PIBO-EMP

PACFISH INFISH BIOLOGICAL OPINION EFFECTIVENESS MONITORING PROGRAM for STREAMS and RIPARIAN AREAS

2011 SAMPLING PROTOCOL for STREAM CHANNEL ATTRIBUTES

Fish & Aquatic Ecology Unit

UPPER COLUMBIA BASIN NETWORK UCBN

2011 SAMPLING PROTOCOL FOR STREAM CHANNEL ATTRIBUTES

By

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INTRODUCTION

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

This document describes the sampling methods used by the PIBO-EM program during 2011. The methods are a result of 11 years of use, evaluation, and peer review. We worked with the Aquatic and Riparian Effectiveness Monitoring Program to standardize methods, which resulted in a document titled "Effectiveness Monitoring for Streams and Riparian Areas within the Pacific Northwest: Stream Channel Methods for Core Attributes" (USDA 2006). The PIBO-EM protocol incorporates all methods described in this document. In addition, we would like to recognize the following authors and acknowledge the original citations for each method, while recognizing that numerous modification have been made.

- Harrelson et al. (1994) - Reach layout, bankfull elevation, gradient, and sinuosity.
- Wolman (1954) and Lazorchak et al. (1998) - Streambed particle counts
- Bauer and Burton (1993) and USFS R5 SCI Guidebook (1998) - Pool tail fines
- Bauer and Burton (1993) and Platts et al. (1987) – Bank stability
- Kershner et al. (2004) - Defining habitat units
- Lisle (1987) - Residual pool depths
- Platts et al. (1987) - Bank angle and undercut banks
- Rosgen (1996) - Channel cross-sections
- Hawkins et al. (2003) - Macroinvertebrates
- Moore et al. (2002) and Hankin and Reeves (1988) - Large wood

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

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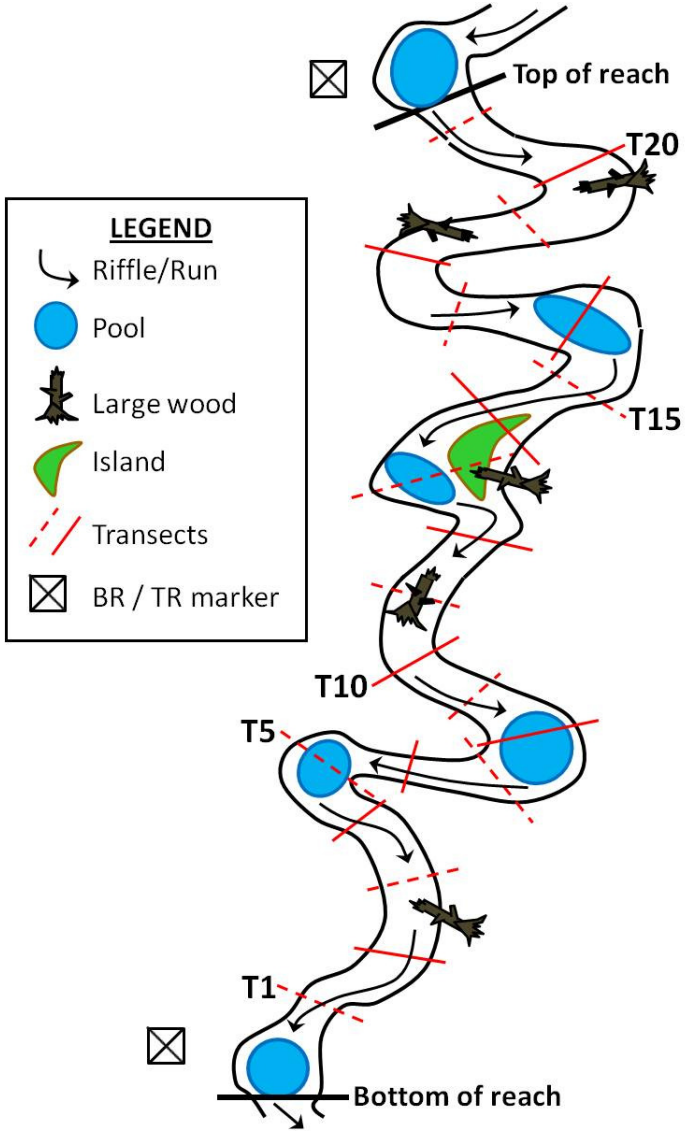


Figure 1. Overview of reach layout showing locations of BR / TR, BR / TR markers, habitat units, large wood, islands, and transects.

SAMPLING ORDER

1. Navigate to the site using all information (driving directions, hiking directions, UTMs, etc)
2. Pinpoint BR location and establish transect 1
3. Determine bankfull elevation, scour line, and where streambed and stream bank meet – as a group (stream and veg. techs)
4. While at the BR
   1st technician collects macroinvertebrates*
   2nd technician:
   a. Begin filling out forms 1,2, and 4 (you can do this while driving to site)
   b. Validate BR marker info
   c. Take RchID / Date photo
   d. Take BR photos
   e. Record BR and BR marker UTMs*
5. Finish setting up the reach: Place additional transect flags and pinpoint TR
6. While you're at the TR:
   a. Calculate reach length
   b. Validate TR marker info
   c. Record TR and TR marker UTMs*
   d. Water chemistry
   e. Record disturbance
   f. Take TR photos
7. Quantify habitat units (pools vs. riffle / run) and count wood in each habitat unit
8. Measure channel cross-sections, bankfull widths, and pebbles
9. Measure streambanks (bank angle, bank stability, bank type)
10. Assess and measure large wood
11. Draw reach map*
12. Measure the elevation change
13. Before leaving the reach:
    a. Review **all** forms for completeness
    b. Review entries in the data logger
    c. Check to make sure you have all equipment and forms
14. After returning to the truck
    a. Decontaminate gear before going to the next site
    b. Backup logger

NOTE: Take photos during favorable light conditions, not directly into the sun or when it's too dark

*Only collect this information if specified on Site Information Sheet

BANKFULL

Objective:

- Examine bankfull indicators throughout the reach and determine dominant bankfull height.
- Do not sample until you are confident of the bankfull height!
- Do this as a group (all crew members)

Bankfull Indicators: All six indicators may not be present.

1. **Examine streambanks for an active floodplain.** This is a relatively flat, depositional area that is commonly vegetated and above the current water level unless there is a large amount of spring runoff or there has been a substantial rain event (i.e. stream running at bankfull stage).
2. **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.
3. **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.
4. **Define an elevation where mature key riparian woody vegetation exists**. The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found below the bankfull elevation.
5. **Examine the ceiling of undercut banks.** This elevation is normally below the bankfull elevation.
6. **Stream channels actively attempt to reform bankfull features such as floodplains after shifts or down cutting in the channel.** Be careful not to confuse old floodplains and terraces with the present indicators.

Measuring Bankfull Height

- After you identify bankfull, measure the vertical distance from the water's surface to the dominant bankfull elevation measured throughout the reach.
- This vertical distance can be used when bankfull indicators are not present at a particular point along the streambank.
- Bankfull height is needed for streambank measurements, bankfull widths, pebble counts, large wood, and cross-sections.

WHERE STREAMBED AND STREAMBANK MEET

The location where the streambed and bank meet can be identified by:

- Break in the relatively steep streambank slope to a more gently sloping streambed.
- Associated with a rapid fining of particles from relatively coarse streambed particles to the finer streambank particles.
- Normally (but not always) below the current water level.
- The streambed has <50% terrestrial vegetative cover.
- The streambank is usually consolidated, the streambed is usually unconsolidated.
- In a few situations, it can be difficult to determine differences between the streambed and streambank in reaches with cobble or bedrock substrate. Begin assessing all streambank measurements at the scour line in these situations.

SCOUR LINE

Use these indicators to identify the lowest consistent scour line within your reach, and measure how far above the water's surface it occurs:

- Lowest consistent limit of sod forming vegetation
- Lowest consistent limit of perennial vegetation
- The ceiling of undercut banks in straight sections of stream channel
- On depositional features such as point bars, the scour line is often defined by the limit of perennial vegetation, or by an indentation in the bar (locally steep area).

Where to look: the best place to identify scour line is in a straight, well-vegetated section of the stream channel.

If you cannot identify the scour line at a specific location or transect, then use the average scour line elevation measured throughout the reach.

If flows are above scour line we generally don't sample. If this is the case, call prior to sampling.

SETTING UP YOUR REACH: GETTING STARTED

Background:
The PIBO-EM sample design consists of a 5-year rotation of sites; sites sampled in 2001 were re-sampled in 2006, and will be sampled again in 2011.

It is absolutely vital that you sample the same section of stream that was previously sampled. Your data is not useful if it is not collected from the same location!

What is a BR or TR?
- **Bottom of Reach (BR):** is the starting point / downstream boundary for collecting data
- **Top of Reach (TR):** is the ending point / upstream boundary for collecting data
- **NOTE:** Your BR / TR will be in the same precise BR / TR location of previous sample(s)

Objectives:
- Determine the precise location of BR and TR
- Set up your reach using one of the 2 procedures below.
  1. Scouted or unscouted OLD SITE
  2. Scouted NEW SITE

Before setting up your reach, locate the following as a crew:
- Bankfull elevation – page 2
- Where streambed and streambank meet – page 3
- Scour line – page 3

It is unlikely, but you may encounter:
- Beaver activity within site - See Appendix B pg 89.
- High water. If the water is above the scour line (pg 3), call before you sample.
- Stream flows through a different channel. Carefully read about 'channel shifts' in the Disturbance section (page17).
- Site is on private land. Do not sample if you are sure it is on private land, call hotline. If you cannot call, go to next site, and call.

OLD SITE: Setting Up Your Reach

Remember: it is absolutely vital that you sample the same section of stream that was previously sampled; your data is not useful if it is not collected from the same location!

Important: Set up transect 1 as quickly as possible when arriving at a reach. The vegetation technician cannot begin working until you do so.

OLD SITES have:
- Been sampled before
- Photographs from a prior sample
- 'Site Information Sheet' with UTM coordinates for BR, BR marker, TR, TR marker & Reach overview.
- Site marker information

Scouted OLD SITES:
- Were visited by a scout earlier in the field season
- Have orange flagging labeled 'PIBO BR / PIBO TR' at or near the BR and TR
- Have a 'Site Revisit' form with specific information about where to precisely establish BR and TR in relation to flagging

Unscouted OLD SITES:
- Don't have orange flagging at BR / TR
- Have a blank 'Site Revisit' form that you fill out

The only real difference between a scouted and unscouted site is that the crew, not the scout, will have to determine the exact BR and TR locations.

1. Navigate to the site using all available information:
- Driving and hiking directions
- UTM coordinates
- Photos
- Topographic map
- Reach map

2. Determine the precise location of the BR

If site was scouted:

- Carefully read the 'Site Revisit Form' to determine where the BR is relative to the BR flagging.
- Be careful not to confuse BR and TR flagging, they will be labeled 'PIBO BR' and 'PIBO TR' respectively.
- Question: the 'Site Revisit Form' indicates that flagging was hung, but I cannot find it. What do I do?
- Answer: confirm with 100% certainty that you correctly navigated to the BR. Photos are best for doing this.

Site was not scouted:

- **Take your time and carefully pinpoint the precise BR location; be diligent, careful, and detailed.**
- Photos are the best piece of information
- Also use: site marker, UTMs, reach map, hiking directions

3. Mark BR with a cluster of multi-colored flags on both banks

- Place flags perpendicular to channel (NOT thalweg)
- *You do not collect data at BR!*

4. Use the 'width category' on 'Site Information Sheet' to establish transect 1

- Identify where the thalweg crosses the BR. Technician 1 holds the 'dumb end' of the measuring tape there.
- Technician 2 will measure upstream, along the thalweg, a distance equal to the width category.
- Establish transect 1 by placing a flag on each bank, perpendicular to the channel (not the thalweg).

Before moving to step 5:

1st technician:

- Collect macroinvertebrates (don't walk where you'll collect bugs!) - see 'Macroinvertebrates pg 23

2nd technician

- Validate BR marker info - see 'Site Markers' pg 20
- Begin filling out forms 1, 2, and 4
- Take RchID / Date, and BR photos - see 'Photos' pg 28
- Record BR UTMs – if indicated on 'Site Info Sheet' - see 'UTM Coordinates' pg 14

NOTE: Setting up your reach is a 2-person job.

5. Using the same procedure, place additional transects moving upstream.

- Identify where the thalweg crosses transect 1. Technician 1 holds the 'dumb end' of the measuring tape there.
- Technician 2 will measure upstream, along the thalweg, a distance equal to the width category.
- Place a flag on each bank, perpendicular to the channel (not the thalweg)

6. Place additional transects moving upstream until you reach the TR

- Using the same procedure, continue placing transects upstream until you reach the TR.
- Question: what if I encounter side channels?
- Answer: see 'Side Channels' pg 12

7. Determine precise location of TR

Scouted site: locate TR relative to flagging.

- Carefully read the 'Site Revisit' form to determine where the TR is relative to the TR flagging.
- Your last transect is the last one that will fit before you pass upstream of the TR. The distance upstream from your last transect to the TR will be less than the width category.

Unscouted site: locate TR

- Your last transect is the last one that will fit before you pass upstream of the TR. The distance upstream from your last transect to the TR will be less than the width category.
- TR photos are your best piece of info for locating the TR; familiarize yourself with them so that you have a good idea of what it looks like.
- Other helpful pieces of information:
    - TR site marker info
    - TR UTMs (use 'go to' function of GPS)
    - Reach map

8. Mark your TR with a cluster of multi-colored flags on both banks

- Place flags perpendicular to channel (NOT thalweg)

9. Calculate reach length using the formula on Form 1.

- The reach length is distance from BR to TR measured along the thalweg.
- Record the data on Form 1 and in the data logger.
- Question: What if my reach length is different that the old one?
- Answer: That is OK. Reach length is measured along the thalweg, which changes due to water level, channel shifts, creation of oxbows, etc.

10. What's next? While you're at the TR:

- Water chemistry - see 'Water Chemistry' pg 26
- Take TR photos - see 'Photos' 28
- Validate TR marker info - see 'Site Marker' pg 20
- Record TR UTMs if indicated on 'Site Info Sheet' - see 'UTM Coordinates' pg 14

NEW SITE: Setting Up Your Reach

IMPORTANT: Set up transect 1 as quickly as possible when arriving at a reach. The vegetation technician cannot begin working until you do so.

NEW SITES have:

- Never been sampled
- Been visited by a scout earlier in the field season
- Orange flagging hanging at / near the BR
- 'Site Information Sheet' with BR UTMs
- Do not have BR / TR site markers

1. Navigate to the site using the following information:

- Driving directions
- Hiking directions
- UTM coordinates (BR and Temp Probe)

2. Locate the orange flagging hung at the BR

- Question: I cannot find the flagging, what do I do?
- Answer: Navigate to the site using all available information. Remember to use Probe information. There are UTMs and a map showing BR.

3. Determine the precise location of your BR relative to the scout's flagging.

- Carefully read the 'Site Information Sheet' and follow the scout's instructions for placing the BR relative to the BR flagging.
- If the scout did not write specific instructions:
    - BR will be a pool tail within 10m US / DS of flagging
    - If there isn't a pool tail 10m US / DS of flagging, the BR will be in line with the BR flagging
- Question: What if the pool tail identified by the scout doesn't meet pool criteria?
- Answer: Establish the BR at a qualifying pool tail 10m US / DS from flagging, if there isn't one, start at flagged location

4. Mark BR with a cluster of multi-colored flags on both banks

- Place flags perpendicular to channel (NOT thalweg)
- *You do not collect data at BR!*

5. Use the 'width category' on 'Site Information Sheet' to establish transect 1

- Identify where the thalweg crosses the BR. Technician 1 holds the 'dumb end' of the measuring tape there.
- Technician 2 will measure upstream, along the thalweg, a distance equal to the width category.
- Establish transect 1 by placing a flag on each bank, perpendicular to the channel (not the thalweg).

Before moving to step 6:

1st technician:

- Collect macroinvertebrates (don't walk where you'll collect bugs!) - see 'Macroinvertebrates' pg 23

2nd technician

- Place BR marker and record marker information - see 'Site Markers' 20
- Record BR and BR marker UTMs - see 'UTM Coordinates' pg 14
- Begin filling out forms 1, 2, and 4
- Take RchID / Date photo and BR photos - see 'Photos' pg 28

NOTE: Setting up your reach is a 2-person job.

