved up or downstream from the transect flag 4m.
- Find the most suitable location within this area, try to avoid:

Undercut banks	Brushy banks
Islands	Logs and log jams
Boulders	Uneven water surface
Bars	

Bankfull width

- Stretch a meter tape from the left bankfull elevation to the right bankfull elevation, ensuring that it is level and perpendicular to the bankfull channel. To test for levelness where the water surface is even on both banks measure the distance from the tape to the wetted, this distance should be no more than 5 cm different.
- When using bank pins make sure to account for the distance from the pin to the clip when stretching the tape.
- Record the width in meters (to the nearest cm, example; 1.05 m).

Depths

- With the meter tape secured with the bank pins, use the stadia rod to take depth measurements at (left bankfull and right bankfull should be zero since

that is where the tape is held at) left wetted edge, thalweg, right wetted edge; and five equally spaced points calculated by the excel form at 10%, 30%, 50%, 70%, and 90% from left bankfull. For each measurement record the height from the substrate to where the bank tape crosses the stadia rod (to the nearest cm).

Special Situation: if either the bankfull or wetted width is undercut (in locations where you can't bump the transect away from it) record the amount of undercut with the stadia rod, only record undercuts greater than 0.1 meters (note depths are recorded in cm while widths are recorded in meters).

Special Situation: If a large boulder or log is located on an increment point and the obstruction is <u>below</u> bankfull elevation, collect the point on top of the obstruction. If the obstruction is <u>above</u> the bankfull elevation, bump the increment point a little left or right to bypass the obstruction (50% might be more like 55% or 45%, that's okay).

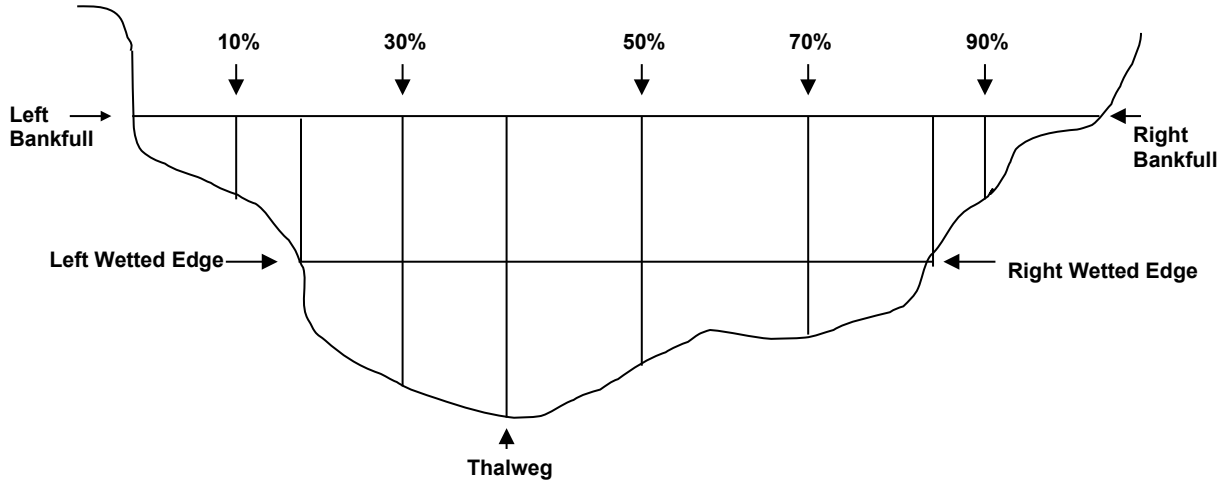


Figure 6— Example of the points measured at each major transect.

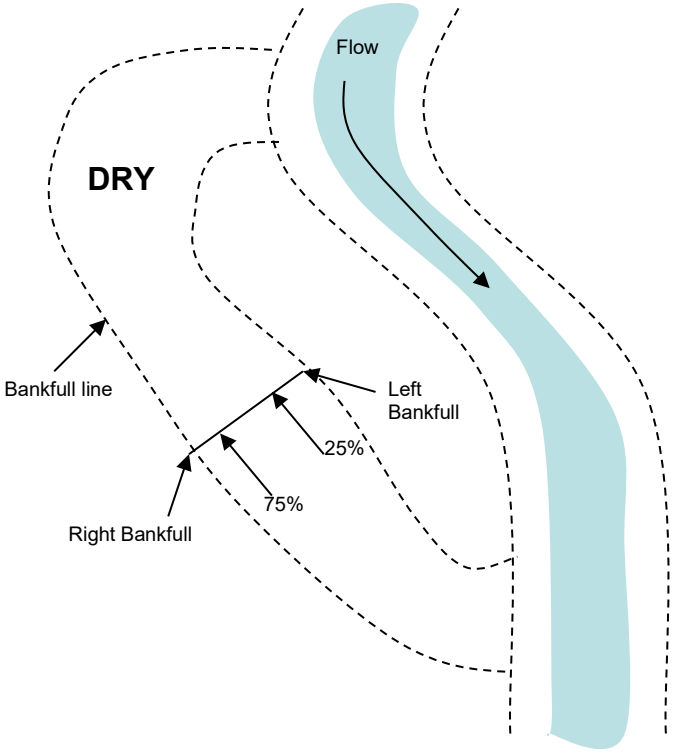


Figure 7—If the channel is **dry**, measure only the bankfull width and the depths at left bankfull, 25% and 75% of the bankfull width, and right bankfull.

Stream Gradient

The stream gradient is measured by the change in elevation measured between the left wetted at Transect A and the left wetted at Transect K (or their respective thalweg's if the reach is dry at either Transect A or K; fig 8) divided by the reach length. Since the reach length is already known, this section discusses how to measure the change in elevation between A and K.

The elevation change will be measured twice, once upstream (traveling from Transect A-K) and once downstream (traveling from Transect K-A). The second trial provides a means of comparing the relative precision of the first trial. If the difference in the elevation of the second trial is outside of the plus or minus 10% confidence interval for the first trial then a third trial is taken.

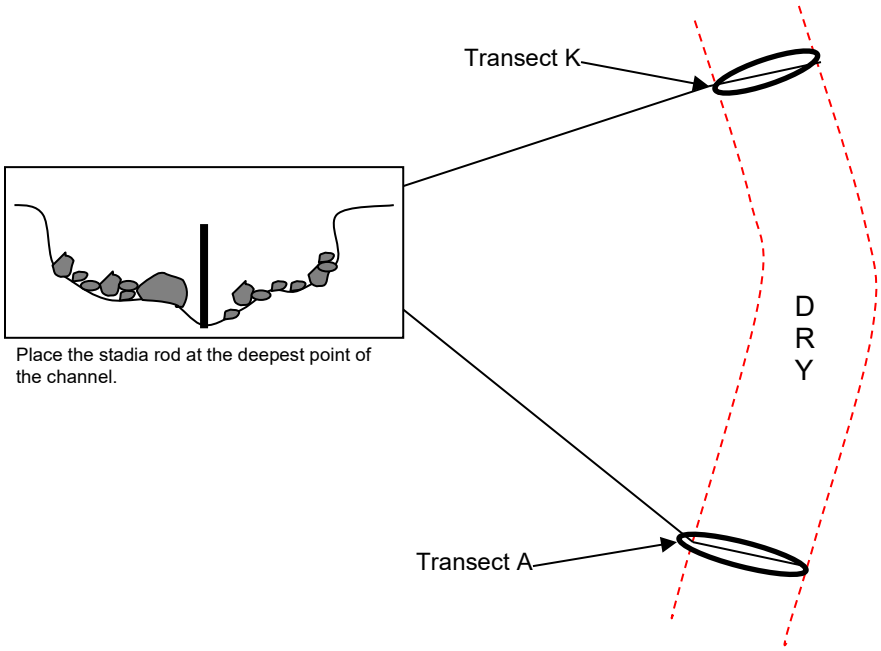


Figure 8— Example of where to place the stadia rod in the situation where the stream channel is dry at both Transect A and K.

Setting up the tripod and auto level

1. Determine a location to set up the auto level so that in addition to Transect A being within view, as much of the reach upstream is also visible to minimize the number of measurements taken. Each measurement introduces potential sources of error whereby the tripod or stadia rod may (accidentally) not be level.

- Sometimes vegetation removal is required but waving the rod around through vegetation can help see the rod through the level.
- Sighting across land can be easier than trying to move up the stream.
- It is ok to have a negative slope for a section as long as the total reach slope is positive.

2. Extend the tripod legs and firmly set into the ground. Adjust so the legs are in a regular triangle and are set so there is no wobble.

3. Place the auto level on the base plate and tighten the center screw. Just make sure it's snug, don't overtighten.

4. Begin adjusting the legs of the tripod until the bubble is approximately in the center of the level.

5. Adjust the foot or fine screws until the bubble is exactly in the center of the circle. Be careful with these screws as if they are too tight, they will break. Be EXTREMELY careful around the tripod as to keep it from falling over.

6. Gently swivel the instrument to make sure it is level in all planes.

Note: If the bubble moves out of center when the instrument is swiveled, the vial needs adjustment. To adjust the vial turn the fine screws to bring the bubble halfway to center. Using the Allen wrench, turn the two vial adjustment screws to center the bubble. Repeat this procedure until the bubble remains centered when the level is rotated 180 degrees.

Taking measurements

1. Position the stadia rod at Transect A, holding the bottom of the rod at left wet (or thalweg if dry) as vertical as possible with the numbers facing the auto level. To ensure the correct height is recorded the stadia rod should be slowly rocked forward and backward, recording the minimum rod reading (fig. 9). The true reading occurs at the minimum value when the rod is plumb (level).