6. Using the same procedure place additional transects moving upstream.

- Identify where the thalweg crosses transect 1. Technician 1 holds the 'dumb end' of the measuring tape there.
- Technician 2 will measure upstream, along the thalweg, a distance equal to the width category.
- Place a flag on each bank, perpendicular to the channel (not the thalweg)
- Question: What if I encounter side channels?
- Answer: See 'Side Channels' pg 12

7. Establish TR, you will have 21 – 25 transects.

- Your TR will be the first pool tail upstream of transect 21, if no pool tail is found your TR will be at transect 25 *(you will collect data at this transect)*
- If the stream is dry, stop at transect 21. *(you will collect data at this transect)*

8. Mark TR with a cluster of multi-colored flags on both banks

- Place flags perpendicular to channel (NOT thalweg)

9. Calculate reach length using the formula on Form 1.

- The reach length is distance from BR to TR measured along the thalweg.
- Record the data on Form 1 and in the data logger.

10. What's next? While you're at the TR:

- Place TR marker and record marker information - see 'Site Markers' pg 20
- Record TR and TR marker UTMs - see 'UTM Coordinates' pg 14
- Meaure water chemistry - see 'Water Chemistry' pg 26
- Take TR photos - see 'Photos' 28

WIDTH CATEGORY

- Width category = transect spacing interval, or the distance between transects (measured along the thalweg).
- Use the width category provided to you on Site Information Sheet.
- Width categories are even numbers that increase by multiples of 2 (4m, 6m, 8m, 10m, 12m, 14m, etc) in proportion to bankfull width.
- **If info is missing or misleading: Call hotline!**

SIDE CHANNELS

In this section you will find information about how to place transects when you encounter side channels.

Side Channels

- The main channel (MC) has the most volume of water flowing through it; additional channels are referred to as side channels.
- A side channel (SC) is any channel separated directly from the main channel by an island / bar with an elevation above bankfull (A Figure 2).
- Channels that are separated from the main channel by islands <bankfull elevation are considered part of the main channel (E Figure 2).
- Place flags in all side channels that have flowing water through their entire course (A Figure 2).
- Do not sample in tributaries (F Figure 2).

Dry Side Channels

The following criteria must be met in order for a non-flowing side channel (water is not flowing through entire channel) to be included in your survey:

1. Include it if the side channel is a continuous feature whose thalweg is <bankfull of the main channel (D Figure 3). Determine the thalweg location by envisioning where water would flow through the side channel.
2. Don't include it if at any location (normally at the upstream end) the side channel's thalweg is ≥bankfull elevation (B & C Figure 3), unless at that transect the island is below bankfull; then the flag will be placed on the outside bank of the side channel (transect 12 in Figure 2).

Data Collected in Side Channels

- Record the widths of side channels when doing cross-sections and bankfull widths
- Measure wood in side channels
- Don't measure pools in side channels
- Pebbles
- Streambank measurements (if the side channel qualifies)

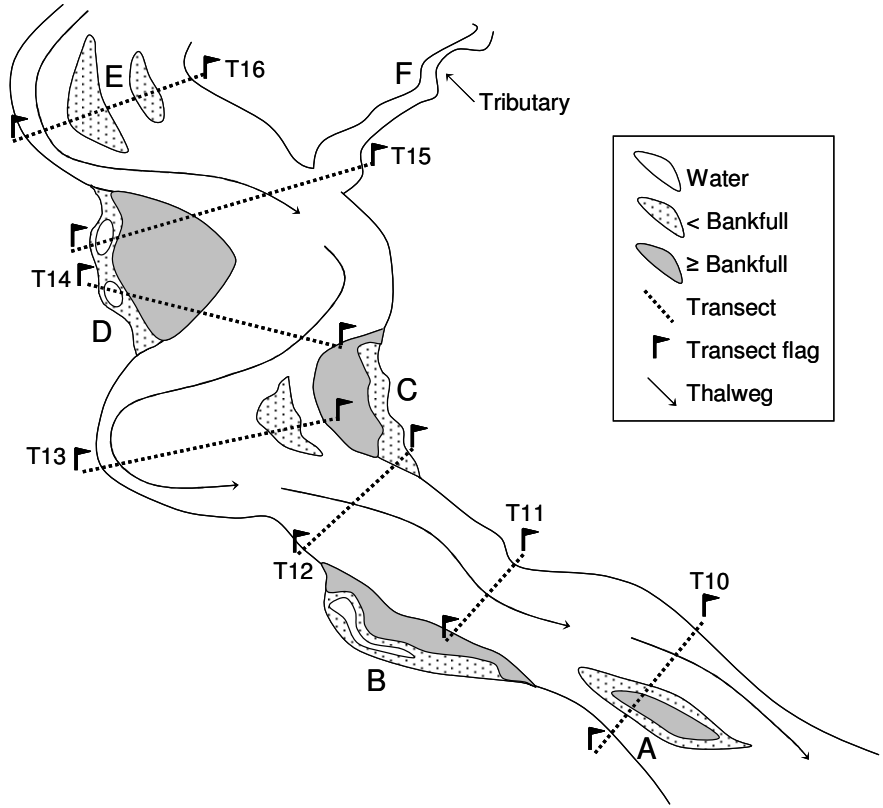


Figure 2. Transect placement when side channels are encountered.

- Place transects across all flowing channels (A & E),
- And across non-flowing side channels that are entirely below bankfull elevation (D).
- DO NOT place transects across side channels whose thalwegs are at any point ≥bankfull elevation (B & C),
- Unless at that transect the island is below bankfull; then the flag will be placed on the outside bank of the side channel (RL transect 12).

UTM COORDINATES

Objective: Use the global positioning system (GPS) receiver to record the Universal Transverse Mercator (UTM) coordinates.

UTMs are used to identify these locations:

- BR
- BR marker*
- TR
- TR marker*
- Reach overview photo
- Temperature probe

When to record UTMs?

- **Record reach overview photo UTMS at all sites**

- **Record BR, BR marker, TR, TR marker UTMs IF:**
  - The 'Site Information Sheet' indicates you should
  - OR, your UTMs seem erroneous
  - OR, you move / replace markers

  If you are asked to collect UTMs collect them from all locations; we need a good, complete 'set' of UTMs

- **Record the location of a temperature probe if you are asked to place it.** (Appendix E: Placing a Temp Probe).

Before you Start: Make sure your GPS is set using the NAD CONUS 27 datum. The PIBO-EM manual of manuals (M.O.M.) has instructions for selecting the datum of your GPS receiver

Procedure:

1. Record two sets of coordinates at each location
2. Turn GPS off in between 1st and 2nd measurements at each location.

3. Each coordinate consists of 4 components:
   a. Zone
   b. Easting coordinate
   c. Northing coordinate
   d. Accuracy
4. Calculate the average UTM coordinate and accuracy; record them on Form 1 and in the data logger (BR / TR marker UTMs are only recorded on Form 1 not in logger).
5. We want UTM coordinates to be as precise as possible. If your accuracy is >± 20m, then wait until you get better accuracy**.**

***UTM Coordinates- record if 1) instructed 2) move/replace markers 3) UTMs provided are erroneous**																		
		Accuracy	Zone	UTM Easting							UTM Northing							
*Bottom of Reach	1st																	
	2nd																	
	Avg																	
*BR Site Marker	1st																	
	2nd																	
	Avg																	
*Top of Reach	1st																	
	2nd																	
	Avg																	
*TR Site Marker	1st																	
	2nd																	
	Avg																	
Reach Overview Photo **record at all sites**	1st																	
	2nd																	
	Avg																	

Figure 3. Excerpt from Form 1.

Recording data:

- All sites within our study area have a '0' as the first number in the easting coordinate. Don't record this '0' on Form 1 or in the logger, just record the last 6 numbers.

- Please be careful when recording UTMs on Form 1 and in the logger, transcription errors are very common!

RECORD DISTURBANCE

Objective: Record disturbances on Form 1 and in the logger

Disturbance												
Beaver: % reach impacted	N	Y*	10	20	30	40	50	60	70	80	90	100
Y* = evidence of beaver, but no dams within reach												
Grazing %	N	10	20	30	40	50	60	70	80	90	100	
Channel Shift: *one of the two lengths must be ≥15m*	Length of old main channel that is now abandoned: _____m						Length of new main channel: _____m					

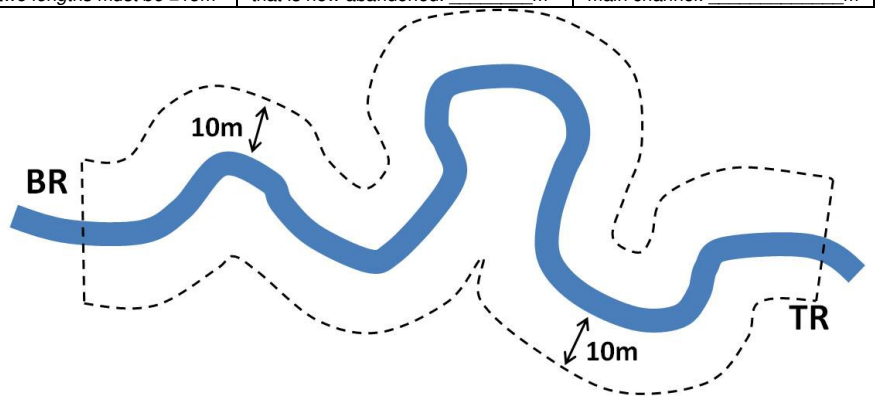


Figure 4. Depiction of where to assess disturbance and excerpt from Form 1. Area of consideration is between the BR and TR, and extends 10m from the stream channel (blue line) on both banks. In this example you would assess all disturbances within the dotted shape.

Record disturbances found within the area depicted above.

Beaver:

- N = no beaver dams and no evidence of beavers
- Y = evidence of beavers (chewed sticks, beaver lodge, slides, etc) but no dams
- % reach impacted: select % of area (depicted above) impacted by beaver dams and beaver pools.
- Always draw a reach map if your site is impacted by beavers

Grazing:

- Estimate the percent of the area (depicted above) that shows evidence of livestock.
- Indicators include: trampling (evidence of hoof prints), trailing, grazed vegetation, cow pies, etc.

Other disturbances?

- If you see other disturbances within the area depicted above, make a comment in the logger and on Form 1.
- Examples include: Fire, Mining, Timber Harvest, other?

Channel Shift:

- Compared with past visits, has the main channel has shifted?
- If a main channel shift has occurred and is ≥15m, measure and record the following on Form 1 and in the logger:
  - Length of the old main channel that is now abandoned (80m in the example below)
  - Length of the new main channel (50m in the example below)

Visit 1: BR looking US Visit 2

The main channel has shifted and the BR is in a dry channel.

If your site has a channel shift ≥15m:

- Record channel shift on Form 1 and in logger, AND make a detailed comment
- Draw a new map. Label 'new / old main channel'
- Photos
  - Repeat any photos in old main channel
  - Take new misc stream photos in the new main channel
  - Take new misc stream photos of where new and old main channels meet (starred location in figure 5).
  - Take new misc. stream photos showing the change

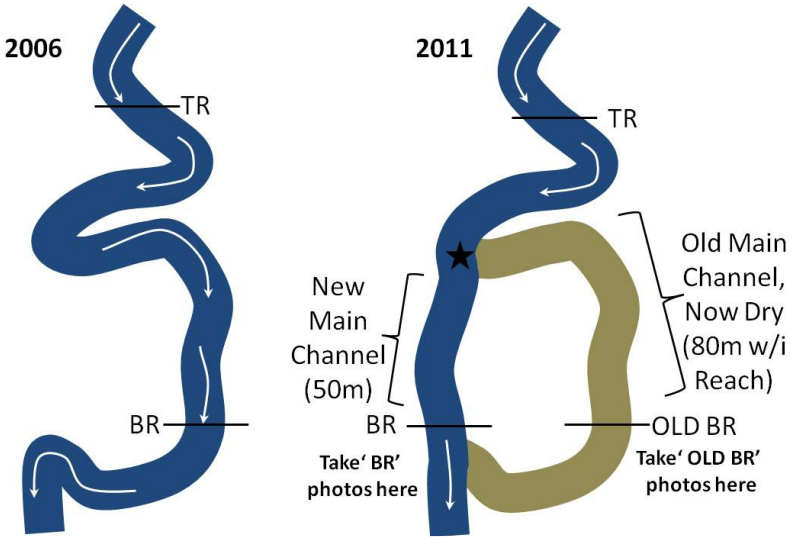


Figure 5. Since 2006, the main channel has shifted and the old BR is now in a dry channel. Move BR to new main channel, perpendicular to valley. Take new misc. stream photos of where the old and new main channels split (starred location). Repeat any photos in the old main channel, and take new ones of the new main channel.

If BR / TR are no longer in a main channel:

- Move BR / TR (perpendicular to the valley) into the new main channel
- Move BR / TR marker if necessary, and record maker info
- Record new UTMs (BR, BR marker, TR, TR marker)
- Repeat photos of BR / TR and label them 'OLD BR / TR'
- Take new BR / TR photos
- Sample in old channel? If it qualifies (reference side channels)
- Question: Do I sample the old main channel?
- Answer: If it is a qualifying channel - see 'Side Channels' pg 12

RECORDING STREAM FLOW

Stream Flow (circle one)
Flow (whole reach) No flow (completely dry) Other (make detailed comment)
Ex: *trickle of flowing water transects 1 – 7, water in pools transect 8-17, rest reach dry*

Figure 6. Excerpt from Form 1 showing flow categories and an example of a detailed comment.

Objective: describe flow conditions throughout your reach.

After you have walked the entire reach, circle the appropriate flow category:

- Flow (whole reach): there is continuous flow of water throughout the entire reach
- No flow (completely dry): there is no water within your reach, it is 'bone dry'
- Other (make detailed comment): this can describe a wide variety of flow conditions, so please write a thorough, detailed comment on Form 1 and in the logger.
- Examples of flow comments:
  - *"No flowing water within reach, but there is water in pools"*
  - *"Flow whole reach, but it is just a trickle"*
  - *"Trickle of flowing water transect 1-7, water in pools transects 8 – 17, rest of the reach is dry"*

If the flow at your reach is 'no flow' or 'other' consult 'Appendix C: Sampling When There Isn't Flowing Water throughout the Site' pg 95 for additional sampling instructions

SITE MARKERS

Background: Bottom of reach (BR) and top of reach (TR) markers are used to monument the site location and determine where to start and stop sampling. Nearly all of the sites you sample will already have BR and TR markers placed.

Wilderness: Site markers will not be placed in designated wilderness areas. Rather, a distinctive feature (large spanner, snag, rock or tree) near the BR and TR will be used to monument the site in wilderness areas.

Some sites have markers, some don't:

- Old Sites have should have BR and TR markers, BUT some may be missing (the tree it was on fell over, the wire attaching it broke, etc)
- New sites have no markers

Objective: We want to have 1 marker at the BR and 1 marker at the TR. Determine if your site has markers at the BR and TR. If marker(s) were placed, validate them, if there isn't a marker at the BR and / or TR, place it.

Validate OLD BR / TR Markers

1. Locate OLD marker
2. Validate / record UTMs
   Only record UTMs if:
   a. Site Information Sheet indicates to collect UTMs
   b. You place a new marker
   c. You move an existing marker
   d. Old UTMs are incorrect
3. Validate marker info. We want to maintain the OLDEST marker info, because we always want to go back to the original BR / TR. CORRECT the following information, DO NOT UPDATE IT.
   a. Description – does it accurately describe marker location, if not update it.
   b. Bearing – does the old compass bearing seem reasonable, or was the crew off by 180°?
   c. Distance – was the old distance reasonable?

4. Replace the marker if you don't think it will last another 5 years.
5. Always take a new photo of the markers. The purpose of this photo is to help you quickly locate the marker. Always strive to take a better photo. Take the photo from a new location if the old location is unsuitable (zoomed in too much, poor angle, can't see BR in picture, etc).

Recording marker data

- If you update any marker info:
  - Circle 'Y' in the 'Marker Info / Info Collected' column on the back of Form 1
  - Write marker info on the front of Form 1
  - NOTE: no marker info is entered into the logger
- If you didn't update marker info circle 'N' in the 'Info Collected' column on the back of Form 1.

- Question: What if the marker is gone?
- Answer: Confirm that you are 100% in the correct spot and that the marker is gone, then follow the 'Placing new BR / TR marker' procedure.

- Question: "What if a wilderness site has markers? Should I take them out?"
- Answer: Yes, take them out. Select a distinctive feature to use as a surrogate. Record new marker info on Form 1 and circle 'Y' in the 'Marker Info / Info Collected' column on the back of Form 1.