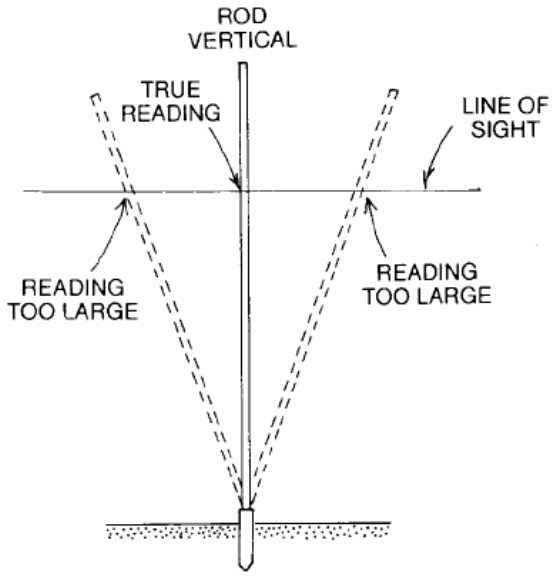


Figure 9—Diagram depicting how swaying the stadia rod back and forth captures the height of the stadia rod when level

2. Sight the stadia rod through the auto level and record the reading to the nearest 1 cm (fig. 10).

a. Stadia rods are 5 m in length and alternate between black and red 1 m sections.

b. Each 1 m section is broken up into 10 cm increments designated by a large number on the right side and a line that stretches all the way across the stadia rod.

c. Each 10 cm section is divided in half with “E” symbols that are 5 cm in length.

d. The top or bottom of each block or line in the “E” is 1 cm.

e. For the image below (fig. 10) the final measurement would be recorded as 142 cm.

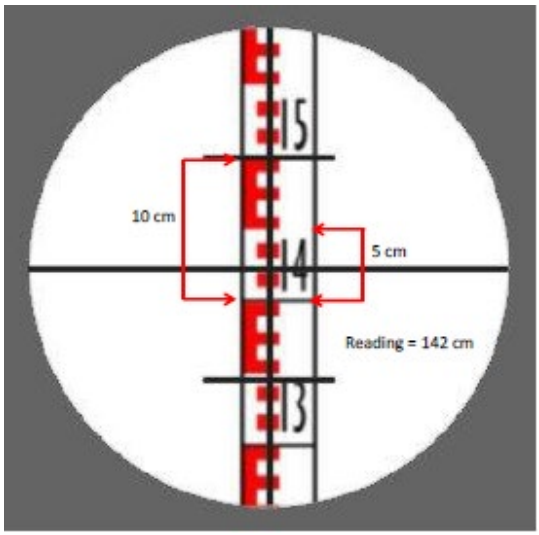


Figure 10—Stadia rods are broken up into 10 cm sections, denoted by the large number on the right. Each 10 cm section has a large "E" that is 5 cm long. Each meter section is broken up by alternating red and black section colors.

3. Move the stadia rod to the farthest location upstream that can still be seen from the location of the level, the rod does not need to be at left wet again until Transect K. Gently swivel the instrument (being careful to make sure the bubble stays inside the center of the level) to face the next reading.

4. Hold the stadia rod as before, vertically, swaying back and forth to get the level reading of the rod with the numbers facing the auto level.

5. Sight the stadia rod and record the reading to the nearest 1 cm.

6. Keep the stadia rod in the exact position as the reading before (this serves as a reference point connecting the next line of shots).

7. Move the auto level to a new position where the stadia rod can be seen as well as a new portion of the reach. Set up as before making sure the equipment is level.

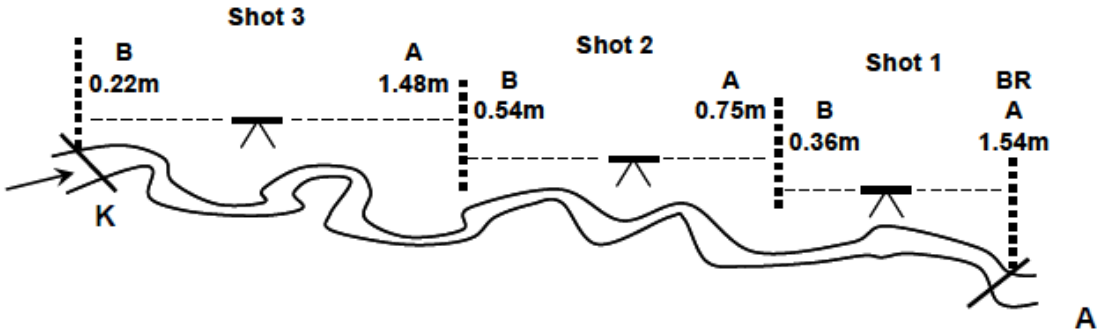
8. Back sight to the stadia rod and record the reading to the nearest 1 cm, start the new line of measurements from that point.

9. Repeat steps 3-8 until the stadia rod is sighted at Transect K, hold the stadia rod at left wet.

10. Repeat steps 1-9 via a second pass from Transect K to A to get a second total change in slope.

11. The data form calculates the % difference between the two readings. If it is greater than 10%, conduct a third pass (fig. 11).

Special Situation: If a large vertical waterfall is encountered within a site that is too steep to use the level and stadia rod the bank tape will have to be used for this section of the reach (Appendix A).



Measuring stream gradient: starting from Transect A, shooting upstream

A → K

	Shot 1			Shot 2			Shot 3			Shot 4			Shot 5			Sum of Dif (Dif 1+Dif 2...)
	A	Dif 1 A - B	B	A	Dif 2 A - B	B	A	Dif 3 A - B	B	A	Dif 4 A - B	B	A	Dif 5 A - B	B	
Elevation 1	1.54	1.18	0.36	0.75	0.21	0.54	1.48	1.26	0.22							2.65
Elevation 2	1.77	1.10	0.67	0.63	0.33	0.30	1.56	1.20	0.36							2.63
Elevation 3																

Measuring stream gradient: starting from Transect K, shooting downstream

K → A

	Shot 1			Shot 2			Shot 3			Shot 4			Shot 5			Sum of Dif (Dif 1+Dif 2...)
	A	Dif 1 B - A	B	A	Dif 2 B - A	B	A	Dif 3 B - A	B	A	Dif 4 B - A	B	A	Dif 5 B - A	B	
Elevation 1	0.29	1.13	1.42	0.48	0.16	0.64	0.41	1.08	1.49							2.37
Elevation 2																
Elevation 3																

Are measurements within 10%?

		lower limit	upper limit
Elevation	2.65 * 0.9 =	2.39	* 1.1 = 2.92
Elevation	* 0.9 =		* 1.1 =
Elevation	* 0.9 =		* 1.1 =

Figure 11—Calculating stream gradient using three trials. When the first two measurements are not within ±10% threshold (The 2nd trial of 2.37 is not between 2.39 and 2.92, the confidence bounds of the 1st trial), calculate elevation change a third time (2.63).

Pools

Objectives:

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

Pool Criteria:

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

1. Pools are depressions in the streambed that are concave in profile, laterally and longitudinally (think of a spoon).
2. Pools are bounded by a head crest (upstream break in streambed slope) and a tail crest (fig. 12).
3. Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
4. Pools span at least 50% of the wetted channel width at any one location within the pool. For example, a pool that spans 50% of the wetted channel width at one point, but spans <50% elsewhere is a qualifying pool. This is done as an ocular estimate.
5. Pool length, measured along the thalweg from the head to the pool tail crest, is greater than its width. Pool width is measured perpendicular to the thalweg at the **widest wetted point of the channel**.
6. Maximum pool depth is at least 1.5 times the maximum depth of the pool tail crest.

Determine if the pool is 'full' or 'partial' (fig. 13).

- Full-channel pool – Concave shape of the pool (measured perpendicular to the thalweg) at any location is >90% of the wetted channel width.
- Partial-channel pool – Concave shape of the pool (measured perpendicular to the thalweg) at any location is between 50 and 90% of the wetted channel width.

Classify pool formation type as scour, dammed, plunge or beaver.

- Scour – formed by flow that creates a depression in the stream channel.
- Dammed – formed by the impoundment of water upstream of a channel blockage (debris jams, landslides, large wood).
- Plunge –formed by a vertical fall of water flowing over an obstruction in the stream channel such as wood, boulders or bedrock. For a plunge pool to count the maximum depth must be within 20% or less of the pool's length. Example: if the plunge pool is 10m long, then the max depth must be 2m or less from the pool head.
- Beaver – formed by a beaver dam that slows water flow and backs up the water (see Appendix B).

Special Situations:

Measure all qualifying pools that have water (even a trickle) flowing into and out of them. Don't measure stagnant pools.

Don't measure pools in side channels

In addition to the wetted width of the channel with the pool if there are other wetted channels adjacent to the pool that are separated by a bar, they need to be taken into account when determining whether the pool spans at least 50% of the wetted channel(s). For example, an ocular estimate of the channel where the pool has the most concavity has a wetted width of 8m, a gravel bar adjacent to the pool creates another wetted channel that is estimated at 2m wide (measure the width of the second channel in a straight line across from the main channel). With an estimate of 10m of wetted width, does the concavity of the pool span at least 50% (5m) of the total 10m of wetted width? If it does, this piece of the criteria for an AREMP pool is satisfied, if there isn't at least 5m of concavity then it's not a pool.

When considering whether to lump or split two potential pools, consider them two pools if the upstream pool has a pool tail that is ≤10cm deeper than the downstream pool tail. Conversely, consider it one pool if the upstream pool tail depth is >10cm deeper than the downstream pool tail depth (fig. 14).

Taking measurements

For each pool measure the pool's length (m), the depth of the pool tail crest (cm) and the maximum depth (cm).

1. For each pool select the longitude where the tail is found. If a pool starts before Transect A or ends outside of Transect K, collect all the pool measurements (tail, max depth, and head) regardless of whether they fall outside of the reach use longitude AA to denote features starting below the reach. Identify whether the pool is a "Full" or "Partial" and the pool type (Scour, Plunge, Dam or Beaver).

2. Measure the water depth of the pool tail crest by placing the stadia rod at the deepest point along the pool tail crest.
    a. Measure the pool tail crest depth on dammed pools along the top of the obstruction (usually large wood) if all flow is going over the obstruction. Conversely, measure to the streambed if some of the water is observed flowing under/through the obstruction.

3. Measure the maximum water depth in the pool with the stadia rod.

4. Measure the length of the pool by holding the bank tape near the water surface at the head of the pool and hold the other end at the pool tail crest, be careful to follow the thalweg. If a sharp bend is encountered, account for this by taking

multiple measurements to capture the pool length. If the pool is a plunge pool, hold the bank tape at the head crest where the plunge or cascading fall of the water hits the water's surface. If the pool "undercuts" the cascade of falling water, stretch the tape behind the cascade to include this portion in the length of the pool.

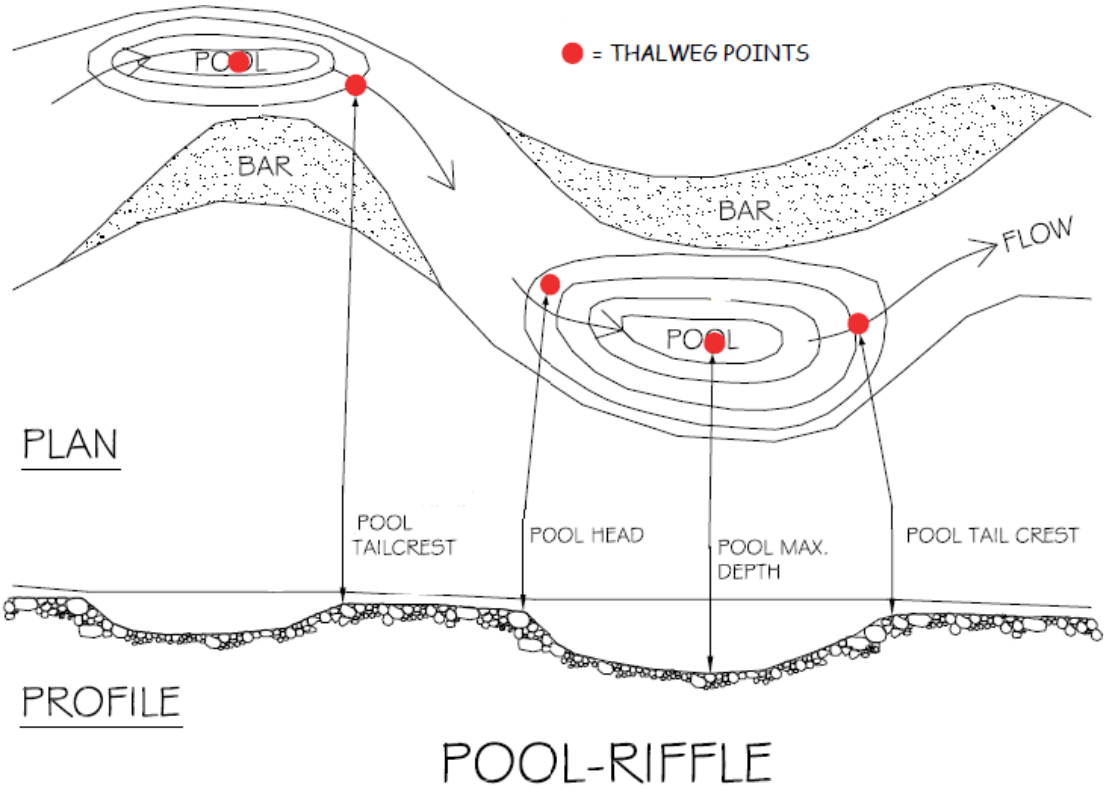


Figure 12— Diagram of pool features in a pool-riffle system including thalweg, pool head, maximum pool depth and pool tail crest.

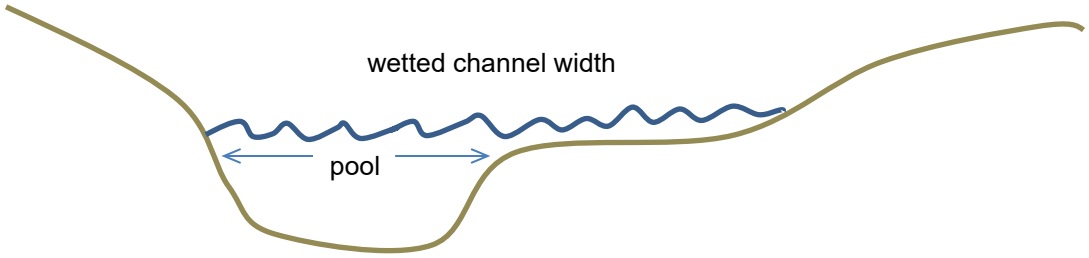


Figure 13—Pool width relative to wetted channel width. The widest point of the pool feature above is approximately 40% of the wetted channel width. Therefore this pool feature would be disqualified as an AREMP pool.

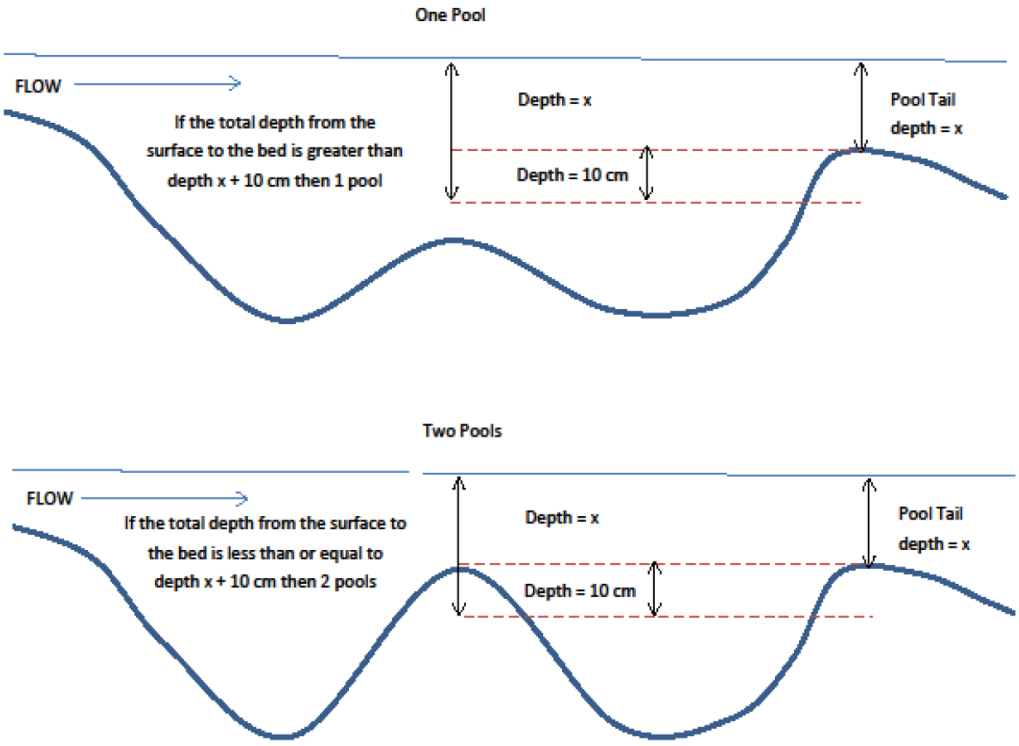


Figure 14— Example of lumping and splitting pools.

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 substrate for cover. The procedure requires taking measurements of substrate at increments along the main channel and side channels transects within bankfull constraints.

DO NOT PICK UP THREE PIECES OF SUBSTRATE AT ONCE.

Pebble Counts

1. Substrate will be measured at 20 transect locations (Transects A2 – K; major and intermediate transects) which may extend into adjacent qualifying side channels.
2. Transects shall be divided into five increment points visually estimated at 10%, 30%, 50%, 70% and 90% within the bankfull width starting at left bank. At each increment point three substrate samples will be collected for a total of 15 substrate samples at each transect.
3. When side channels are present at a transect, split the five increment points between the main and side channels in proportion to their bankfull widths and adjust the measurement increments accordingly. The main channel should always have the most samples. For example, if the main channel has a 10-meter bankfull width and the adjacent side channel has a 5-meter bankfull width, estimate three increment points at 25%, 50% and 75% of the main channel bankfull width and then two increment points at 25% and 75% of the side-channel bankfull width.
4. Without looking directly at the substrate of your increment location, step forward bringing your meter stick LIGHTLY (don't drop meter stick down so that it bounces off of the substrate) down to touch the substrate. Reach down to the tip of the meter stick and pick up the FIRST substrate that you touch with the tip of your finger. DO NOT LOOK while you are selecting the substrate.
5. Measure two more pieces of substrate at the same increment location, repeat step 4 and do not record the same piece of substrate multiple times. If the same piece of substrate is encountered, select another piece either from upstream or downstream (downstream when at Transect K).
6. Measure the substrate along the intermediate axis with a ruler (mm). The intermediate axis is the median side (B axis) of the rock (fig. 15); it is not the longest side (length-wise) or the shortest side (depth) of the rock. Visualize the B axis as the smallest width of a hole that the substrate could pass through.
7. If the substrate has a smooth dirt feel and is not gritty, record it as silt. If it is gritty and is < 2 mm, record it as sand. Anything 2 mm and greater should be measured and recorded. If you are unable to access the substrate due to a large piece of wood, enter wood on the Substrate data form. Only use the code if you are unable to get under the log. *Do not call it "wood" if it is a piece of bark or a twig.*

8. For large boulders, you may have to use a field tape or flip the ruler end-over-end several times to get a measurement. Any measurements over 4096 mm record as Bedrock.
9. If rocks are embedded, you may have to feel for the intermediate axis with your hand and use your fingers as calipers. If you can't find the intermediate axis select another piece of substrate by repeating step 4.
10. All pieces are considered wet unless the pieces measured near bankfull (usually 10% and 90%) are completely dry
11. If it is not possible to measure the substrate, perhaps because of a deep pool. Take all the measurements for that transect either upstream or downstream (don't move flag) to the closest surveyable location that is not on another transect. If a deep pool exists at Transect K, move downstream to collect measurements, do not go above Transect K.