Placing new BR / TR markers:

1. Locate an easily identifiable feature near the BR / TR to attach the marker.
   a. Use something relatively permanent like a tree near the BR / TR.
   b. Use something distinctive. For example a lone cottonwood tree near the BR, or a large stump with a burn mark.
2. Make sure the BR marker has 'PIBO BR' indented into it and the TR marker has 'PIBO TR' indented into it.
3. Attach the marker to your chosen spots with a nail or wire.
4. Record the following information and record it on Form 1
   a. UTM coordinates of the site markers location.
   b. Brief description of the site marker location (eg. US of BR 5m on RL attached to trunk of large juniper).
   c. Compass bearing from the BR marker to the BR and from the TR marker to the TR.
   d. Measure the distance from the marker to the thalweg at BR and TR.

Remember, if you are replacing markers at an OLD site, we want the directions to point to the original BR / TR!

MACROINVERTEBRATES

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

Special situations:

- Yes, collect macroinvertebrates (bugs) in sites with beaver dams, see 'Appendix B: Sampling Sites with Beaver Activity' pg 89 (*simply stated we want bugs collected DS from dams)*
- Yes, 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 - see Appendix C: 'Sampling When There Isn't Flowing Water throughout the Site' pg 95

Sampling Overview:

- Collect bugs from the first 4 riffle / runs (fast-water habitat) upstream from your BR.
- Collect bugs at 2 locations in within each riffle / runs, for a total of 8 samples
- Determine each bug net placement using random numbers.
  - Generate 2 pairs of random numbers 1 - 9 on the data logger.
  - The first number in each pair (multiplied by 10) represents the percent upstream along the habitat unit's length.
  - The second number in each pair represents the percent of the stream's width from river left (RL) looking downstream.
  - Repeat this process to locate the second sampling location.
  - Take samples where the length and width distances intersect (estimate by eye).
  - If it is not possible to collect bugs at one of these locations (log in the way, too deep, cannot seal bottom of net, etc.), generate an additional set of random numbers and sample the new location.
- NOTE: If no fast-water habitats occur, take the samples from shallow, slow-water habitat units.

How to collect bugs at each net placement:

1. Collect samples using a Fixed Area Design (0.72 m^2) 500 µm mesh net from fast water habitats.
2. Place the kick net so the mouth if facing into the flow of water. If there is no detectable flow, orient the net to most easily facilitate washing benthic material into the net.
3. Collect invertebrates from within the sampling frame in front of the net.
   - Work from the upstream edge of the sampling plot backward and carefully pick up and rub stones directly in front of the net to remove attached organisms.
   - Quickly inspect each stone to make sure you have dislodged everything and then set it aside. If a rock is lodged in the stream bottom, rub it a few times concentrating on any cracks or indentations.
   - After removing all large stones, disturb small substrates (i.e. sand or gravel) to a depth of about 10 cm by raking and stirring with your hands.
   - Continue this process until you can see no additional organisms or organic matter being washed into the net.
   - After completing the sample, hold the net vertically (cup down!) and rinse material into the bottom of the cup.
   - If a substantial amount of material is in the net, empty the net into the 14-liter bucket for processing before continuing to the next sample location. Otherwise, move to the next sample location and repeat the above procedure to create a composite sample.
4. Field processing requires a 14-liter bucket, a white plastic washtub, and a 500 µm sieve. Use the bucket to decant organisms from inorganic substrates into the sieve. Use the washtub to transfer stream water into the bucket and then to visually inspect inorganic residue for heavy organisms that were not decanted.
5. Continue this process until all 8 samples have been collected and placed in the bucket. Make sure you thoroughly wash organisms from the net by vigorously pouring water down the net and into the cup. If the net has a cup at the end, remove the cup over the top of the bucket and wash it out.
6. Remove and release all vertebrates, including fish and amphibians.
7. Collect all crayfish and put them in their own jar.

8. Add water to the bucket and decant invertebrates and organic matter from the sample by stirring the contents of the bucket and then pouring suspended material through the 500-µm sieve. Repeat this process until no additional material can be decanted. Transfer the material in the sieve (invertebrates and organic matter) into the 2-liter sample jar with a small spoon and then wash any remaining material in the sieve into the jar with a squirt bottle. Place the inorganic residue remaining in the bucket into the plastic washtub and cover with water to a depth of 1 cm. Inspect the gravel on the bottom of the tub for any cased caddis flies or other organisms that might remain. Remove any remaining organisms by hand and place in the sample jar.
9. Once all samples have been processed, fill the jars with 95% EtOH. Immediately label the jars inside and outside. Preserve this composite sample in 1 or more sample jars depending on the amount of material collected. If there are multiple jars, label them as 1 of 2 and 2 of 2, etc. and then tape them together.
10. Record the number of bug jars on Form 1 and in the data logger.

Reach ID: 150-05-IK-M2-05 Jar # 1 of 2
Stream Name: Big Ramey Cr
Date: 06/15/05

Figure 7. Example of macroinvertebrate label.

WATER CHEMISTRY

Conductivity

- Measure conductivity once at the TR using a hand held conductivity meter.
- Measure the first time you are at the TR. Don't take samples where channel sediment has been disturbed, i.e. don't measure water chemistry where you've walked.
- Take the reading in flowing water, near the center of the channel, and record on Form 1 and in the data logger.

Recalibrate the conductivity meter at the beginning of each 8-day sampling period.

Alkalinity

- Measure and record total alkalinity at the same time and location as conductivity.
- Record measurements on Form 1 and in the data logger. Specific instructions below (Figure 8).

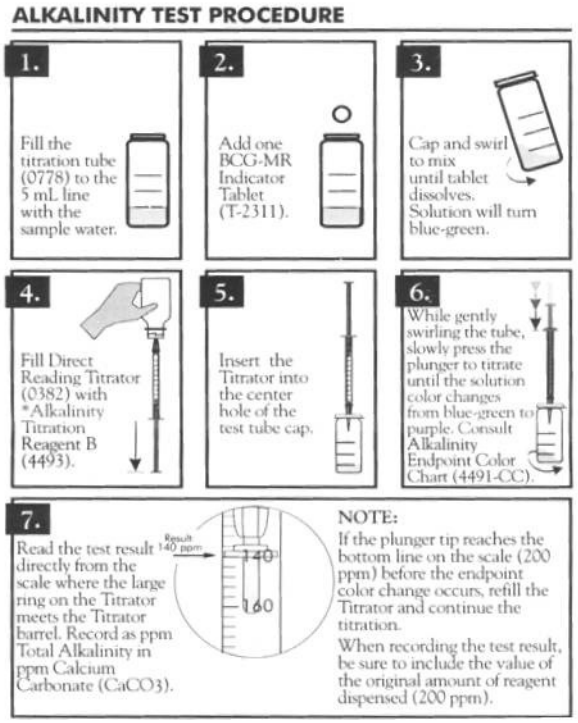


Figure 8.

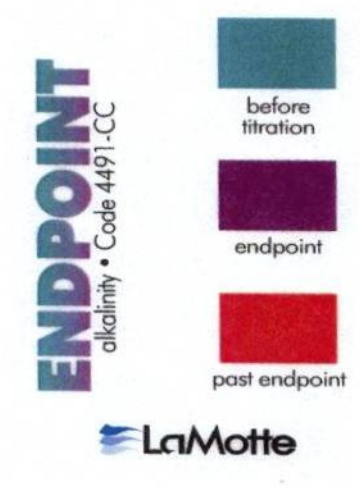


Figure 9. Sequence of color changes for the alkalinity test.

- Each mark on the Titrator is equal to 4 ppm.
- Discard the remaining titration solution and the contents of the Titrator (pour into stream).
- About the device: Leave the adapter tip on. The adaptor tip reduces the size of the drops that are dispensed and increases the precision of the test results.
- A small air bubble may appear in the Titrator barrel. Expel the bubble by partially filling the barrel and pumping the titration solution back into the inverted reagent container. Repeat this pumping action until the bubble disappears.

Special situations:

- Partial flow: measure water chemistry in sites with partial flow. The rule is, if there is any water in any part of the reach, measure it. Describe flow conditions on Form 1 and in logger.
- Beaver: measure water chemistry at the bottom of the reach, not the top of reach. If there is a beaver dam / pool at BR, measure water chemistry below the dam / pool even if it is downstream from the reach.

PHOTOS

Background: Photos are important for relocating sites and detecting change through time. They are included in annual reports and presentations, and used by others outside of our program. Photos are one of the easier tasks that you will perform, please relax, take your time and take quality photos.

General photo do's and dont's:

- Do not take photos displaying unprofessional behavior.
- You must be wearing a shirt and boots / shoes (no sandals) if you are in a photo.
- Do not zoom-in.
- Avoid taking photos looking into the sun, take photos with the sun at your back.
- Try to avoid taking photographs where part of the frame is in the shadows and part in the sun.
- Hold the camera 1.5 meters from the ground (use a depth rod as a guide).
- A depth rod should be in the following photos: BR, TR, misc. stream
- If your camera is **broken or lost,** use a personal camera if one is available, and download photos with supervisor at the end of the hitch

Recording details about each photo on Form 4 and in the data logger:

NOTE: Don't fill in grayed out boxes on Form 4 or equivalent info in the logger

- Photo Number: record the number in the display screen on the back of the camera after you take the photo.
- Description: select appropriate description on Form 4 and in logger.
- Rod Location: rod should be in BR, TR, and misc. stream photos
  - Streambank – Record whether the rod is on River Right (RR) or River Left (RL).
  - Transect Number (misc. stream only) – List the number of the closest stream transect to the depth rod.
  - Direction from Transect – Circle whether the depth rod is upstream or downstream of the transect.
  - Distance – Measure the distance from the rod to the transect.
- Camera Location:
  - Camera Facing – Circle whether the camera is facing upstream (US), downstream (DS).
  - Distance to Rod – Distance from camera to depth rod.
  - Bearing to Rod – Use a compass and record the bearing from the photo point to the depth rod.

NOTE: Record reach overview UTMs on Form 1 and in the logger

Reach ID / Date Photo

- Always take this photo first. Remaining photos can be taken in any order.
- Include stream name, reach name (group – order – site type – crew code – year), reach ID (four digit # given on the site info sheet), and date using the format below.

> *Elk Creek*
> *123–07–I–M2–07*
> *5144*
> *June 11, 2007*

BR & TR Marker Photos

- Take these photos at every site.
- The purpose is to help you locate the marker.
- Always strive to take the best photo possible (don't repeat an old photo unless it is from the best location)
- Don't zoom in too close (see example below)
- The photo should include the marker and the BR (see examples below)


Bad reach marker photo. Imagine you are sampling the reach in the photograph on the left. Does this marker photo help you locate which willow the marker is attached to? No, it is zoomed in too closely.

There are 2 different scenarios for shooting BR, TR, Misc. Stream, and Reach Overview photos:
1. Duplicating photos from **OLD SITES**, and
2. Taking photos at **NEW SITES** which have not been sampled.

Photos at OLD SITES

Objective:

- Duplicate BR, TR, misc. stream, beaver photos and reach overview photos as closely as possible
- Take more photos if:
  - Stream changed
  - Old photos do not depict the entire reach
  - You think you can take a better photo that will be easier to repeat in 5 years.

Repeating BR, TR, Misc. Stream, and Reach Overview Photos

- Your primary goal is to duplicate old photos as closely as possible
- Examples of good repeat photos are on the cover
- Old photos will be provided when you sample an old site.
- Use an old photo's description to help locate where it was taken.
  - Beware that many old photo descriptions have errors.
  - Your transects won't necessarily be in the same location as past samples

- After relocating where the old photo was taken from, visually compare the old photo with what you are seeing through the camera's viewfinder.
- Pay particular attention to the corners of the old photo, does your photo have the same features in each corner?
- Does your photo look like it is too close or too far away? If so move.
- Is the horizon the same? For example, is the meadow behind the stream towards the top of the old photo, but near the middle of yours? If so make the necessary adjustments.
- Once you take the new photo, compare it to the old version. If they don't match, shoot it again.

Repeating Photos, Special Circumstances

- **NOTE about 2001 photos: You may be** given BR / TR from 2001; these pictures were taken standing on the BR / TR, not standing back looking at the BR / TR. Do not repeat 2001 BR / TR photos. Take new photos standing at least 5 meters back from BR / TR (as far back as necessary to include both banks)
- **Channel shifts** (read ' Recording Disturbance' pg 16 for more details)
  - Repeat any photos in old main channel, even if it is dry
  - Take new misc stream photos in the new main channel
  - Take new misc stream photos of where new and old main channels meet (starred location in figure 5).
  - Take new misc. stream photos showing the change
  - If BR / TR are no longer in main channel:
    - Repeat photos of BR / TR and label them 'OLD BR / TR'
    - Take new BR / TR photos
- **Beaver sites** – read Appendix B

Poor repeat photos. When repeating photos use both foreground and background indicators to match the original. The horizon matches in these photos, but the left photo was taken from the middle of the stream while the right photo was taken near the RR bank. Notice how the large conifer is not framed in the photo on the right? and that the mountain is not in the same position?

Take a new photo, rather than repeating the old one if:

- You are instructed not to repeat it
- OLD photo is missing
- OLD photo is horribly out of focus
- OLD photo was taken from incorrect / unsuitable location
- There should be a minimum of 5 misc stream photos / reach. Take additional misc stream photos if there are less than 5, make sure to repeat of the stream channel (include both banks) that are:
  - Representative of the site
  - Areas that you think may show change through time
  - Areas of the reach that are not included in other photos

Taking additional photos if:

- Stream changed dramatically, or something 'weird' is going on (burned, partial flow, much more / less LW, heavily grazed, etc.)
- If your site is really brushy, attempt to take additional photos in less brushy locations.

Photos at New Sites

Take photos of the following at each reach.

- Reach ID / Date: Take this photo first. Write the stream name, group / order, reach type, date, and crew on the back of Form 2 using a marker.
- Site marker location (BR and TR): Take the photographs looking towards the reach with the marker in the foreground. Have a second person pointing at the marker. If in a wilderness area do not place a marker, instead choose a good distinctive feature to use as the marker and take a photo of it with someone pointing at it.
- Reach overview:
  - Should be taken from a location where the greatest extent of the reach can be observed.
  - A hillside overlooking the reach is ideal.
  - Sometimes this is a hard shot, try your best.
  - Record UTMs in logger and on Form 1.
- The bottom and top of the reach: Take a photograph looking both upstream and downstream. Stand parallel to the channel at a distance of 5 meters (unless you cannot see both banks, if you cannot, move further back).
- Misc. Stream: Take a minimum of 5 misc. stream photos. Your goal is to take photos of the stream channel (include both banks) that are either:
  - Representative of the site
  - Areas that you think may show change through time

Some points to remember when taking photos at new sites:

- Make sure you include both banks in the photo. For smaller streams stand back from the object of interest at least 5 meters. For larger streams (>8 meters wide) stand back 10 meters or more to assure you can see both banks.
- Try and disperse your misc. stream photos throughout the sample reach, this will lead to a better documented reach.

HABITAT UNITS: POOLS vs. RIFFLE / RUNS

Objective: Classify habitat units within reach as pools or riffle / runs

- **Pools:**
  - Classify formation as: scour, dam, plunge, or beaver*
  - Classify as either 'full' channel pool or a 'partial' channel pool
  - Locate the 'head' and 'tail' of each pool and mark with blue flags
  - Measure:
    - Pool length, along the thalweg
    - Pool tail depth
    - Maximum depth
  - Count the number of pieces of wood within the pool

*Appendix B pg 89 describes how to quantify beaver pools

- **Riffle / Runs**
  - Measure the length
  - Count the number of pieces of wood within the riffle / run

Is it a pool or a riffle / run? If it is a pool, what is the formation?

- Pools are depressions in the streambed that are concave in profile, laterally and longitudinally.
- Pools are bound by a 'head' crest (upstream break in streambed slope) and a 'tail' crest (downstream break in streambed slope).
- Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
- Pools span at least 50% of the wetted channel width at any location within the pool. So a pool that spans 50% of the wetted channel width at one point, but spans <50% elsewhere is a qualifying pool.
- Side channels
  - When islands are present only consider pools in the main channel; don't measure pools in side channels.
  - If a side channel is present, the pool must span at least 50% of the main channel's wetted width; disregard side channels width when making this determination.
- Maximum pool depth is at least 1.5 times the pool tail depth.