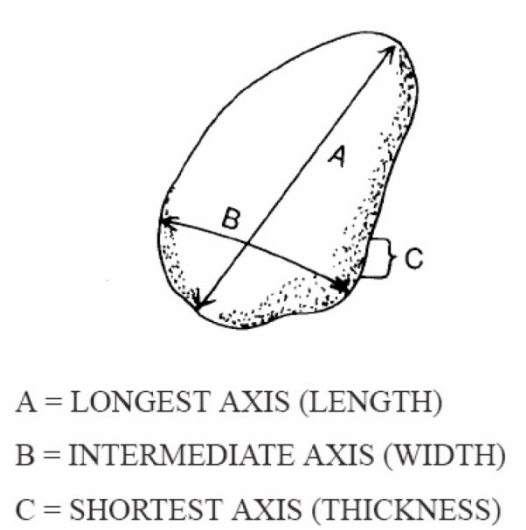


Figure 15—Axes of a pebble. The "B" of intermediate axis is measured for pebble counts (from Harrelson et al 1994).

Percent Surface Fines on Pool Tails

Objective:

- Quantify the percentage of fine sediments in the interstitial spaces of pool tail substrate for plunge and scour pools only.

Where to take measurements:

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

Sampling method:

1. Assess surface fines using a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid and there are a total of 50 intersections.
2. For each pool record whether the pool is a Plunge or Scour Pool and Partial or a Full Pool.
3. Take **three** measurements per pool.
    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, fig. 16)
    b. Place the center of the grid at 25, 50, and 75% of the distance across the wetted channel, making sure the grid is parallel to and following the shape of the pool-tail crest.
    c. If a portion of the fines grid lands on substrate 512mm (size of the grid) or larger in size, on the b-axis, record the intersections affected as non-measurable intersections (fig. 16).
    d. In narrow streams, it is OK if grid placements overlap. If the stream is so small that part of the grid is on dry ground, count these as non-measurable.
4. Record the number of intersections that are underlain with fine sediment < 2 mm in diameter at the b-axis. The width of the cord that makes up the grid is 2 mm.
5. 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.

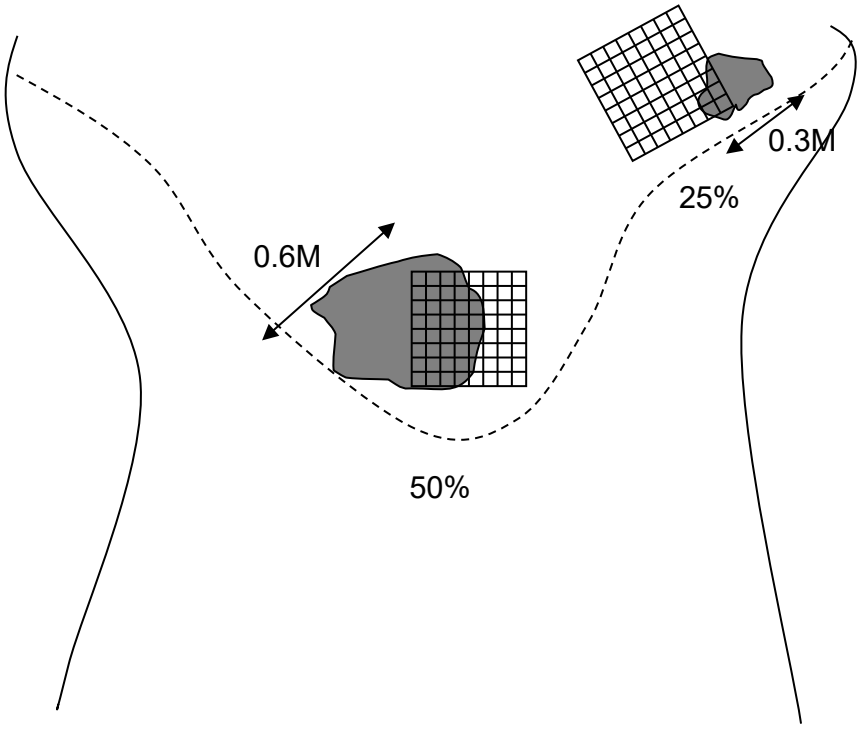


Figure 16—All intersections of the fines grid at the 25% placement will be counted and recorded. For the 50% placement, the intersections of the fines grid that land on the boulder will be recorded as non-measurable.

Large Wood

Objective:

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

DO NOT TELL ESTIMATOR WHEN THEY HAVE A MEASURE COMING UP

Sampling method:

1. In order to be counted, each piece must meet ALL of the following criteria.
    a. Each piece must be greater than 3 meter in length and at least 15 cm in diameter one-third of the way up from the base, or largest end.
    b. Only include standing trees that lean within the bankfull channel if they are dead. Dead trees are defined as being devoid of needles or leaves, or where ALL of the needles and leaves have turned brown. Consider it living if the leaves or needles are green (fig. 17).
    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. Include the nurse log as it is dead.
    c. Wood that is embedded within the stream bank is counted if the exposed portion meets the length and width requirements (fig. 18).
    d. Do not count a piece if only the roots (but not the stem/main trunk) extend within the bankfull channel (fig. 19).
    e. Some pieces crack or break when they fall. Include the entire length when the two pieces are still touching at any point along the break (Only count as one piece if they are from the same original piece of wood). Treat them separately if they are no longer touching along the break. Count only the portion within the bankfull channel when they are no longer touching (fig. 20).
    f. Only include pieces that begin in the site, if a piece goes below Transect A it does not count. A piece does count if it starts in JK and goes above K.
    g. When a piece has multiple boles (trunks), measure the bole with the largest diameter and/or length when estimating/measuring.
2. Record the piece number, estimated length (nearest 10 cm), and estimated width (nearest cm) for the first 10 pieces in the site. The same person will make all estimates for a given site. Be consistent with your estimation method as much as possible to minimize variance in your correction factor.
    a. Record your method of estimation on the data form as either walked or visual to indicate how you estimated the length of the piece.
    b. For estimating the diameter, stick with the same method in a site – if you are going to use your hand as a proxy for 15 cm and place your hand directly on the tree or stick used to measure diameter do this for **every** tree in the site.
3. A subset of pieces will be measured at sites with more than 10 qualifying pieces of wood.

   a. At all sites the first 10 pieces of wood encountered will be measured. Starting at piece number 11, measure every 5th piece of wood up to and including the 35th piece of wood. All subsequent pieces of wood will be measured every 10th piece (starting with number 45).
4. If the piece of wood designated for measurement cannot be measured safely, record as a hazard on data form; then measure the next piece of qualifying wood.
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 where the roots are still connected.
6. Identify whether the piece is a single piece or is touching at least one other qualifying piece. Those qualifying pieces that are touching **within** bankfull are part of a complex. The main boles (trunks) not branches need to be touching to count as a complex. Complexes will be individually numbered for a reach.
7. Identify the wood type; see Table 4 for descriptions of wood types.
8. Record whether the piece was **found in or overhanging** a pool, riffle or pool/riffle. **Pool must meet AREMP pool criteria**. Select outside active if the piece is either on or overhanging a dry part of the channel . In a dry site all pieces will be outside of active channel. Select dry channel in comments to indicate this.

If you do not encounter any wood on a longitude, check the box on the data form indicating there is no wood in that longitude.

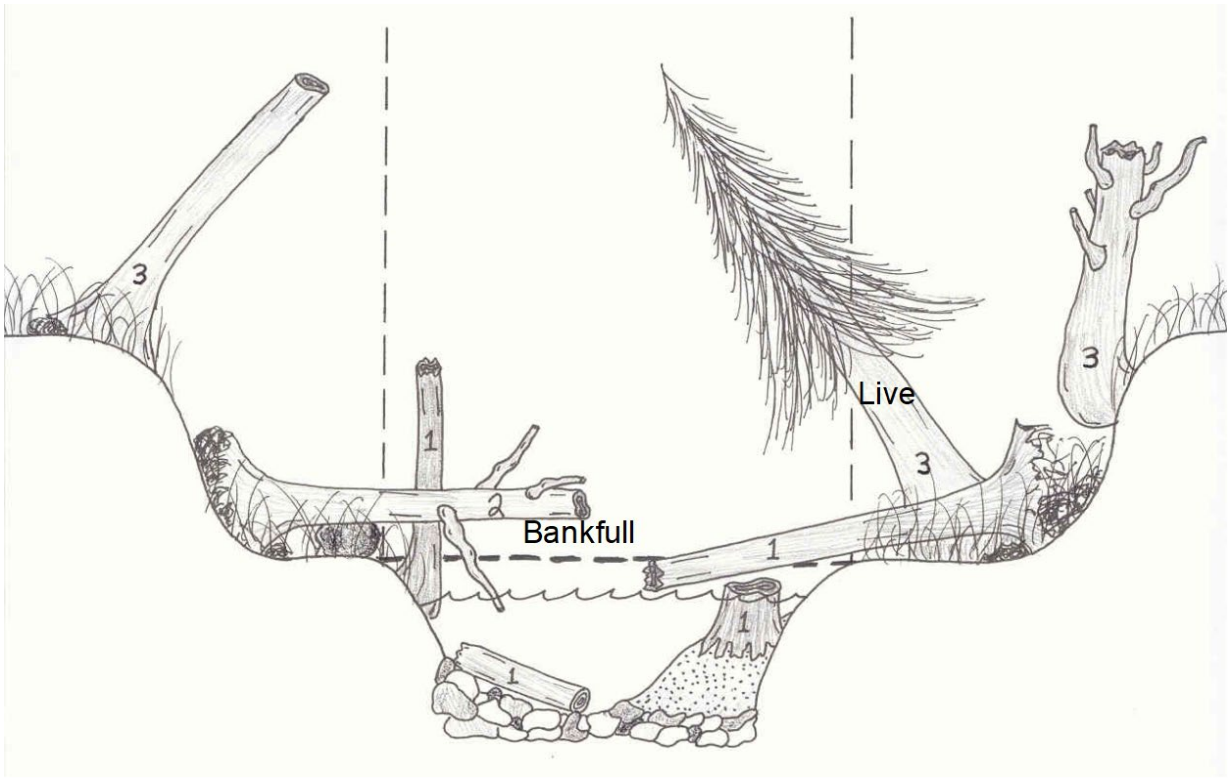


Figure 17— Illustration of large woody debris. Pieces numbered 1 and 2 would be included in the survey, while pieces numbered 3 would not be counted.