If all criteria were not met, it is a Riffle / Run, not a pool.
If criteria were met use this key:

1. Pool length (measured along thalweg), is greater than the pool's width (measured perpendicular to thalweg), at the pool's widest point.
   - No, length <width. Proceed to 3.
   - Yes, length >width

2. Is the pool tail a wood obstruction? And is <u>all</u> water flowing over this obstruction? With no flowing under or beside it?
   - Yes, formation = <u>dam pool</u>
   - No, formation = <u>scour pool</u>

3. Thalweg drops vertically over an obstruction (log, boulder, etc) at the pool's head crest.
   - No = not a pool, classify as <u>Riffle / Run</u>
   - Yes. The max depth must be within a specified distance of the obstruction. This distance is 20% or less of the pool's length. Example: if a reach has a 10m width category, then a plunge pool's max depth must be 2m or less from the obstruction.
     - Yes, formation = <u>plunge pool</u>
     - No, not a pool, classify as Riffle / Run

Determine if pool is 'full' or 'partial' channel pool

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

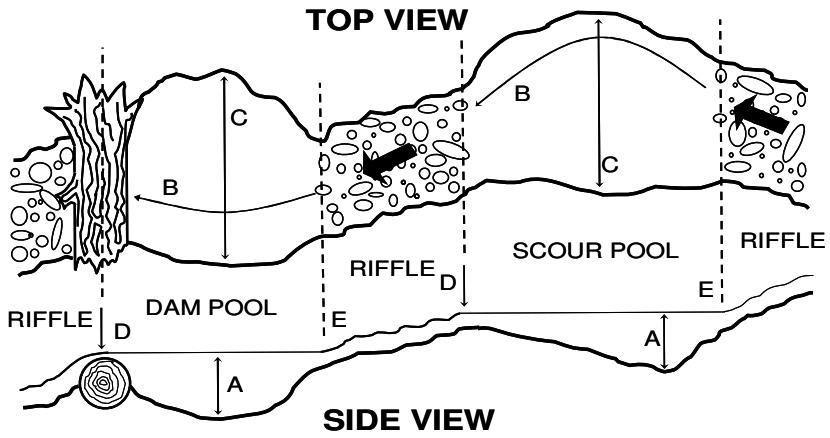


Figure 10. Top and side views of scour and dam pools. Max depth (A), length (B), width (C), tail crest (D) and head crest (E) are labeled.

How to measure pool dimensions

- Length
  - Measure along thalweg
  - Measure between the head and tail crests
  - Measure to the nearest 0.1m
- Pool-tail depth
  - Measured at the maximum depth along the pool tail crest, normally but not always the thalweg
  - Measure to the nearest cm
  - To find this point, imagine that the water in the stream is 'turned off'. You want to measure the depth of the last spot that would have flowing water before the stream stopped flowing.
- Maximum depth
  - This is the deepest point in the pool
  - Locate it by probing the pool with a depth rod
  - Estimate maximum depth if it is unsafe to measure

Riffle / Runs: Data to collect:

- Measure length along thalweg
- Count the number of pieces of large wood within each riffle / run.

COUNTING LARGE WOOD IN POOLS AND RIFFLE / RUNS

Pools

- Only count qualifying pieces of large wood (see large wood section)
- There must be ≥1m of the piece within the concave shape of the pool, pieces beside pools (not within the concave shape) do not count!
- If a piece is in both a riffle and ≥1m is in the concave shape of the pool, include it in the total for both habitat units.

Riffle / Runs

- All qualifying pieces count, no size requirements.
- If a piece is in both a riffle and ≥1m is in the concave shape of the pool, include it in the total for both habitat units.

Select the number of pieces from the dropdown menu in the logger:

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11 – 15
- 16 – 20
- 21 – 50
- 51 – 75
- 76 – 100
- >100

#	Fill out for Pools & Riffle/Runs			Fill out for Pools only			
	Habitat Unit (Pool or Riffle/Run)	Length (m)	# pieces of LW[a]	Formation (scour, dam, plunge, beaver)	Full or Partial	Max Depth (cm)	Pool tail depth (cm)[b]
1	(P) R	5	0	(S) D P B	(F) P	55	7
2	P (R)	30	1	S D P B	F P		
3	(P) R	15	1	(S) D P B	(F) P	65	8
4	P (R)	60	2	S D P B	F P		
5	(P) R	20	0	(S) D P B	F (P)	50	6
6	P (R)	30	0	S D P B	F P		

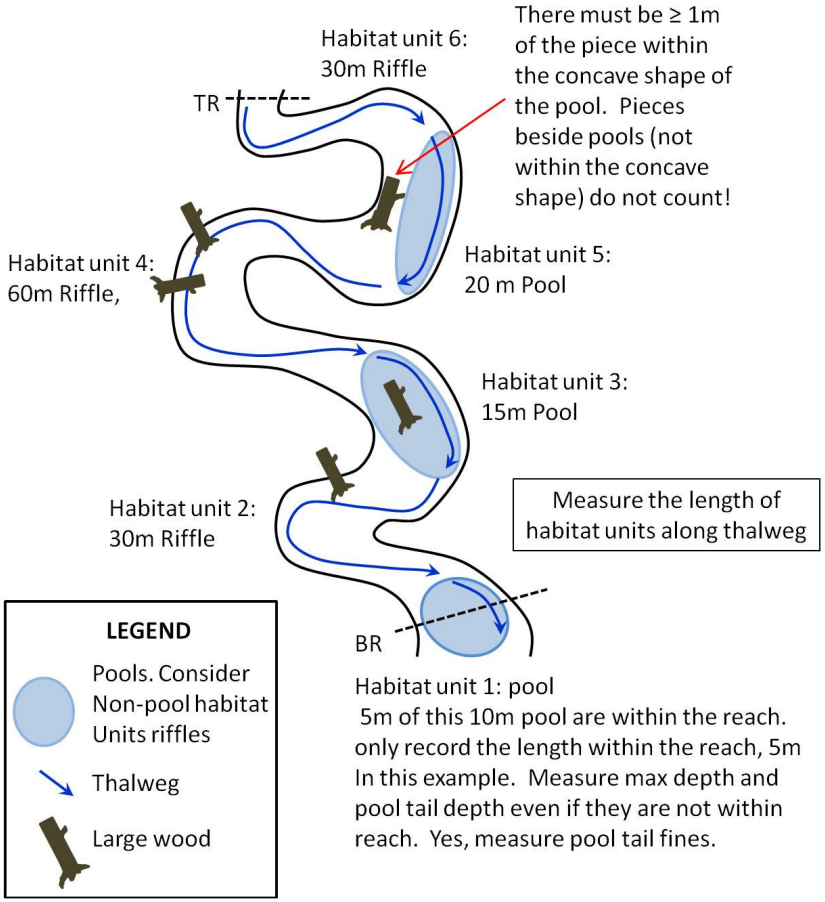


Figure 11. How to record habitat unit information.

Habitat Units: Special Situations and FAQ

Pool partially in reach?

- Question: What if there is a pool near my BR (or TR) that is only partially in my reach? Do I measure it?
- Answer: Yes. Examine figure 11. If a qualifying pool is partially in the reach, measure the length within the reach. Measure the pool tail depth and max depth even if they fall outside the reach. You also measure pool tail fines.

Reach length discrepancy?

- Question: What if 'normal' reach length vs. habitat unit reach lengths are not the same?
- Answer: OK, should be close, but don't have to be exact

No pools?

- Question: What if our whole reach is a riffle?
- Answer: Enter it as 1 riffle.

Partial flow in reach, measure pools?

- Question: What if there isn't water flowing throughout my reach, do I measure pools?
- Answer: Yes! Measure all qualifying pools that have water (even a trickle) flowing into and out of them. Don't measure stagnant pools. Make a comment explaining 'weird' flow issues. For example: 'partial flow in reach. Water was flowing from BR to transect 12, US from transect 12 to TR, there was water in pools, but no flowing water'. In this example you would measure pools between BR and transect 12 only.

Is it 2 pools or 1?

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.

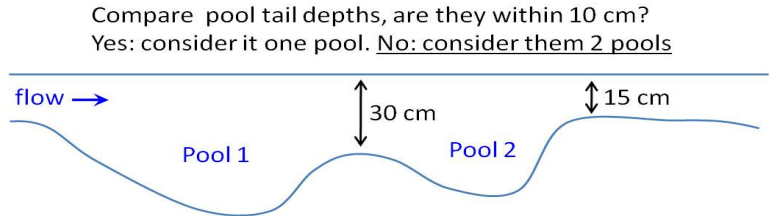


Figure 12. 2 pools or 1? Consider them 2 pools in this example since the pool tail depths are not within 10cm of one another.

POOL TAIL FINES

Objective: Quantify the percentage of fine sediments on the pool tail surface of scour pools and plunge pools.

Sampling method:

1. Measure the first ten scour and plunge pools, beginning at the BR and working upstream. Exclude dam and beaver pools.
2. Use a 14 x 14 inch grid with 49 evenly distributed intersections. Include the top right corner of the grid for a total of 50 intersections.
3. Take 3 measurements per pool.
   a. Sample within the wetted channel
   b. 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 (Figure13).
   c. 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.
   d. Grid placements are estimated visually
   e. If the fines grid lands on a boulder (≥512 mm b-axis diameter), record intersections on the boulder as 'non-measurable' (Figure 14).
   f. In narrow streams, it is OK if grid placements overlap
4. Record the number of intersections that are underlain with fine sediment <2 mm in diameter at the b-axis. Use the 2 mm wide piece of electrical tape on the grid as a reference.
5. Record the number of intersections that are underlain with fine sediment <6 mm in diameter at the b-axis. Use the 6 mm wide piece of electrical tape on the grid as a reference.
6. 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 due to debris, then record the number of non-measurable intersections. Do not attempt to move the obstructing debris.

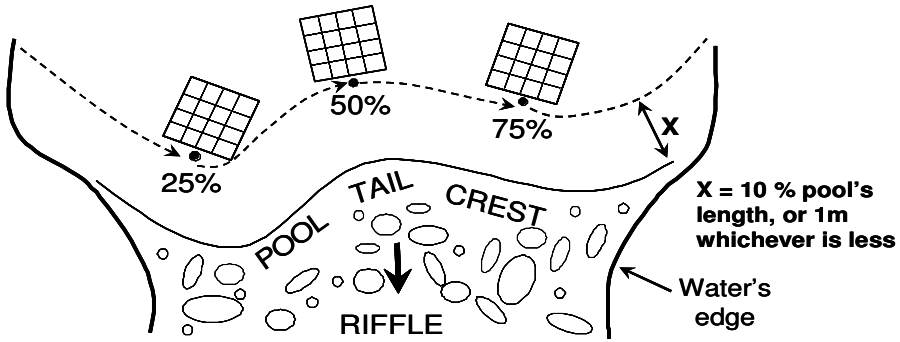


Figure 13. Location and orientation of pool tail fines grids relative to the pool tail crest

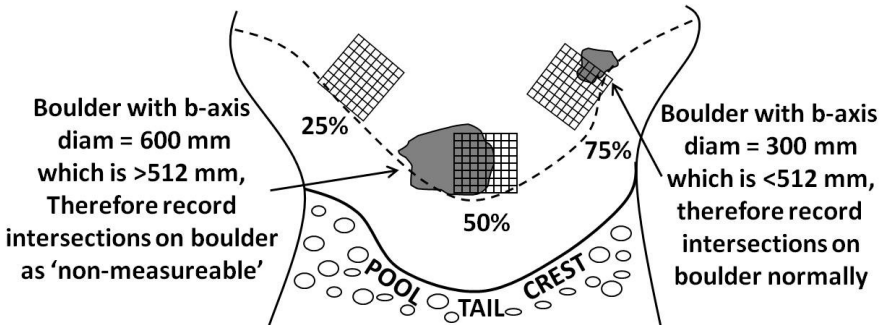


Figure 14. Record intersections of the fines grid that land on boulders ≥512 mm (b-axis diam.) as 'non-measureable'. In this example are recorded as non-measureable.

Reminders

- The number of fines <2mm **cannot exceed** the number of fines <6mm
- The number of fines <6 mm + non-measureable intersections must be ≤50
- This measurement evaluates the size distribution of particles making up the streambed, dust on top of rocks does not count as pool tail fines.

CROSS SECTIONS: INTRO

Gear:

- 30 or 50m Tape
- 2 Depth rods with levels
- 3 (or more) candy canes
- Logger / Form 9
- Ruler
- For wide streams: Stadia rod & Hand level

You will do these 3 measurements at once while working upstream:

1. Cross sections: at even numbered transects ≤20
2. Bankfull widths: at odd numbered transects - see 'Bankfull Width' pg 55
3. Pebble counts: at all transects - see 'Pebble Counts' 53

You will measure 10 cross sections / reach (transects 2, 4, 6, 8, 10, 12, 14, 16, 18, 20).

- Question: What if I measured 10 cross sections but still have more even numbered transects upstream? (This will occur when you have ≥22 or more transects)
- Answer: The logger won't allow you to collect cross sections from even transects >20. Just measure bankfull and pebbles like you do at odd numbered transects.

1. Determine precise location of each cross-section in relationship to even-numbered transects.

- Cross sections are perpendicular to the channel
- You don't have to place cross-sections exactly in line with transects, you can move up or downstream from the transect ½ of the width category (measured along thalweg). If the width category is 8m, you can go up / downstream from the transect 4m (figure 15). If the width category is 14m, you can go up / downstream 7m.
- Find the most suitable location within this area, try to avoid:
  - Undercuts banks
  - Islands
  - Boulders
  - Bars
  - Brushy banks
  - Logs & Log jams
  - Uneven water surface

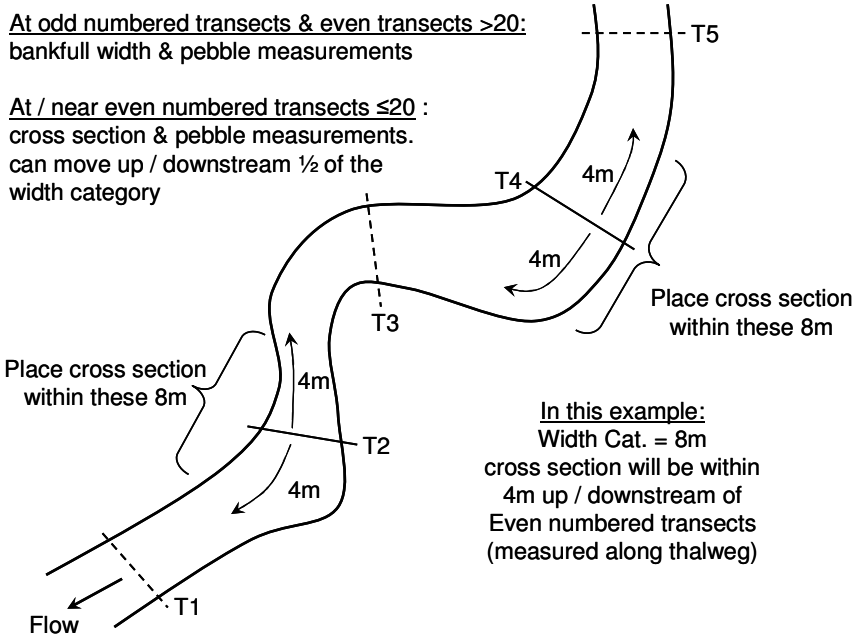


Figure 15. Determine precise location of each cross-section in relationship to even-numbered transect.

2. Determine if you will use the 'water' or 'BF' (bankfull) method to measure each cross section.

- Use the 'water' method when possible, it is faster
- The 'water' method can be used if **all** of these criteria are met:
  1. Water's surface is level from one bank to another
  2. There aren't any islands or bars
  3. The wetted width divided by bankfull width ≥0.5.
  4. Wetted width is >0.20 m

  NOTE: The logger will warn you if you try to use the 'water' method when criterion 3 is not met.

CROSS SECTIONS: Water

Bankfull cross section measurements:

1. Record if the cross section is located in riffle or pool. If one side is in a riffle and the other is in a pool label it 'pool'.

2. Determine bankfull height and mark this location on each bank using candy canes.

3. Pin / hold tape on RL at bankfull.

4. Using the tape, measure the following:
   - LEW distance
   - Bankfull depth at LEW – distance from water's surface to bankfull
   - REW distance
   - Bankfull depth at REW - distance from water's surface to bankfull
   - Bankfull distance on RR bank

   NOTE: Distances are in meters to the nearest cm (3.02 for example), depths are measured in cm.
   NOTE: Bankful heights on LEW / REW must be within 3cm.

5. Within the wetted width, start at the LEW and measure water depth at these locations: 1% (of the wetted width starting from LEW), 10%, 30%, 50%, 70%, 90%, 99% (figure 16)

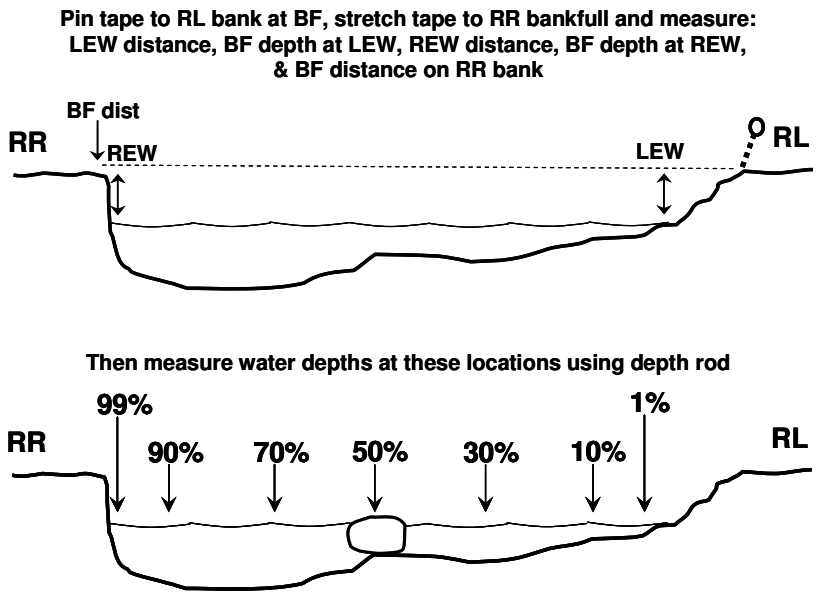


Figure 16. Depiction of water-based cross section method. Notice that the 50% measurement falls on a boulder. Measure how high the boulder is above the water's surface and enter this depth as a negative number.

- Question: What if I cannot measure the bankfull height because the distance from the water's edge to bankfull is too far (i.e. horizontally longer than my depth rod)?
- Answer: Use your stadia rod or the hand level. To use your hand level, hold your depth rod vertically at water's edge. Note the height. Next, have your partner hold the rod vertically at bankull. Subtract this number from your first. This is bankfull height.

- Question: What if one of my measurements falls on a feature (bar, boulder, log, etc) that is above the water's surface? (Figure 16)
- Answer: Enter the distance from the water's surface to top of feature as a negative number using 2 depth rods.

6. Record the width of tertiary channels

7. Measure pebbles before leaving this location - see 'Pebble Counts' section

- Question: What if you cannot find a suitable cross section within +/- Xm?
- Answer: Do the best you can

- Question: what if I select water method, but then I want to change to the BF method because of something
- Answer: hit F4 twice and change method type

CROSS-SECTIONS: BF

Comments:

How to take measurements:

1. Record if cross section is located in riffle or pool. If one side is in a riffle and the other is in a pool label it 'pool'.

2. Determine the bankfull elevation on each bank. Stretch the tape perpendicular to the channel between bankfull elevations with the "zero" end of the tape on the left bank (RL) looking downstream. Make sure the tape is straight and not bowed.

3. Take a minimum of 10 depth measurements starting at bankfull on the left bank and ending at bankfull on the right bank. Calculate the distance between measurements by dividing the bankfull width by 10 and rounding down (ex. bf width=7.8m → interval between measurements=0.7m). Randomly choose the location of the first measurement (using the random number table in the data logger) between bankfull on the left bank and the distance of the interval calculated above (Figure 17a).

4. At each depth measurement record the distance along the tape and the depth from the streambed to the bankfull elevation in cm. At the bankfull location of each bank, record the location along the tape and a depth of "0".

5. In addition, record a measurement type for each applicable depth measurement. Use the following codes:

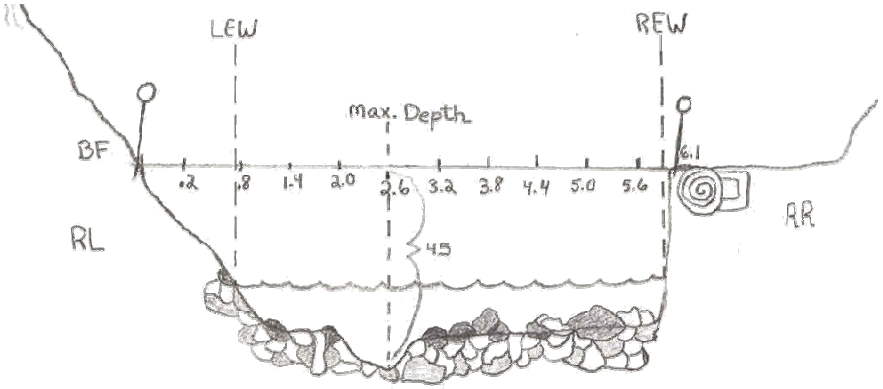
Meas. Type Code	Rod Location
BFDIST	Bankfull distance on RR
LEB	Left edge of bar/island
LEW	Left edge of water
MAXDEP	Maximum depth
ON_BAR	On bar or island
ON_BLD	On a boulder
REB	Right edge of bar/island
REW	Right edge of water

6. If your cross section is dry, enter 'Dry X-sec' as a comment, and don't record LEW / REW measurements.

7. If your cross section has an uneven water surface (LEW vs. REW heights differ by 3cm or more), enter 'Pitched riffle surface' as a comment.

7. Record the width of tertiary channels

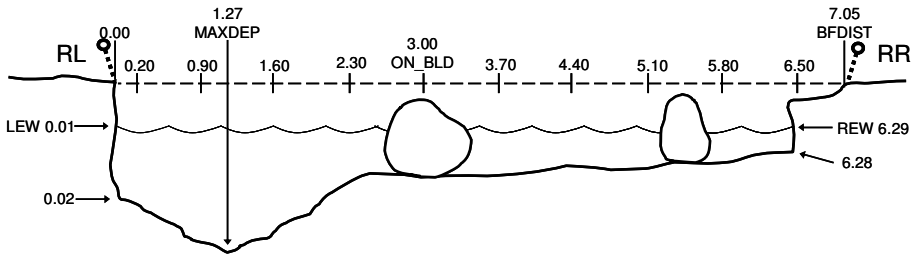
8. Measure pebbles before leaving this location - see 'Pebble Counts' section



Random # =	0.2 m
BF Width =	6.1 m
Interval =	0.6 m

XsecNum	1	
BFDist	BFDepth	MeasType
0.20	10	
0.70	20	LEW
0.80	30	
1.40	40	
2.00	38	
2.60	45	MAXDEP
3.20	40	
3.80	35	
4.40	33	
6.00	30	
6.08	30	
6.09	20	REW
6.10	0	BFDIST

Figure 17a. Channel cross-section figure and tables displaying the location of the tape; layout of depth measurements along the tape; additional measurements of LEW, REW, and maximum depth, and bankfull distance.



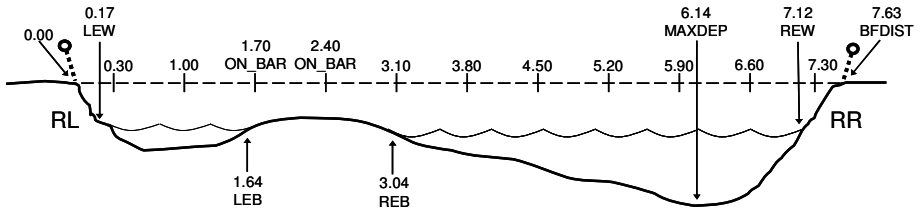
Random # =	0.2 m
BF Width =	7.05 m
Interval =	0.7 m

XsecNum	2	
BFDist	BFDepth	MeasType
0.01	20	LEW
0.02	37	
0.20	39	
0.90	50	
1.27	53	MAXDEP
1.60	41	
2.30	32	
3.00	9	ON_BLD
3.70	32	
4.40	30	
5.10	29	
5.80	27	
6.28	24	
6.29	20	REW
6.50	10	
7.05	0	BFDIST

Figure 17b. Channel cross-section with vertical banks and boulders. If measurements fall on boulders a) within wetted channel and b) above water's surface code the measurements 'ON_BLD'. Enter 'Rocky riffle surface' as a comment.

When the streambank is vertical, enter a depth of "0" at bankfull on the tape, "0.01" for the water's edge and the depth to the streambed at "0.02". For example, (0.01,0.20 LEW), and (0.02,0.40) (Figure 17b).

Only measure to the edge of the bank when an undercut exists. Do not measure beneath the undercut.

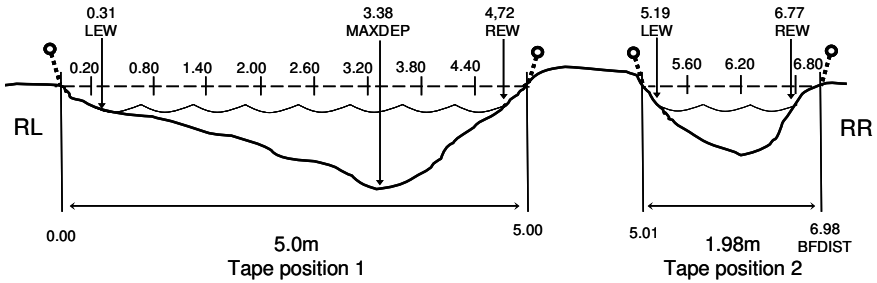


Random # =	0.3 m
BF Width =	7.63 m
Interval =	0.7 m

XsecNum	3	
BFDist	BFDepth	MeasType
0.17	20	LEW
0.30	22	
1.00	25	
1.64	20	LEB
1.70	18	ON_BAR
2.40	15	ON_BAR
3.04	20	REB
3.10	22	
3.80	26	
4.50	30	
5.20	34	
5.90	39	
6.14	44	MAXDEP
6.60	40	
7.12	20	REW
7.30	13	
7.63	0	BFDIST

Figure 17c. Channel cross-section with bar below bankfull.

Measure islands lower than the bankfull elevation as illustrated above (Figure 17c).



Random # =	0.2 m
BF Width =	6.98 m
Interval =	0.6 m

XsecNum	4	
BFDist	BFDepth	MeasType
0.20	12	
0.31	20	LEW
0.80	23	
1.40	33	
2.00	38	
2.60	41	
3.20	46	
3.38	51	MAXDEP
3.80	42	
4.40	23	
4.72	20	REW
5.00	0	
5.01	0	
5.19	20	LEW
5.60	34	
6.20	39	
6.77	20	REW
6.80	17	
6.98	0	BFDIST

Figure 17d. Cross section with island ≥bankfull height. Enter 'Island present' as a comment

For islands higher than bankfull, measure the 2 channels separately (Figure 17d). Make sure to record a "0" depth at bankfull for both channels. Record two 'REW', two 'LEW' and one 'MAXDEP'. Tapes must be perpendicular to each channel. After entering data, hit F4 to back out, the logger will beep and display a message indicating there are errors. Hit F5, and under 'comment' hit F2 and select "island present" as a comment from the drop down menu.

PEBBLE COUNTS

Objective:

- Determine the D50 (median particle size) within the reach.

Where to take measurements:

1. Take measurements at all transects.
2. Sample the entire bankfull channel width across the transect (including qualifying side channels).

Sampling Method:

1. Five particles will be sampled across each transect, from flag to flag.
2. Samples will be taken at 10, 30, 50, 70, and 90% of the way across the bankfull channel width, starting from river left (Figure 18).

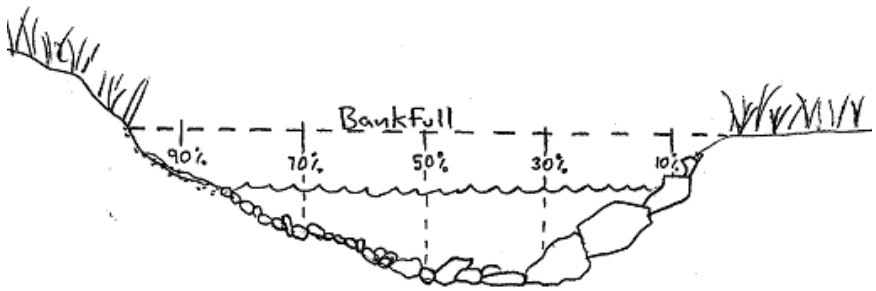


Figure 18. Location across transect for pebble count sampling.

3. Do not include the width of islands / bars that are ≥bankfull elevation.
4. Visually estimate the sample locations prior to walking across the transect.

Continued on following page.

5. Sample the particle at the toe of the foot / depth rod. Reach down with the forefinger (without looking down) and pick up the first particle touched. Measure the middle width (B axis) of the particle. Visualize the B axis as the smallest width of a hole that the particle could pass through.

6. Record particles <2 mm as 2 mm. Record the width of larger particles to the nearest mm. For particles >4097mm, record as 4097mm.

7. Also record whether the particle was found on the streambed (bed) or streambank (bank). See 'Where Streambed and Streambank Meet' pg 3.

8. In deep water estimate the width of the particle.

9. If unable to measure / estimate particle size because it cannot be seen (covered by large wood, excessive depth, turbidity or dangerous conditions) skip it (you will have less than 5 for that transect)

BANKFULL WIDTH

Objective: Determine the average bankfull width for the reach.

Where to take measurements:
- At all odd numbered transects and even numbered transects >20
- Measure the entire bankfull channel width across the transect

Sampling Method:
1. Measure the bankfull width to the nearest 0.1 meters perpendicular to the stream channel at all transects.
2. Measure the bankfull width from one transect flag to the other transect flag on the opposite bank.
3. When local bankfull indicators are not present use the height from the water surface to the bankfull elevation (bankfull height) defined at channel cross-sections to approximate bankfull.
4. Do not take measurements in these situations, record '-99' in the logger:
    - Large wood or heavy brush may obstruct a transect.
    - At tight meanders where the transect may cross a point bar without intersecting the actual bank (located behind the point bar).

Continued on following page.

5. Side channels:
   - Record the width of each channel individually
   - Record the width of the main channel (most flow) as 'MC' in the logger
   - Record the width of the first side channel (2nd most flow) as 'SC 1', and the second channel (3rd most flow) as 'SC 2'.
   - Record the widths of additional channels in the comment field (ex: 'SC 3 = 1.2 m')
   - Do not include the width of islands / bars that are above bankfull.

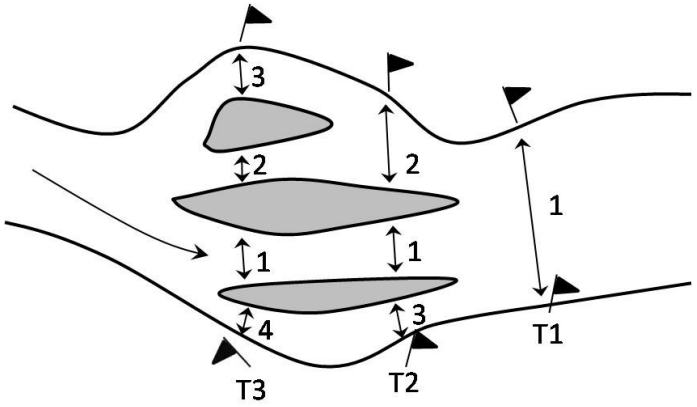


Figure 19. Depiction of how to record bankfull widths when side channels are encountered. The numbers 1 – 4 are used to identify the relative amount of water flowing through each channel, 1 has the most water, 4 has the least. How to label bankfull widths in this example:

- Transect 1: MC = 8.3m
- Transect 2:
  - MC = 2.4 m (labeled '1')
  - SC 1 = 2.6 m (labeled '2')
  - SC 2 = 1.8 m (labeled '3')
- Transect 3:
  - MC = 2.2 m (labeled '1')
  - SC 1 = 1.4 m (labeled '2')
  - SC 2 = 2.0 m (labeled '3')
  - SC 3 = 1.6 m (labeled '4')
  - NOTE: The logger only allows you to enter MC, SC 1, and SC 2, record the widths of additional channels as a comment.

BANK ANGLE

Objective: Quantify bank angle and the frequency of undercut banks within the reach.

Equipment needed:

- Protocol
- Compass
- Depth rod

Locate the following at each transect flag before measuring bank angle:

- Where the streambed and bank meet – pg 3
- Scour line (SL) – pg 3
- Bankfull elevation - pg 2
- First flat, depositional feature – pg 2

Measurement basics

- Lay a depth rod along the bank, perpendicular to the channel, at the exact location of the transect flag. Place a compass on top of the depth rod (not on the sides) and record the angle to the nearest degree.
- Carefully read the instructions for measuring different types of banks

Using your compass to measure bank angle

- The back of your compass has a clinometer, which you will use to measure bank angle
- The compass must be set to 90 & 270, or you cannot correctly measure angles
- Acute angles (undercuts) can be read directly from the compass
- Obtuse angles require you to subtract your measurement from 180°. For example, if you read 45, your angle is 180 – 45 = 135°.