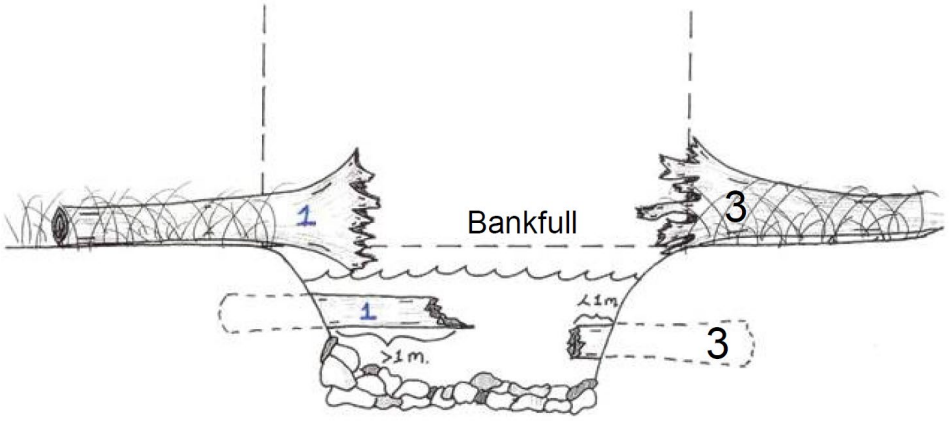


Figure 18— Examples of qualifying large woody debris (1). The pieces on the right side (3) are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is < 3 m in length (lower).

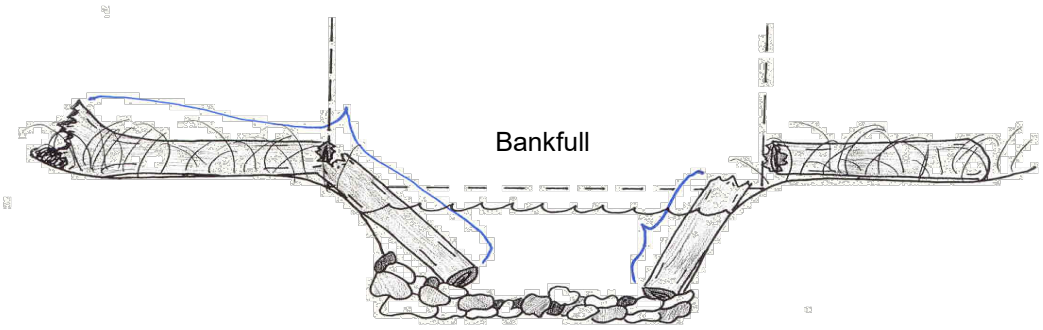


Figure 19— Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

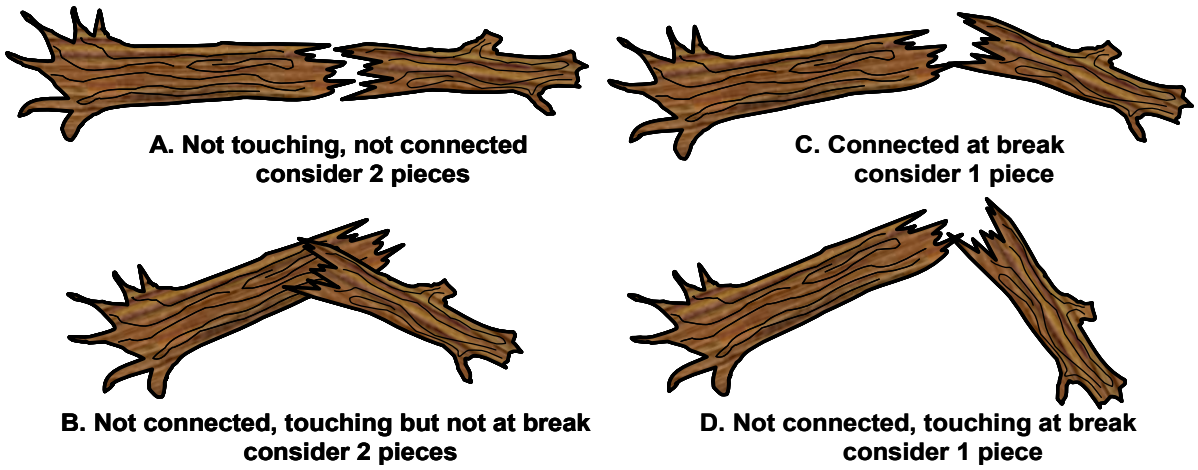


Figure 20— Variations of touching vs. not touching along the break.

Table 4— Codes used with the wood data form.

Code Type		Definition
# Pieces Touching		
S	→	**S**ingle piece
C	→	**C**omplex (> 1 piece)
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

Biological Sampling

Benthic Macroinvertebrates

Sampling method:

1. Determine net placement within each habitat unit by reading the 2 pairs of random numbers on the Headings form on the tablet. The first number in each pair represents the percent upstream along the habitat unit's length. The second number in each pair represents the percent of the stream's width from river left looking downstream. Each sample will be obtained from the location where the length and width distances intersect (estimate by eye).
2. Collect samples using a 500 μm mesh net D net from fast water habitats. Take invertebrate samples from the first four fast-water (e.g. riffles, runs) habitat units. Take two separate 0.09 m^2 fixed-area kick net samples from each unit for a total of eight samples.
3. Place the kick net so the mouth of the net is perpendicular to and facing into the flow of water. Collect invertebrates from within the 0.09 m^2 sampling frame in front of the net. Work from the upstream edge of the sampling plot backward and carefully pick up and rub stones directly in front of the net to remove attached organisms. Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations. After removing all large stones, disturb small substrates (i.e. sand or gravel) to a depth of about 10 cm by raking and stirring with your hands. Continue this process until you can see no additional organisms or organic matter being washed into the net. After completing the sample, hold the net vertically (cup down!) and rinse material into the bottom of the cup. Move to the next sample location and repeat the above procedure to create a composite sample.

Field processing method:

1. Field processing requires a squirt bottle, white plastic washtub and a 500 μm sieve.
2. Make sure you thoroughly wash organisms clinging to the sides of the net by vigorously splashing water down the net and into the cup. Then transfer the contents of the cup into the washtub using the squirt bottle to ensure the cup is completely empty.
3. Wash off any sticks and small rocks with the squirt bottle into washtub. Add water to the tub and decant invertebrates and organic matter from the sample by stirring the contents of the bucket and then pouring suspended material through the 500-μm sieve. Repeat this process until no additional material can be decanted.
4. Transfer the material in the sieve (invertebrates and organic matter) into the 2-liter sample jar by washing material from the sieve into the jar with a squirt bottle. Inspect the gravel on the bottom of the tub for any cased caddis flies or other organisms that might remain. Remove any remaining organisms by hand and place in the sample jar, fill jar with water so contents are submerged.

5. Examine the contents for non-native snails, mussels, or crayfish.
6. Remove and release from the washtub/sample jar all vertebrates, including fish and amphibians.
7. Store any Megaloptera in a separate container as they will prey upon other macroinvertebrates in the sample.
8. At camp, fill the jars with 95% ETOH. Place labels provided on the outside of the jar. Preserve this composite sample in one or more sample jars depending on the amount of material collected. If there are multiple jars, label them as 1 of 2 and 2 of 2, etc. and then tape them together.

Special situations:
Collect macroinvertebrates in sites with beaver dams, see 'Appendix B: Sampling Sites with Beaver Activity' (simply stated we want bugs collected DS from dams).

Collect bugs in sites with partial flow. The rule is, if there is enough water in any part of the reach to move bugs into the net, collect them in those areas. If no fast-water habitats occur, take the samples from shallow, slow-water habitat units.

Invasive Species

Invasive species can have a multitude of effects on native flora and fauna. The presence of invasive species can indicate degraded watershed condition. All sites will be examined for the presence of any invasive species listed in Table 5. Incidental occurrences of any invasive plants or animals should be recorded.

Aquatic Plants

Sampling methods

1. During site layout, examine the wetted portion of the channel for any potential invasive plants. Be sure to cover the entire site, and thoroughly examine any off-channel wetted areas as well.
2. If an invasive plant is encountered, take photographs and collect specimens. Label with watershed code, site number, date, species code, and personnel code. Try to keep specimens in a cool dark place to avoid rapid decomposition.
3. Record the longitude segment, the species, the jpeg number of any photographs taken, and whether or not a sample was taken of any invasive plants found.

Aquatic Animals

Sampling methods

1. During site layout, examine the wetted portion of the channel for any potential invasive animals. Be sure to cover the entire site, and thoroughly examine any off-channel wetted areas as well.
2. After obtaining eight benthic macroinvertebrate samples in the first four fast-water riffles of the survey (as described in the Benthic Macroinvertebrates section above), empty the contents of the sample collection net into a large washtub or bucket.
3. Examine the contents of the sample for the presence of any invasive snails, mussels, or crayfish listed in Table 5 and pictured in the reference material.
4. If an invasive crayfish, snails or mussels are found in the sample, take photographs and record the species code and jpeg. Preserve the specimen using 95% ETOH as described in the Benthic Macroinvertebrate section of this protocol. Label the jar with watershed code, site number, species, date, and personnel code.
5. If invasive species are found, collect more samples at various locations in the site until more of the invasive specimens are found.
6. Place the extra specimens into a separate jar, preserve them with 95% EtOH, and label the jar with watershed code, site number, species, date, and personnel code.