BANK ANGLE: WHERE TO MEASURE

Define precise location where bank angle is measured at each transect flag

- Measurements are perfectly in-line with transect flags, perpendicular to the channel

- Lower limit of measurement: where streambed and streambank meet
  - Exemption: depositional banks: when deposition of streambed material extends above the scour line, the lower limit of measurements is where deposition meets the streambank. Read page 64 for more information.
  - Exemption: slump blocks, logs, rocks: when the connection point (i.e. where the top of the slump block, logs, rocks meets the bank) is below the scour line, the lower limit of your measurement is there. Read page 65 for more information.

- Upper limit of measurement:
  - First flat depositional feature at or above bankfull
  - If this feature is not present, upper limit is 0.5m above the local bankfull elevation (see Figure 20 below).

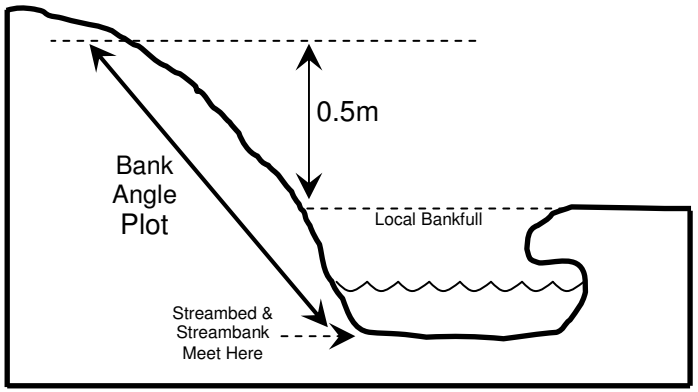


Figure 20. Bank angle plot when flat depositional feature is absent. The upper limit of bank stability plot is 0.5m above the bankfull elevation.

Bank Angle: Undercut Banks

Remember: acute bank angles can be read directly from the compass.

Measure the angle of undercut banks from underneath the overhang using the following criteria:

- A qualifying undercut must be ≥ 5 cm deep, ≥ 10 cm in height, and >10 cm in width. The idea is that you could 'hide' a box of this size in the undercut, without being able to see it from above.
- For all transects with acute bank angles, including undercuts, record undercut depth as one of the following 3 categories:
  - <5 cm non-qualifying undercut
  - ≥5 cm qualifying undercut
  - NA ceiling above BF *(this is a non-qualifying undercut) (*Figures 24 & 25)
- Undercut bank angles are measured from the deepest point of the undercut up to the ceiling of the overhang (Figure 21).
  - Occasionally the back of the undercut will be a consistent depth, thereby lacking a deepest point (Figure 22). Place the depth rod at the highest elevation, resulting in the smallest angle (angle B).
  - Enter the angle as "1°" if the deepest part of the undercut is elevationally above the ceiling (Figure 23).
- In some situations, there will be an undercut with a ceiling below bankfull and a second undercut with a ceiling above bankfull. Measure the lower undercut and ignore the upper one.

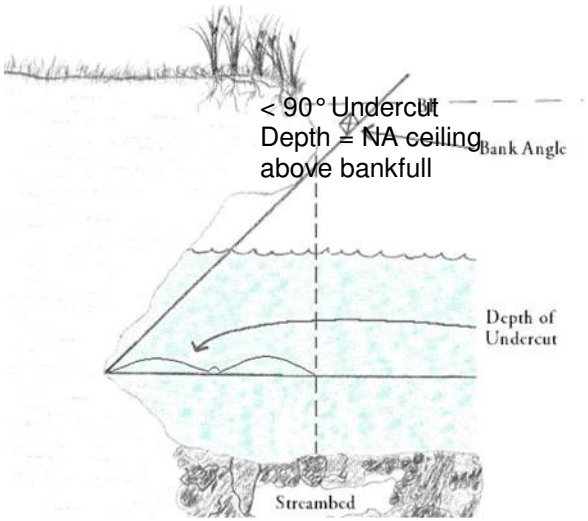


Figure 21. Measure undercut bank angle from the deepest point to the ceiling of the undercut; determine if the undercut has a qualifying depth (≥5 cm) by lowering you depth rod until it is horizontal.

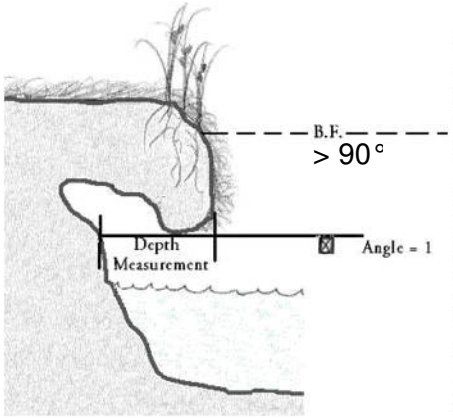


Figure 22. Undercut banks with a constant depth are measured with the base of the depth rod at the highest elevation (angle B, not angle A).

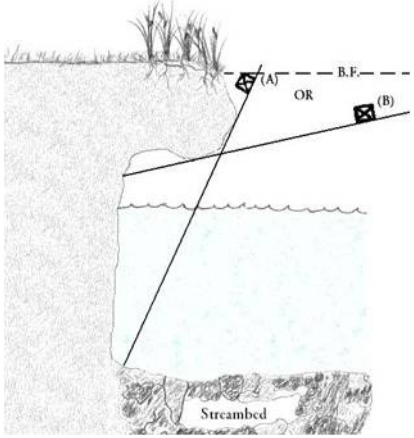
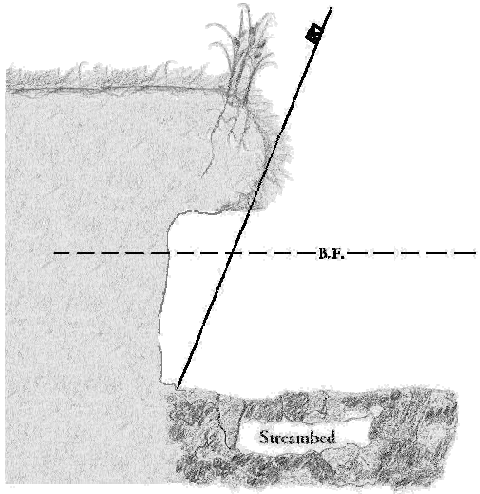
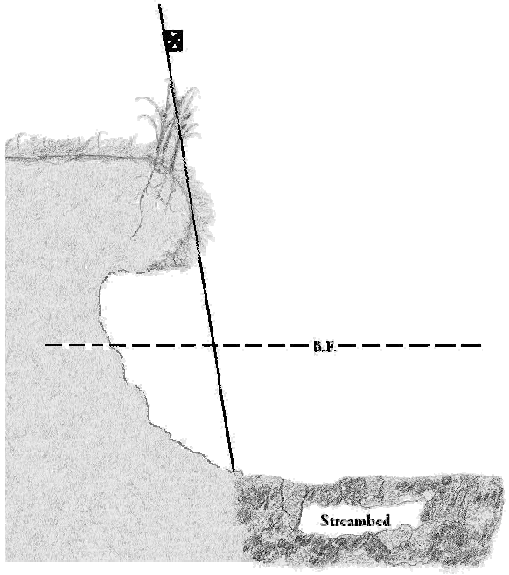


Figure 23. When the deepest point is elevationally above the ceiling of the undercut, determine if the undercut is qualifying by holding the depth rod horizontal and directly underneath the ceiling. Record the angle as 1°.

Figures 24 and 25. Undercut banks with the ceiling above bankfull are measured from where the streambed and bank meet to the outside edge of the undercut.



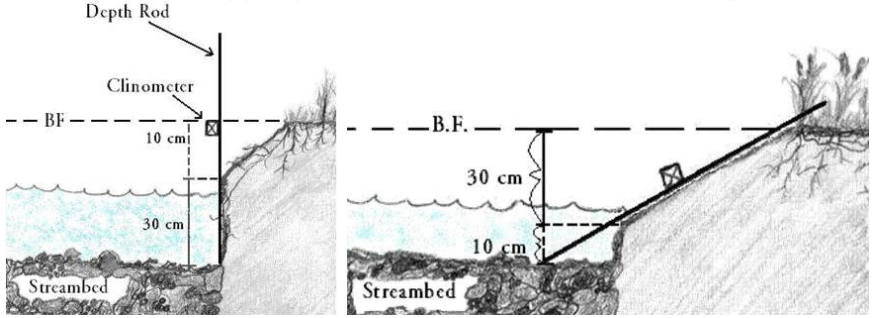


Bank Angles: 1 angle (≥10m in height)

- If the bank slopes away from the streambed, the bank angle is > 90° from horizontal (obtuse). To obtain the actual angle for these banks, subtract the value on the compass from 180 (e.g. the compass reading is 30; 180 - 30 = 150°).
- Forgetting to subtract bank angles from 180 is a common error, before recording data always think, "is the angle obtuse (>90º) or acute (<90º)?"
- Measure the angle from the base of the bank (where the streambed and bank meet) up to the first flat, floodplain-like surface located at or above the bankfull elevation. If a bankfull indicator / feature is not present, the upper limit of bank angle plot is 0.5m above bankfull elevation.

Complex Banks: 2 angles (both ≥10cm in height)

- When a bank has more than 1 angle, consider each angle with a vertical height of ≥10 cm.
- Measure the angle of the lower portion of the bank if it is taller than the upper portion (Figure 26). Similarly, measure the angle of the upper portion of the bank if it is taller (Figure 27).



Figures 26 and 27. Measure the tallest angle when the bank has two dominant angles.

Bank Angles: ≥3 angles (≥10cm in height)

- Measure the average angle by laying the depth rod along the outer corner of the steps (Figure 28).
- Strive to represent the bank angle as accurately as possible with one rod placement.

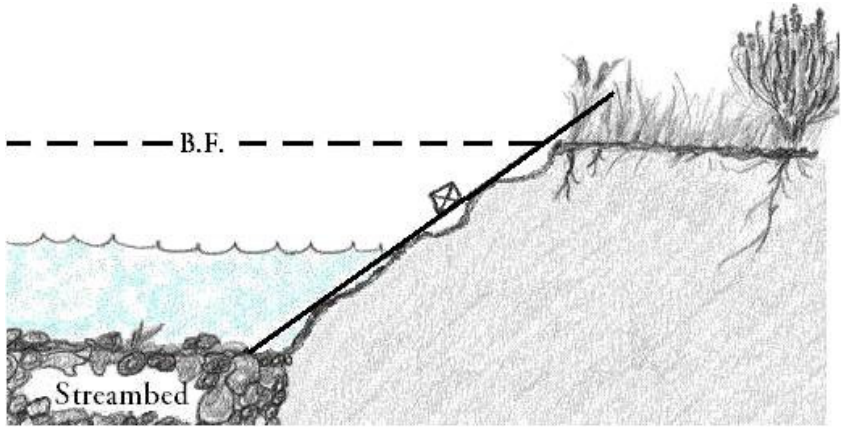


Figure 28. Measure the angle of banks with 3 or more angles by laying the rod along outer edges.

Bank Angle: Depositional Features

Depositional features are not considered part of the bank. Start you bank angle measurement at the point where deposition ends.

- On un-vegetated depositional features such as point bars, start the measurement at the point where the top of the depositional feature and streambank meet (Figure 29).
- If deposition ends at or above the first flat, floodplain-like feature (Figure 30), record '-99 deposition bank' for the bank angle.
- Use the point where the depositional feature becomes >50% vegetated (perennial species) to define were the deposition ends and bank begins.

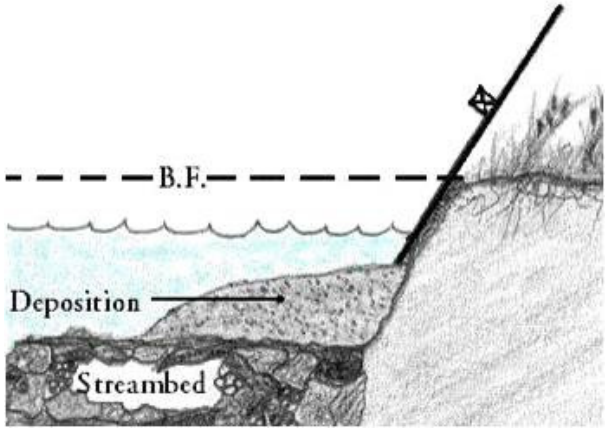


Figure 29. Begin measuring the angle from the point where the deposition and bank meet.

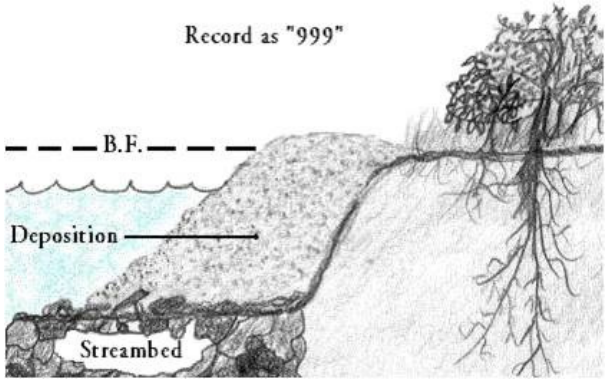
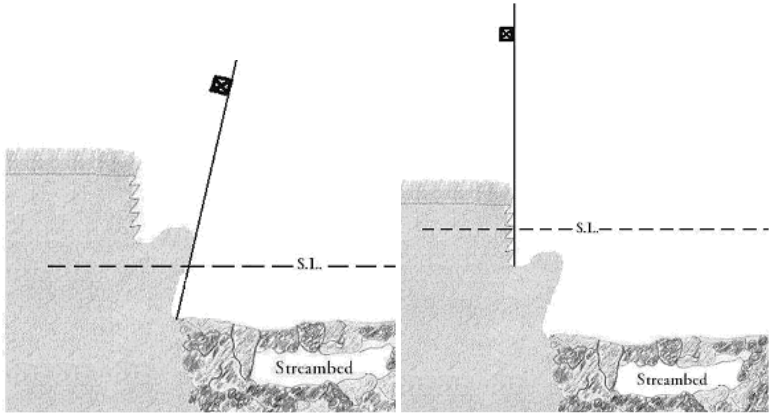


Figure 30. Do not measure an angle when the deposit covers the first flat, floodplain like feature. Record -99 for bank angle.

Bank Angle: Slump Blocks, Logs, Rocks

Slump Blocks

- Slump Block : piece of the bank that is detaching or has detached from the streambank.
- If the connection point (i.e. where the top of the slump block meets the bank) is below the scour line, the lower limit of your measurement is the connection point (Figure 32)
- If the connection point is above the scour line, the lower limit of your measurement is where bed meets bank (Figure 31)
- Do not consider slump blocks that are not attached to streambank



Figures 31 and 32. Location of bank angle measurements with a slump block still attached and relative to the scour line.

Logs and Rocks

- Consider logs (≥10 cm diameter) and rocks (≥15 cm b-axis diameter) as part of the bank if they are embedded within the bank.
- As with slump blocks, determine if the connection point (i.e. where the top of the log / rock meets the bank) is elevationally below the SL. If so, the lower limit of your measurement is the connection point.
- If the connection point is above the scour line, the lower limit of your measurement is where bed meets bank.

Bank Angle Key

This is not a stand-alone key!
Refer to the entire bank angle section of this protocol for specific instructions of how to measure each type of bank

Make sure your compass is set to 90 / 270º

1. Streambank present and accessible?.....Yes, go to 2
   No. Transect located in a tributary..... record -99
   No. Transect inaccessible (too brushy, rattlesnake, etc)..... record -99

2. **Deposition** extends above the first, flat depositional feature?
   Yes..... record -99
   No. Deposition present, but it's below first flat depositional feature.
   Only evaluate portion of bank above deposition.....go to 3
   No deposition, evaluate from where bed / bank meet .....go to 3

3. Is there a qualifying **undercut** bank?
   No qualifying undercut .....go to 4
   Yes, qualifying undercut present. Measure the bank angle, which must be acute (<90°), and classify undercut depth into one of the 3 categories:
   - <5 cm non-qualifying undercut
   - ≥5 cm qualifying undercut
   - NA ceiling above BF

4. Is there a **slump block**, an **embedded log** (≥10cm diam.), or **embedded rock** (≥15cm b-axis diam.) at your transect location?
   No.....go to 5
   - Yes, connection point of the slump block / log / rock elevationally below SL. Follow procedures in #5, but only consider the bank from the connection point up to the first flat depositional feature .....go to 5
   - Yes, connection point of the slump block / log / rock elevationally above SL. Follow procedures in #5 and consider the entire bank from where bed and bank meet up to the first flat depositional feature.....go to 5

5. Bank comprised of **1 angle**.....measure angle
   Bank comprised of **2 angles** ≥10cm in height ..... measure 'taller' angle
   Bank comprised of **≥3 angles** ≥10cm in height .....measure angle

Bank Stability

Objective: Classify streambank stability (into one of 15 categories) at each transect flag

Define precise location where bank stability will be evaluated at each transect flag

- Measurements are perfectly in-line with transect flags, perpendicular to the channel
- The stability plot is 30 cm wide (15 cm on each side of the transect flag).
- Lower limit of stability plot: scour line
  - Exemption: depositional banks: when deposition of streambed material extends above the scour line, the lower limit of the stability plot is where deposition meets the streambank.
  - Use the point where the depositional feature becomes >50% vegetated (perennial species) to define were the deposition ends and bank begins.
- Upper limit of stability plot:
  - First flat depositional feature at or above bankfull
  - If this feature is not present, upper limit is 0.5m above the local bankfull elevation (see Figure 33 below).