Terrestrial Plants

Sampling method

1. Terrestrial plant surveys will be performed in longitudes A-B, F-G, J-K.
2. Left and right bank on each side of the site will be examined for five minutes.
3. Crew members should start at the bankfull indicator of the upper transect (B, G, K) on opposite banks, and thoroughly examine the area downstream to the next transect that is no more than five meters in width from the bankfull indicator line. If you reach the next major transect before the five minute search time elapses, you may continue downstream, but do not pass the next major transect where a plant survey will be performed.
4. If multiple channels occur at the search location (i.e., side channels), conduct the search on the outermost left and right banks. Do not conduct searches on islands or mid-channel gravel bars.
5. Work in a zigzag pattern for five minutes, examining the riparian vegetation for any non-native plants as indicated in the species list (Table 5) and the reference material.
6. When an invasive plant is encountered, pause the stopwatch and document the plant. Record the longitude segment, species, bank the plant was found on (L or R), and the jpeg numbers. Document the location of the invasive plant in the data form.
7. Re-start the stopwatch and continue the survey until five minutes have elapsed.
8. At the end of the five minutes, record the longitude, the time, and the estimated length and width of the area searched on each bank during the survey.
9. If a suspected invasive plant species is encountered, take photographs and collect specimens. Label with watershed code, site number, date, species code, and personnel code. Try to keep specimens in a cool dark place to avoid rapid decomposition.

Terrestrial Animals

Sampling method

1. During the terrestrial plant survey and large wood surveys, crew members should examine the riparian area for any sign of feral swine.
2. Take photographs of any tracks, feces, or disturbed areas that would indicate the presence of feral swine. The most consistent indication of feral swine presence in the area are large dig outs, or disturbed areas that look like areas heavily grazed by cattle but are lacking other signs of domesticated livestock in the area.
3. Record the species, location, and jpeg numbers documenting the presence of feral swine.
4. Do not collect any samples of feral swine or feces (feral swine carry diseases that can infect humans).

Incidental Invasives

If any plants or animals listed in Table 5 are found during other protocol surveys or while traveling to and from sites, be sure to document their presence on the Incidental Invasives data form. **Take photographs** of any specimens found.

Table 5—Invasive species of concern

Type	Common name	Genus species	Species Code
Aquatic animals	New Zealand mudsnails	*Potamopyrgus antipodarum*	POAN
	Zebra mussels	*Dreissena polymorpha*	DRPO
	Quagga mussels	*Dreissena rostriformis bugensis*	DRRO
	Rusty Crayfish	*Orconectes rusticus*	ORRU
	Red Swamp Crayfish	*Procambarus clarkii*	PRCL
	Ringed Crayfish	*Orconectes neglectus*	ORNE
	Bullfrog	*Rana catesbeiana*	RACO
	Northern Crayfish	*Orconectes virilis*	ORVI
	Nutria	*Myocaster coypus*	MYCO
	Asian Clam	*Corbicula flumina*	COFL
	Chinese mystery snail	*Cipangopaludina chinensis*	CICH
	Big Eared Radix	*Radix auricularia*	RAAU
Aquatic plants	Yellow Flag Iris	*Iris pseudacorus*	IRPS
	Hydrilla	*Hydrilla verticillata*	HYVE
	Nonnative Milfoils	*Myriophyllum species*	MYSP
	Yellow Floating Heart	*Nymphoides peltata*	NYPE
	Giant Salvinia	*Salvinia molesta*	SAMO
	Giant Reed	*Arundo donax*	ARDO
	Brazilian Elodea	*Egeria densa*	EGDE
	Didymo	*Didymosphenia geminata*	DIGE
	Flowering rush	*Butomus umbellatus*	BUUM
	Common reed	*Phragmites austalis*	PHAU
	Curly-leaf pondweed	*Potamogeton crispus*	POCR
	Purple Loosestrife	*Lythrum salicaria*	LYSA
	Garden Loosestrife	*Lysimachia vulgaris*	LYVU
	Water primrose	*Ludwigia spp.*	LU
Terrestrial animals	Feral Swine	*Sus scrofa*	SUSC
Terrestrial plants	Japanese Knotweed	*Fallopia japonica*	FAJA
	Hybrid Bohemian Knotweed	*Polygonum bohemicum*	POBO
	Giant Knotweed	*Polygonum sachalinese*	POSA
	Giant Hogweed	*Heracleum mantegazzianum*	HEMA
	Old Man's Beard	*Clematis vitalba*	CLVI
	Garlic Mustard	*Alliaria petiolata*	ALPE
	Himalayan blackberry	*Rubus discolor*	RUDI
	English Ivy	*Hedera helix*	HEHE
	Salt Cedar	*Tamarisk ramosissima*	TARA
	Orange hawkweed	*Hieracium aurantiacum*	HIAU
	Yellow archangel	*Lamiastrum galebdolon*	LAGA

Photographs of Biota

Follow these general guidelines when taking photographs.

- Use a small object for scale (e.g., pencil, ruler).
- Avoid having people in the picture (hands or fingers are ok).
- Zoom in to capture the specimen only.
- Re-take the picture if the clarity, color, focus, angle or lighting is poor.
- It is especially important to take pictures of specimens that cannot be identified.

Amphibians, Aquatic Snails, Mussels, and Crayfish

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

Aquatic and Terrestrial Invasive Plants

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

Water Quality

pH, Specific conductance and Temperature

Bot the YSI and Oakton are calibrated each day (Appendix C).

YSI Sampling method:

1. At Transect F standing mid-channel, in flowing water, if flowing water is not present at Transect F take the measurements at the nearest location/transect that does have flowing water (avoid pools), lower the probe into the water to a depth of 0.5 m below the water surface. If water depth is < 1 m, take measurements at mid-depth.

2. Avoid contacting the stream bottom with the YSI, as the instrument is delicate. Wait for the readings to stabilize.

3. Record the pH, specific conductance (µS), and temperature (C°).

At the end of the day: The instrument is supplied with a grey storage sleeve that slides over the probe guard. The sleeve is used for short-term storage (less than 2 weeks). Be sure to keep a small amount of moisture (clean tap water) on the sponge in the sleeve during storage. The moistened sponge in the sleeve provides a 100% water saturated air environment which is ideal for short-term sensor storage.

Oakton Sampling method:

1. At Transect F standing mid-channel (nearest as possible to YSI collection), in flowing water, if flowing water is not present at Transect F take the water sample (Oakton is not submersible so we are bringing the water to the Oakton) at the nearest location/transect that does have flowing water (avoid pools), lower the water sample jar (closed) into the water to a depth of 0.5 m below the water surface. If water depth is < 1 m, take measurements at mid-depth. Once the appropriate depth is found, open the water sample jar under water (not before then) and let the bottle fill with water, close the bottle underwater and bring it to the surface.

2. Insert the Oakton into the water sample jar and wait for readings to stabilize, record the pH, specific conductance (µS), and temperature (C°).

To switch between pH and specific conductance -press ON/OFF to power on the Oakton. Press the Menu button once then again – press HOLD/<┘ on Measure then arrow up or down to select COND or pH and press HOLD/<┘ . Then press CAL/ESC to enter main menu.

Total Nitrogen and Phosphorus

1. Obtain a 125 ml centrifuge vial (new or acid washed) and rinse it with stream water five times. Be careful not to overly disturb the stream bottom which may increase suspended solids and contaminate the sample.

2. Using the 125 ml vial, collect water sample at Transect F in flowing water. If flowing water is not present at Transect F go to the next closest location with flowing water. Fill the vial about 50% full which leaves enough head space in the vial to allow for freezing (at the office).

Stabilize all samples with concentrated sulfuric acid.

SAFETY NOTE: Exercise extreme caution and ensure nitrile gloves and sunglasses or safety goggles are worn at all times when working with acid. If acid comes in contact with the skin, rinse with a mild, soapy solution or rinse continuously with stream water if soapy water is not available. Do not apply baking soda to your skin. If acid comes in contact with the ground, apply generous amounts of baking soda to neutralize the spill and surrounding area. Continue adding baking soda until all acid is neutralized (i.e., cessation of bubbling and gas).

a. Remove the dropper bottle from a Nalgene storage bottle containing baking soda.
b. Carefully remove the dropper bottle cap, while keeping clear of face. Invert and add 3 drops (0.15 ml) of sulfuric acid to the water quality sample, being careful not to touch the water sample with the dropper bottle tip.
c. Replace the dropper bottle cap and return the dropper to the Nalgene storage bottle.
d. Place the top on the water quality sample and shake vigorously for 5 seconds.

4. Place label on outside of vial back at truck.

Note: If reach has partial or intermittent flow place sonde and collect the water sample where water > 10cm deep and > 1 m^2. If no location exists, do the best you can to take the measurements and record appropriate comments about the quality of the sample. If there is a beaver dam/pool at Transect F place sonde/collect sample at Transect A, if beaver dam/pool is present at Transect A, place sonde/collect sample below the dam/pool even if it is downstream from the reach.

Appendix A – Measuring Gradient with Bank Tape

To capture the steep elevation change associated with a waterfall use the bank tape to measure the height of the waterfall. At the conclusion of a set of down and up shots to the stadia rod go to the top of the waterfall and drop the tape down the waterfall to a person standing as close to the exact position of the stadia rod.

Remember to record the height in cm (the tape says 30 m, this would be 3,000 cm - on the gradient data form the down measurement would be 0 and the up measurement would be 3000. Safely navigate around the waterfall and have the stadia rod start at the safest location near the top of the waterfall and resume surveying as normal prior to the waterfall. Going downstream for the second trial, the same procedure will have to be followed.