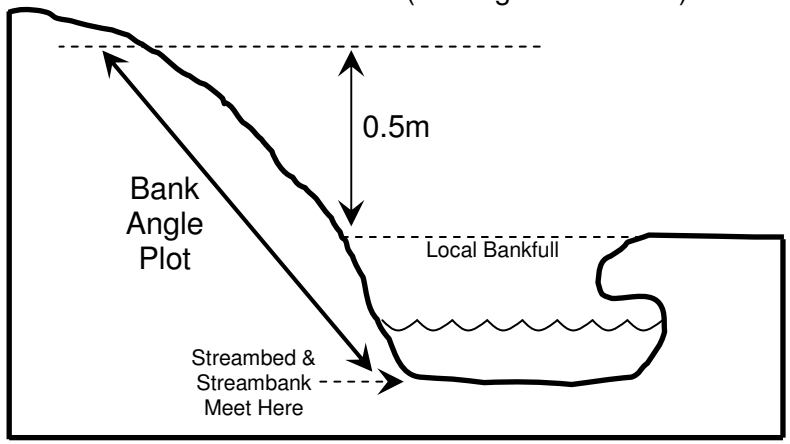


Figure 33. Bank stability plot when flat depositional feature is absent. The upper limit of bank stability plot is determined by adding 0.5m to the bankfull height. The lower limit of the stability plot is the scour line.

Streambank Stability Classification Key - Terminology

Depositional Bank - A streambank with deposition extending above the SL.

Scour Bank - A streambank with no deposition or deposition is below or equal to the elevation of the SL.

Scour Line - Locate the lowest consistent scour line in your reach by examining features along the streambank: lowest consistent limit of sod forming vegetation, lowest consistent limit of perennial vegetation, the ceiling of undercut banks in straight sections of stream channel, on depositional features such as point bars, the scour line is often defined by the limit of perennial vegetation, or by an indentation in the bar (locally steep area). Page 3.

Where to look: the best place to identify scour line is in a straight, well-vegetated section of the stream channel.

Slump Block - That piece of the bank that is detaching or has detached from the streambank.

Crack - A crack in the streambank (start of a fracture feature), but the slump block has not begun detaching from the bank.

Fractured - Slump block has at least partially broken from the bank and is separated from its original location by ≥10 cm.

Fracture Feature - The piece of the bank (usually vertical) exposed by the detaching slump block.

Covered - Banks are 'covered' if >50% of stability plot is covered by:

- Perennial vegetation ground cover (moss is not perennial). Includes live herbaceous vegetation; dead, rooted grasses; and the canopy of shrubs <1 meter in height.
- Roots of vegetation. Deep rooted plants such as willows and sedges provide such root cover.
- Rocks ≥15 cm (b-axis diameter). Rocks do not need to be embedded.
- Logs ≥10 cm in diameter. Logs do not need to be embedded.
- A combination of the above.

Streambank Stability Classification Key

I. Streambank present ____ **go to II**
Tributary ____ **1**

II. Streambank = Scour Bank ____ **go to III**
Streambank = Depositional Bank (Figure 34 II)
Deposition at or above the first, flat depositional feature ____ **2**
Bank covered (deposition below bankfull) ____ **3**
Bank not covered (deposition below bankfull) ____ **4**

III. Bank is not fractured, or the bank is fractured with the slump block no longer attached to the streambank and is either lying adjacent to the breakage or absent ____ **go to IV**

Bank is fractured with the slump block still attached (Figure 34 III). Consider the slump block unattached if only gravity / friction is keeping it in place.

A. The bottom of the fracture feature is elevationally below the SL. View only the fracture feature behind the slump block (III A)
Bank not covered
Bank angle within 10° of vertical (80° - 100°) ____ **5**
Bank angle not within 10° of vertical ____ **6**
Bank covered ____ **7**

B. The bottom of the fracture feature behind slump block is elevationally above the SL (view the bank as the slump block and the fracture feature the vertical, exposed bank) (III B)
Bank not covered ____ **8**
Bank covered
Fracture feature not covered ____ **9**
Fracture feature covered
(slump block re-connected to bank) ____ **10**

IV. No crack visible from the SL up to a point 15 cm behind the top of the bank ____ **go to V**
A crack is visible within this area (Figure 34 IV)
Bank is not covered ____ **11**
Bank covered ____ **12**

V. All other situations.
Bank not covered
Bank angle within 10° of vertical (80° - 100°) ____ **13**
Bank angle not within 10° of vertical ____ **14**
Bank covered ____ **15**

Roman numerals beside pictures on following pages correspond to key

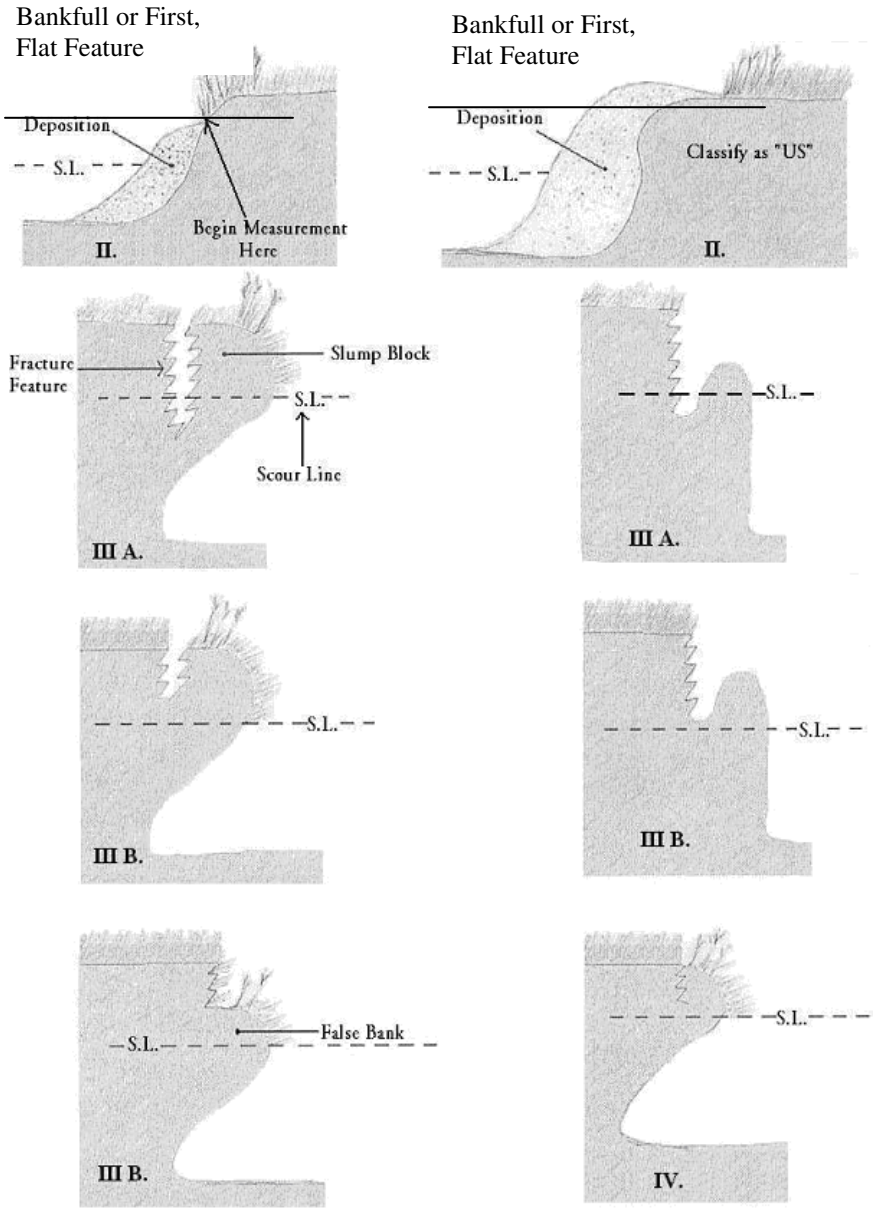


Figure 34. Examples of bank stability types described in sections II, III, and IV in the classification key. The Roman numeral and letter combinations above correspond with the bank stability key on the previous page.

BANK TYPE

Objective: Categorize each transect location based on the fluvial processes forming the streambanks.

How to take the measurements:
Defining the processes that creates the streambank condition at each location is integral to understanding bank stability, bank angles, and undercut bank measurements. Classify the streambanks into 1 of 4 categories based on association with erosion or deposits, pool or non-pool habitat units, and the relation to the thalweg (Figure 31).

1. Determine whether the transect lies within a pool or riffle / run. Consider all non-pool habitat as riffle / run.
2. Record all measurements on the outside bend in pools as “PO” for pool outside.
3. If the pool occurs in a straight stretch of channel, measure from the thalweg to the bankfull elevation on both banks. The bank closer to the thalweg is “pool outside” while the bank further from the thalweg is “pool inside” (Transects 1 & 2 in Figure 35).
4. Streambanks on the inside of pools are further delineated as erosional or depositional. Erosional banks have no deposition or the deposition is below the SL and classified as “PIE” for pool inside, erosional (Transects 1, 2 & 4 in Figure 35). Depositional banks have deposits that extend above the scour line and are classified as “PID” for pool inside, depositional (Transect 5 in Figure 35).
5. For transects where both banks are beside non-pool habitats, record both banks as “R” for riffle / run.
6. In situations near a pool head or tail or side channel, one bank may be within the pool and one in a riffle / run; use the pool classification for both (Transect 2 in Figure 35). For example, you will never have one bank be ‘PO’ and the other ‘R’ for example.

Continued on following page.

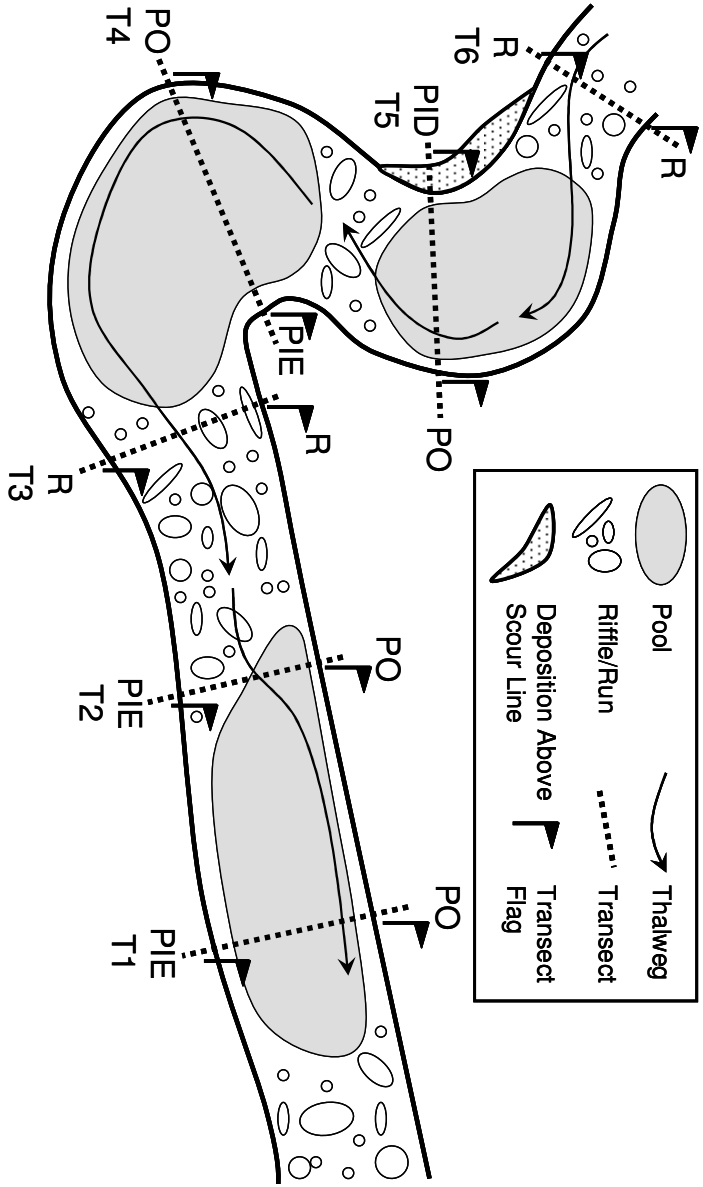


Figure 35. Example of stream showing the four classification categories for bank type.

LARGE WOOD

Objective:

- Quantify all large wood within the bankfull channel, throughout your reach
- Always start at BR and work upstream
- NOTE: you should have already counted large wood when quantifying habitat units (pools vs. riffle / runs)

Sampling Method: In order to be counted, each piece must meet the following criteria.

- Each piece must be greater than 1 meter in length and at least 10 cm in diameter one-third of the way up from the base. For pieces that are not evenly round, measure the widest axis.
- The stem of the large wood piece must extend below the bankfull elevation. Imagine the stream is flowing at bankfull, any piece whose stem is wet would count.
- About dead pieces:
  - Can be fallen or standing trees
  - 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.
  - 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.
- Wood embedded in the streambank is counted if the exposed portion meets the length and width requirements (Figure 37).
- Do not count a piece if only the roots (but not the stem / bole) extend within the bankfull channel.
- 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. Treat them separately if they are no longer touching along the break (Figures 38 and 39).
- Multiple stems originating from one root mass? If you encounter a single root mass with many stems, measure the qualifying stem with the largest diameter.

1. Record the piece number, estimated length (nearest 10 cm), and estimated diameter (nearest cm) of all qualifying pieces in the reach. The same person will make all estimates for a given reach. Record the name of the estimator in the data logger.
2. Also measure the length (nearest 10 cm) and diameter (nearest cm) of the first 10 pieces beginning at the downstream end of the reach. The person estimating should not be made aware of the measured value.
3. An additional subset of pieces will be measured at sites with more than 10 pieces.
    - For sites estimated to have between 11 and 100 pieces, measure the first ten pieces, then starting at the 11th piece only measure every 5th piece.
    - For sites estimated to have over 100 pieces, measure the first ten pieces, then starting at the 11th piece only measure every 10th piece.
4. Measure the length of the main stem and not branches or roots. Begin measurements where the roots attach to the base of the stem when the roots are still connected.
5. Do not measure the length and / or diameter of standing dead trees, pieces buried in log jams, or other pieces that are unsafe to measure. If that piece was one that required measuring, record the estimated length / diameter and leave the measured length and / or diameter blank. Then measure the next required piece, maintaining established interval (see # 4 above).
6. Begin counting from the BR to the TR, and from the bottom up when pieces are stacked on each other.
7. For wood in side channels, see Figure 40 to determine what large wood to count.
8. Large wood in isolated side channels, pools or depressions <bankfull elevation is not measured.

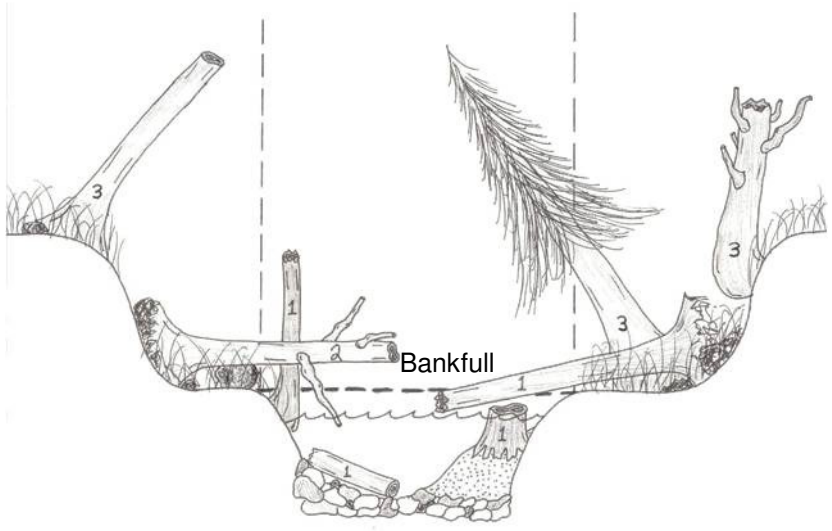


Figure 36. Large wood. Pieces numbered 1 are counted; pieces numbered 2 and 3 are not.