Appendix B – Sampling Sites with Beaver Activity

Setting Up Your Site
Follow standard protocol for site layout with the following exceptions:

- Placing Transect Flags in Beaver Pools
  - Place transect flags perpendicular to the thalweg of the beaver pool (A in fig. 21).
  - If you cannot locate thalweg in the beaver pool, place transect flags perpendicular to the beaver pool's center line (B in fig. 20).

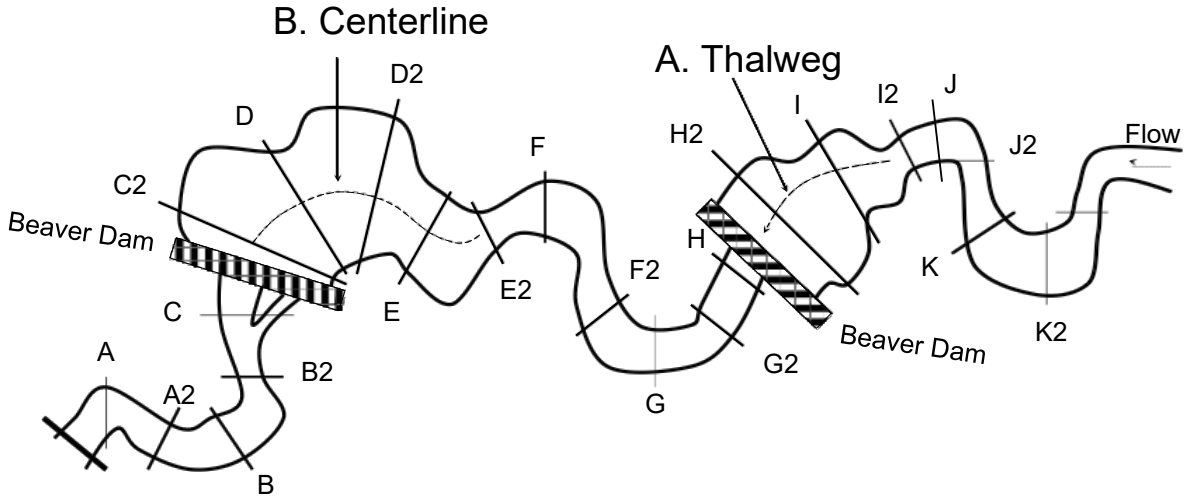


Figure 21— Depiction of a site with beaver dams. In beaver pool "A", transects are placed perpendicular to thalweg. In beaver pool "B", the thalweg cannot be located so transects are placed perpendicular to center line of the pool.

- Placing Transect Flags in Side Channels
  - It can be difficult to discern side channels beside and downstream of beaver dams;
  - Follow normal procedures for determining if measurements are taken in the side channel (see side channel section of protocol).
  - A side channel, even a flowing channel, must have a streambed that has <50% vegetative cover throughout its entire course. If at any point the channel has ≥ 50% vegetative cover, do not take measurements within it. For example if a beaver dam results in water flowing over terrestrial vegetation, do not record measurements there.

Special Situation – this vegetation cover criteria is only used for side channels in beaver pond areas.

UTM Coordinates

- Follow standard procedures.

Macroinvertebrates

- Collect macroinvertebrates downstream, but in close proximity to beaver dams. If your site does not fit into one of the following scenarios, do the best you can and take notes about where the macros were collected.
- Locate the most downstream beaver-impacted area within the site and take samples downstream from this location.
    - If there are 4 or more riffles in between the bottom of the site and the first beaver impacted area, collect 8 samples within the first four riffles downstream from the beaver impacted area.
    - If there are between 1 and 3 riffles between the most downstream beaver impacted area and the bottom of the site, evenly distribute your 8 samples within the available riffles.
    - If there are no riffles between the bottom of the site and the most downstream beaver impacted area, or the bottom of the site is impacted by beavers, select the following option which results in samples being collected closest to the beaver impacted area:
        - Collect 8 samples from the 1st four riffles downstream from bottom of the site.
        - OR, evenly distribute samples in riffles found within 50m downstream from the impacted area.

Cross-Sections, Pebble Counts and Large Wood

- Follow normal procedures in areas not impacted by beaver.
- Within beaver pools/impacted areas:
    - Use normal procedures when possible.
    - These measurements are based on bankfull width. If bankfull cannot be located or is underwater, then use water's edge to determine:
        - Boundaries for establishing cross sections, measuring bankfull widths, collecting pebbles and determining whether wood qualifies.

Pool Tail Fines

- Do not measure pool tail fines at beaver dam pools.

Photographs

- In addition to the standard reach photographs take the following additional photographs (Use the OptPhotos form and for Photo Type select Subject and the required beaver photos will appear):
    - Top of beaver pool (DS) and top of beaver pool (US)
        - Take photographs of the top of the beaver pools looking both upstream and downstream.
        - Use the "criteria for determining the upstream boundary of beaver pools" to locate these positions (Table 6).

        - Hold the stadia rod on either bank at the upstream end of the beaver impacted area(s).
        - Take the photographs parallel to the channel at a distance that allows you to see as much of the beaver pool as possible.
    - Beaver dam (DS) and beaver dam (US)
        - Take photographs of the dam(s) looking both upstream and downstream.
        - Hold the stadia rod on/beside the dam.
        - Take the photographs parallel to the channel at a distance that allows you to see as much of the dam as possible.
    - Beaver pool overview
        - Take at least one overview photograph of each beaver pool/impacted area.
        - These photographs should be taken from a location where the greatest extent of the beaver pool(s) can be observed. This is often a hillside or terrace. Sometimes this is a difficult shot, try your best.

Pools

- Disregard standard pool criteria when evaluating a beaver pool.
- Beaver pool criteria (Table 6):
    - Beaver pools are areas where a beaver dam is slowing down and backing up water.
    - The dam does not have to be actively maintained.
    - The pool tail is the beaver dam.
    - Determine the upstream boundary of beaver pools using the following criteria (fig. 22):
        - Flowing water
        - “Normal” wetted width (i.e. not impacted by beaver)
        - Elevation above beaver dam height
        - “Normal” substrate (i.e. not all fines)
- Measuring beaver pools:
    - Full or partial: follow standard procedures
    - Length, Max and Head – follow standard procedures

Large Wood

- Follow normal procedures when possible.
- Determining whether or not large wood qualifies requires identifying bankfull. If bankfull cannot be located or is underwater in beaver impacted areas, use water’s edge instead.

Transects

- Identify and record transects that fall in an areas impacted by beaver in the comment section.

Table 6—Characteristics for determining beaver pools and the area upstream of beaver pools.

Beaver Pools	Upstream of Beaver Pools
• Low/zero water velocity • Wide wetted width • Elevation below beaver dam height • Fine substrate • Level water surface is best indicator	• Flowing water • “Normal” wetted width • Elevation above beaver dam height • “Normal” substrate

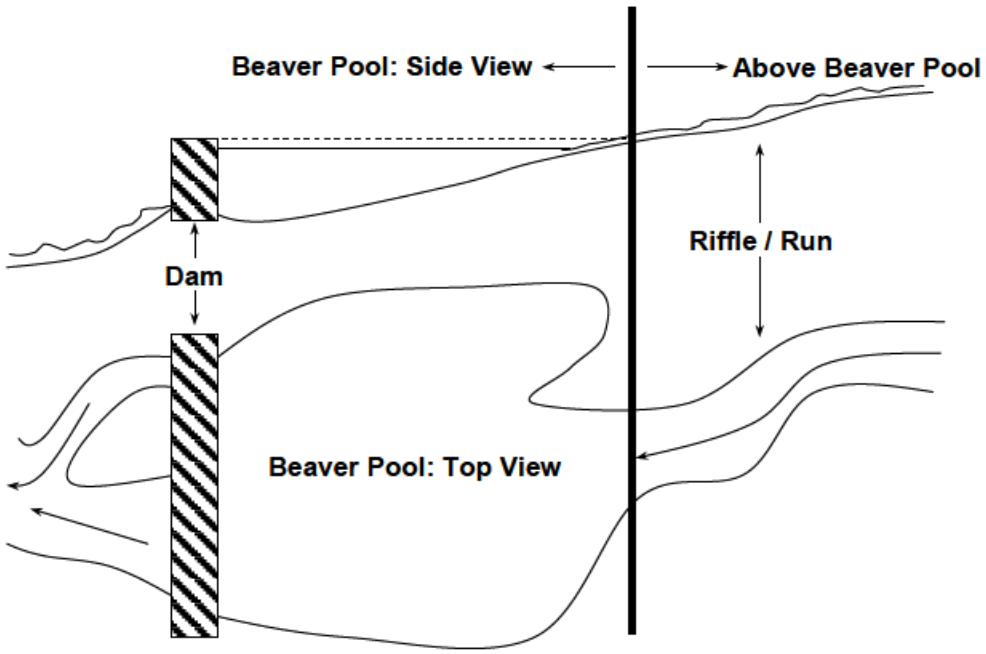


Figure 22—Top and side view of a beaver pool and how to determine the upstream boundary.

Appendix C – YSI and Oakton Calibration

Calibration of both instruments must be conducted every day for pH and Spc. Standard solutions for pH are only viable for 2 months after the solution bottle has been opened. The specific conductance solutions are only viable for 30 days. Whenever a new standard solution bottle is opened write the date opened on the side of the bottle.

YSI

pH calibration

pH calibration will be conducted using 3 different pH standards (pH 4, pH 7, and pH 10). Calibration must always start with pH 7.

1. Fill the graduated cylinder with the pH 7 standard. Be sure the standard covers the black thermistor on the side of the gray probe bulkhead.

2. Press and hold CAL for three seconds

3. Highlight pH and press enter. If pH is not listed as an option, check the System Setup menu to ensure pH is enabled in the ISE Sensor Type menu.

4. Highlight 3 point and press enter.

Note the temperature displayed in screen and on the bottle of the solution and the corresponding pH buffer value at that standard. So even though the front of your standard solution may say 7.01 or 7 the meter will adjust for the temperature so the meter may show up as 7.03. Keep this in mind for all pH buffer values.

If necessary, use the up and down arrow keys to adjust the pH buffer value. Note the pH mV reading which should be between -50 and 50 in buffer 7.

6. Press enter to continue to second point.

7. Rinse the sensor and place it in the second pH buffer (4 or 10). If necessary, use the up and down arrow keys to adjust the pH buffer value.

8. Wait approximately 30 to 60 seconds for the pH sensor to stabilize and for the temperature reading to stabilize. Note the pH mV reading. pH mVs in buffer 4 should be 159 to 180 mV from the previous buffer 7 pH mV value. pH mVs in buffer 10 should be -159 to 180 mV from the previous buffer 7 pH mV value.

9. Rinse the sensor and place it in the third pH buffer (4 or 10). If necessary, use the up and down arrow keys to adjust the pH buffer value.

10. Wait approximately 30 to 60 seconds for the pH sensor to stabilize and for the temperature reading to stabilize. Note the pH mV reading. pH mVs in buffer 4 should be 159 to 180 mV from the previous buffer 7 pH mV value. pH mVs in buffer 10 should be -159 to 180 mV from the previous buffer 7 pH mV value.

11. Press enter to complete the calibration or press Cal to cancel.

12. 'Calibration Successful' will display for a few seconds to indicate a successful calibration and then the instrument will return to the Run screen.

13. If the calibration is unsuccessful, an error message will display on the screen. Press the Cal key to exit the calibration error message and return to the Run screen.

Specific conductance calibration

1. Place at least 7 inches of the standard solution in the plastic container or a clean glass beaker.

Note: Do NOT use the 100 mL graduated cylinder. The diameter of the cylinder is too small for accurate conductivity measurements.

2. Turn the instrument on and allow the conductivity and temperature readings to stabilize. Press and hold the Cal key for 3 seconds. Highlight Conductivity and press enter. Next, highlight Sp. Conductance, and press enter.

3. Highlight uS/cm and press enter.

4. The value present should already be correct (1413 or 84 µS) if not use the up or down arrow key to adjust the value on the display to the value of standard solution. Most conductivity solutions are labeled with a value at 25°C. If calibrating specific conductance, enter the value listed for 25°C (on bottle of solution). Press and holding either the up or down arrow key for 5 seconds will move the changing digit one place to the left.

5. Press enter to complete the calibration or press Cal to cancel.

6. 'Calibration Successful' will display for a few seconds to indicate a successful calibration and then the instrument will return to the Run screen.

7. If the calibration is unsuccessful, an error message will display on the screen. Press the Cal key to exit the calibration error message and return to the Run screen. Check the fields below to ensure they are set correctly.

Oakton

pH calibration

1. Remove the cap and press ON/OFF to power on the Oakton. If pH is not displayed press the Menu button once then again – press HOLD/<┘ on Measure then arrow to pH and press HOLD/<┘ . Then press CAL/ESC to enter main menu.

2. Dip electrode about 2 cm to 3 cm into the pH standard buffer solution (start with 7) in the cap of a water sample jar

3. Stir gently and press CAL/ESC to enter calibration mode. The CAL indicator will be displayed. The upper display will show the measured reading based on the last calibration while the lower display will indicate the pH standard buffer solution. To abort calibration, press CAL/ESC to escape.

4. Allow about 2 minutes for the tester reading to stabilize. The timer icon blinks during this time. Once the reading is stabilized, the timer stops blinking and a checkmark appears. Automatic confirmation happens when the buffer is found and the display returned to measurement window with reading calibrated to pH standard buffer solution. Rinse the electrode and cap between buffer solutions.

5. Repeat with other buffers.

Automatic Calibration for Conductivity

1. Remove the cap and press ON/OFF to power on the Oakton. Press the Menu button once then again – press HOLD/<┘ on Measure then arrow to COND and press HOLD/<┘ . Then press CAL/ESC to enter main menu.

2. Dip the sensor in at least 30 mm of calibration standard in the cap of a water sample jar.

3. Stir gently let the reading stabilize and press CAL/ESC to begin the calibration. Minimize moving the probe as it can cause the calibration to misread the standard solution.

4. The display will show CAL followed by the default value. CAL is indicated on the display during calibration mode.

5. If the reading is within the calibration range of the automatically recognized standards; 80 (84 µS/cm) or 1410 (1413 µS/cm), the checkmark icon is displayed when the automatic calibration standard value has been detected.

6. Press HOLD/<┘ to accept the auto conductivity standard and finish the calibration. If the auto calibration misreads the standard solution begin again at step 3 being careful to let the reading stabilize and not moving the probe after CAL/ESC has been selected.

7. Display returns to Measurement window.

Manual Calibration for Conductivity

When the conductivity reading is outside calibration range of the automatic conductivity standards or when TDS or salinity is used, the oakton will require manual adjustment.

1. Repeat steps 1 to 4 from “Automatic Calibration for Conductivity”.

2. Press MENU/V to manually adjust the value to the desired reading. The adjustment will decrease only, however the adjustment will eventually cycle to the highest available value after decreasing by 40% of the initial value.

3. Press HOLD/<┘ to accept and finish the calibration when the desired value is selected. To abort calibration, press CAL/ESC to escape.

Appendix D – Invasive Species Disinfection Protocol

Invasive Species Disinfection Protocol
Use stiff brush to remove any seeds potentially lodged in wading boots when moving between survey sites. When moving between watersheds follow the instructions below.

Use protective, unlined rubber gloves and eye protection when handling the solutions and take extra precautions when handling undiluted chemicals. Have clean water available on-site to treat accidental exposure. Virkon can cause irreversible eye damage and skin burns.

Field Gear

Survey gear to be disinfected:

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

In the field disinfection equipment provided:

- Bucket with Virkon® Aquatic
- 5 gallon backpack sprayer with water
- Stiff brush to remove mud from gear
- Rubber gloves and eye protection

In the field disinfection

1. At the site: Before leaving the stream all waders, boots, nets and net handles carried to the site that day, will be rinsed with stream water and any mud or dirt will be scrubbed off with a stiff bristle fingernail brush.
2. Be sure to decontaminate gear at least 100 meters from a water source.
    a. Use a ratio of 1/3 cup of Virkon® Aquatic to 1 gallon of water in bucket.
    b. Fully immerse gear for at least 20 minutes.
    c. After disinfection, thoroughly rinse gear with sprayer especially the foot/gravel guard portion of waders.
        i. The solution can be used multiple times as long as it maintains its effectiveness (see testing solution effectiveness section below).
        ii. Once the solution is no longer effective dispose of the solution away from any water sources preferably in a flat area where potential runoff to a water source is minimal.
    d. When possible, gear should be hung to dry overnight.

Notes on Virkon® Aquatic:
Virkon® Aquatic is an oxygen based disinfectant containing simple inorganic salts and organic acids. The active substance in Virkon® Aquatic is Oxone®, or potassium peroxomonosulphate triple salt. This is an inorganic oxidant that degrades in the environment to potassium and sulphate ions. In total, about three quarters of the components of Virkon® Aquatic are inorganic and the primary decomposition mechanisms are abiotic, such as hydrolysis and catalytic decompositions, leading to simple inorganic salts at concentrations that are insignificant compared to those present naturally in the environment.

Appendix E – Field Database Management

Backing up Data

Data will be backed up during the day to prevent accidental data loss should a tablet be lost or damaged to the point where data on the tablet is irretrievable. To back up the tablet the data will be backed up on a flash drive on site. Crew leaders will have a second flash drive to back up completed sites at the end of the day.

1. From My Files navigate to the desired excel spreadsheet to be backed up, follow basic copy/paste procedures to copy files from tablet to USB drive.

    a. For GPS file (JSON), open file explorer on the tablet navigate to \Card\Android\data\gov.s1.s1mobile\Edit_Data\Waypoints.
        i. If the Waypoints folder has two .json files….S1waypoints.json and waypoints.json….copy/rename the S1waypoints.json
        ii. Example naming convention; ORDRE1004_TK.json (T stands for tablet and K stands for the letter of the tablet).

    b. For Survey 123 files (eDNA, photos and thermograph), open file explorer (or Total Commander on newer tablets) navigate to Internalstorage/Android/data/com.esri.survey123/files/ArcGIS/MySurveys/Databases…copy/rename the Databases folder to Databases_1 for the first day in the field then Databases_2 for the second day and so on.

2. All files go into \Incoming\CrewX\StintX\CC\Sitenumber

Downloading the Camera

1. Remove the SD card from the camera and place into SD card reader thumb drive and connect to tablet. Locate the photos on the camera card (using file explorer find the SD drive)

2. Copy/Paste them into \Incoming\CrewX\StintX\CC\Sitenumber. Create a new folder for each camera used on a site (i.e., Camera_4A).

3. Review the photos to make sure required shots were captured at each site. Replace the card in the camera leaving ALL photo files on the card.

References

Abel, L. M. 2013. YSI Professional 1030 instrument (Pro1030) User's Manual. YSI, Inc. United States of America. 34 p.

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

Archer, E.K., R.A. Scully, R. Henderson, B.B. Roper, and J.D. Heitke. 2012. Effectiveness monitoring for streams and riparian areas; sampling protocol for stream channel attributes. Unpublished paper on file at: http://www.fs.fed.us/biology/fishecology/emp.

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

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

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

Miller S, J. Courtwrigtht, S. Judson and R. Leonard. 2014. BLM Western Rivers and Streams Assessment (WRSA) Protocol, 2014 Field Season.

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

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

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

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

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

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

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

Saunders, W.C.; Ojala, J.V.; Van Wagenen, A.; Haynes, D ; Archer, E.K.; and Henderson, R. 2019. PacFish InFish Biological Opinion (PIBO) Monitoring Program: Effectiveness Monitoring Sampling Methods for Stream Channel Attributes. Unpublished paper on file with PIBO Monitoring Program.

NOTES