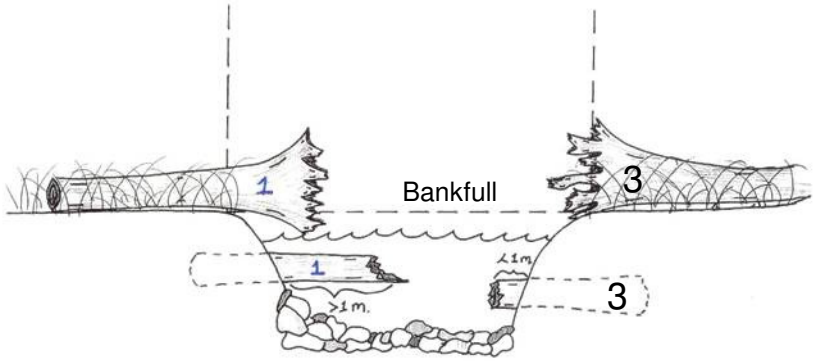


Figure 37. Examples of qualifying large wood (1). The pieces on the right side (3) are not counted (3) because only the roots extend over the bankfull channel (upper) and the exposed section is ≥1 m in length (lower).

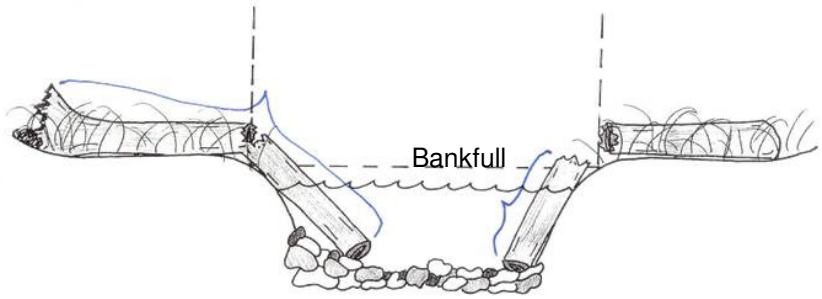


Figure 38. Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

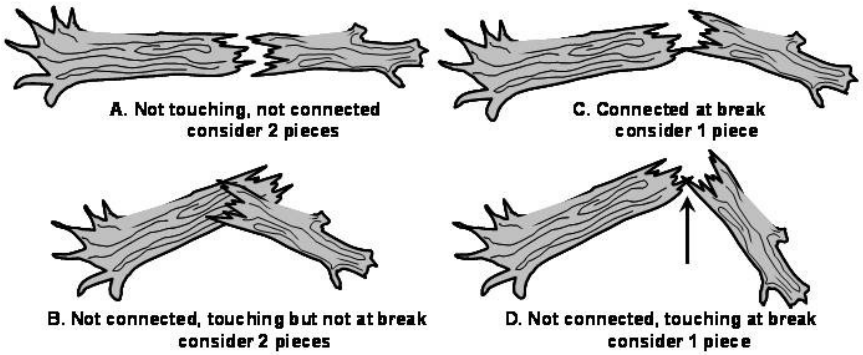


Figure 39. Is it one piece or two? Variations of touching vs. not touching along the break.

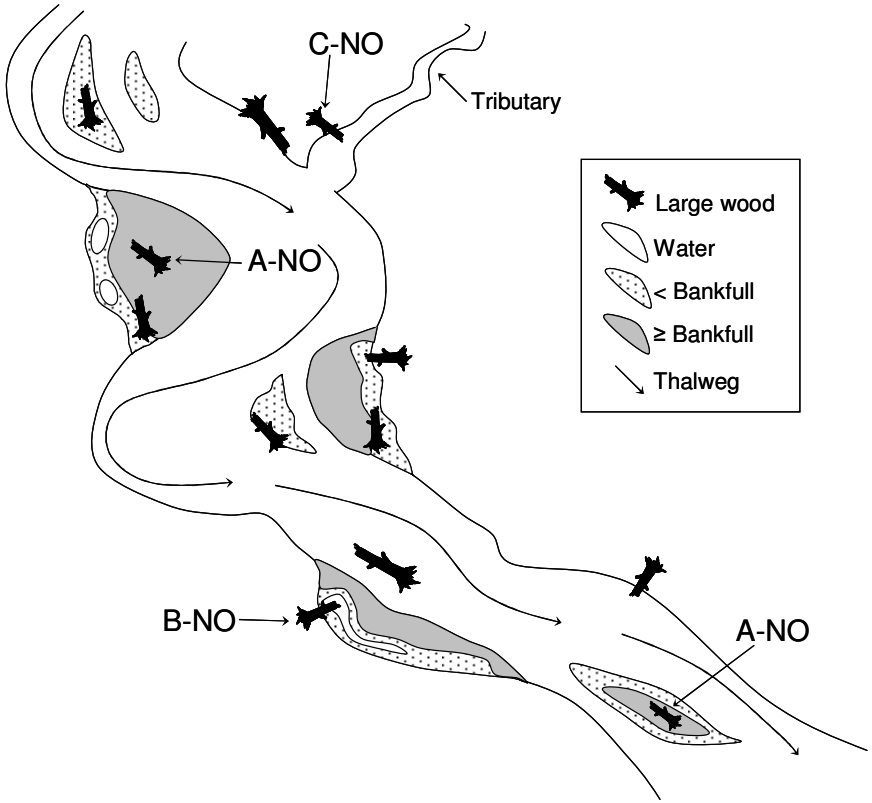


Figure 40. Depiction of qualifying and non-qualifying large wood. Unlabelled pieces qualify because they are within bankfull channel. Large wood on islands ≥bankfull elevation is not measured unless it meets category 1 requirements (A). Large wood in tributary streams is not measured (C). To determine if large wood qualifies, visualize the water level at bankfull; if the stem is touching water, it qualifies. Large wood associated with isolated side channels, pools and depressions does not qualify (B).

REACH MAP

The reach map is drawn on Form 2 to show important features that describe the site and will be used to help relocate the site in the future. For most sites a previously drawn map will be provided to you on the back of the site sampling sheet.

Good maps:

- Clearly show the reach drawn to scale.
- Show the main channel (with flow arrow to show thalwag) extending at least 10 m above and below the reach boundaries, including site markers, and any distinct feature that will help in relocating the site.
- Show natural features such as: side channels, tributaries, shrubs and trees, large wood, bars, islands, pools, beaver activity, burned areas, hill slopes, etc…
- Show presence of management activities at the site: roads, trails, fences, timber harvest, grazing, campsites, restoration, etc…
- Show locations of transects, 5, 10, and 15

When to draw a reach map:

- At new sites
- If instructed to do so on the site information sheet
- Channel shifts
- Beaver impacts
- Stream looks different and has obvious changes

When to modify an old Map:

- **You cannot modify the old map if instructed to draw a new map.**
- If the map is generally well drawn but is missing important features, and those features can be easily included without re-drawing the entire map.

Commonly Used Symbols for Reach Maps

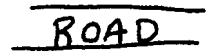
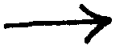
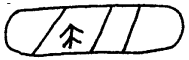
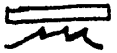
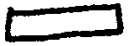
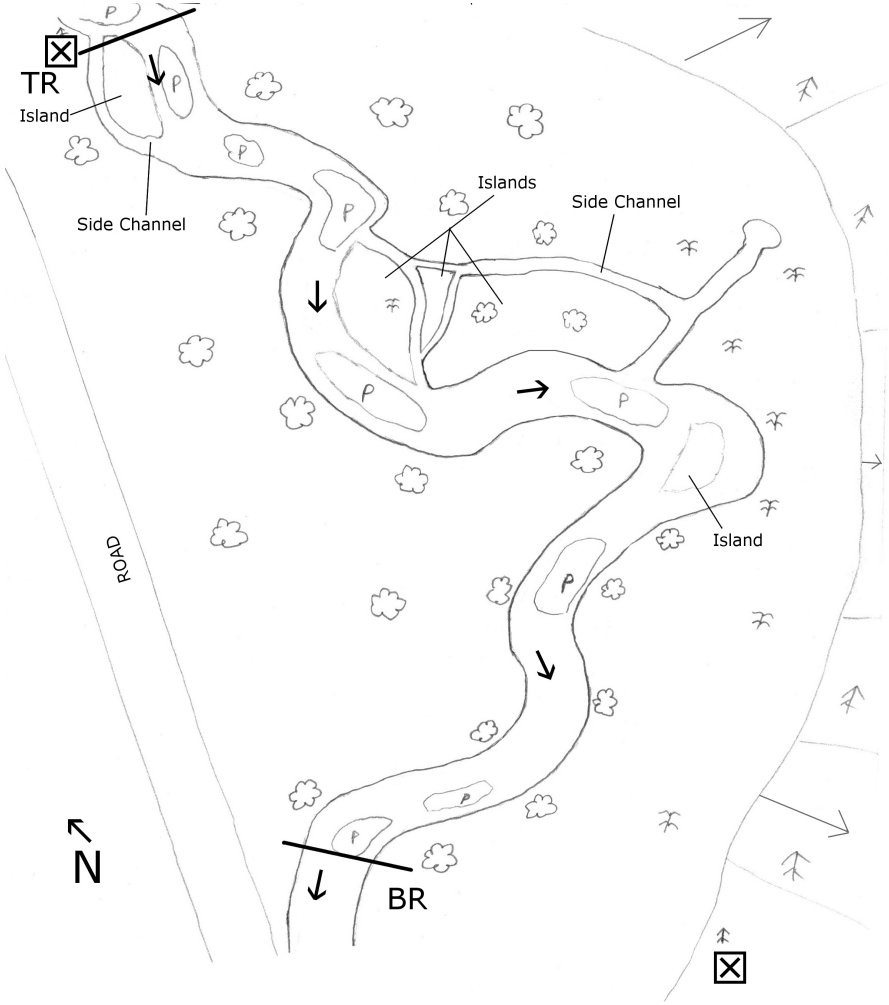
Site Marker		Fence	
Bottom of Reach		Road	
Top of Reach		Thalwag	
Conifer		Upslope	
Deciduous		Cutbank	
Herbaceous / meadow		Snag	
Fore		Spanner	
Stump		Log jam	
Large Wood		Pool	
Rock		Side Channel	SC
Bar		North Arrow	→ N
T-post / rebar		Transect 5, 10, 15	T5, T10, T15
Overview Photo		Main Channel	MC

Table 1. Commonly used symbols for reach maps.



Figures 41. Example of a well drawn reach map.

MEASURING CHANGE IN REACH ELEVATION

Equipment: automatic level, tripod, and stadia rod

Definitions:
Elevation change = vertical difference or drop between the water surface at the Top of the Reach (TR) and the water surface at the Bottom of the Reach (BR).

Gradient = the percent slope of the stream reach (elevation change / reach length)

Introduction:

- Measure elevation change between the water surface at the Top of the Reach (TR) and the water surface at the Bottom of the Reach (BR) using a tripod and surveyors' level
- Measure elevation change 2 or more times
- The second measurement must be ±10% of the first measurement
- If the second measurement falls outside the ±10% window continue measuring elevation change until 2 measurements are within ±10% of one another.
- Only record the two elevation changes within 10% of one another on Form 1 and in the data logger
- If you knowingly make an error while shooting elevation change, DO NOT enter this data into logger
- Special situation: If there is not flowing water at your BR / TR, position the stadia rod in line with the BR / TR at the deepest location within the channel.

Overview:
One person operates the level and records heights from the stadia rod. The other person positions the stadia rod at the BR, any intermediate spots (if necessary) and at the TR. It is very important to keep the stadia rod plumb (vertical in all directions) when taking measurements. The person operating the level will be able to tell if the stadia rod is plumb or not and will communicate what needs to happen to the other person. **The bottom surface of the stadia rod must be held at the surface of the water, not the stream bottom when positioned at the BR and TR.**

LEVEL SET UP

STEP 1: Leveling with Tripod and Affixing Level

- Be very careful when handling the levels because they are fragile and expensive.
- The levels must be setup properly or the measurements will not be accurate.
- Stomp the tripod legs into the ground; when it is stable, **carefully** mount the level on the top of the tripod. Thread the support screw in the center of the tripod into the corresponding hole on the bottom of the level. How tight? Just right – don't break it.

STEP 2: Center the bubble

Once the level is secured onto the tripod, do as much leveling as possible using the tripod legs while looking at the bubble window.

STEP 3: Fine adjustments

Use the knobs for fine scale leveling. The three knobs can be adjusted independent of one another and it may seem counterintuitive, but if the level moves one way the bubble goes the other. Once the bubble is **entirely** within the center circle it is level.

- Be careful when using the fine adjustment knobs because they will break if they are tightened too hard.
- Be EXTREMELY careful, do not bump the tripod and level once it is set up or you will have to start over.

EXAMPLE 1: Measuring elevation change with one shot

Position the level somewhere between the BR and TR. Under ideal conditions, you will be able to view the stadia rod through the level when it is at the BR and TR. Record the heights from the stadia rod that line up with the horizontal crosshair inside the level for both locations on the back of Form 1. Calculate elevation change. Figure 38 shows how to record individual shots and calculate elevation change.

You must measure the elevation change either two or more times. Between repeat measurements, the tripod must be re-leveled or moved (you must move 1 tripod leg at least) to get an independent measurement. In order for the two measurements to be valid, the measurements must be ±10% of one another. For example, in Figure 42 the elevation change of the first shot is 1.21m (4.1 – 2.89). The second shot must be ±10% of the first. To calculate this range, multiply 1.21m by 0.9 to establish the lower threshold (1.09m), and multiply 1.21m by 1.1 to establish the upper threshold (1.33m) (Figure 43). Because the second elevation change was within the ±10% range (1.19m), a third measurement was not required.

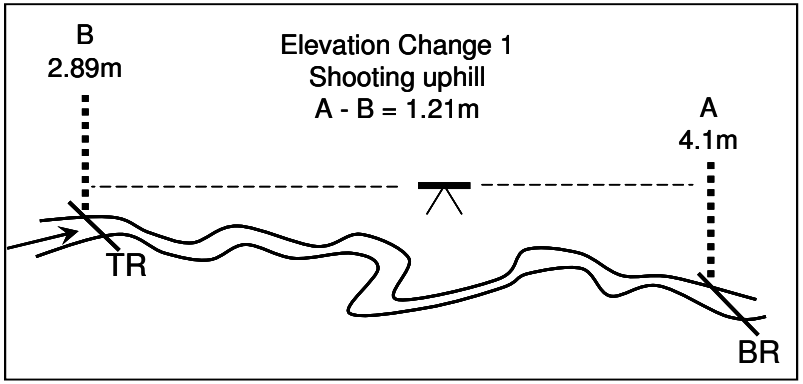


Figure 42: Measuring elevation change using a single shot. The 1st of 2 elevation changes is depicted above.

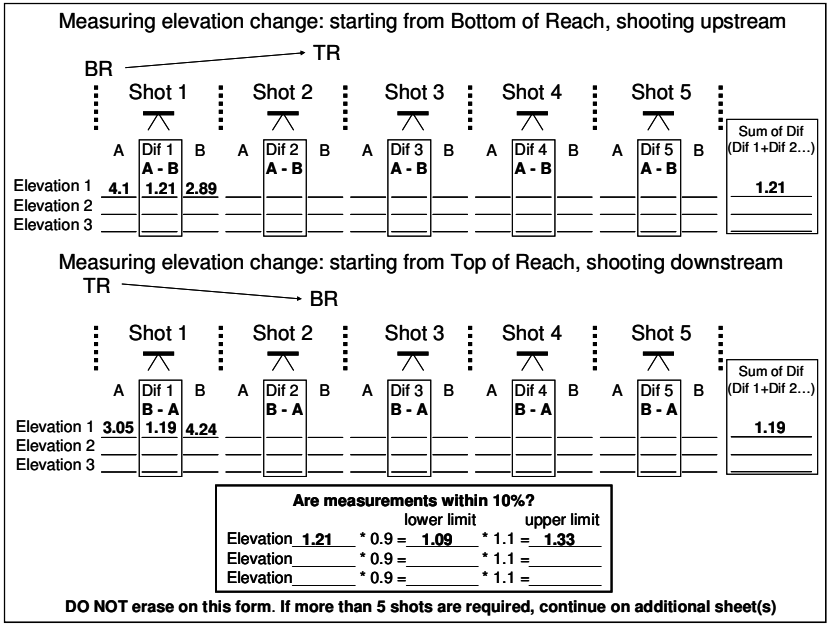


Figure 43. Measuring elevation change using a single shot. (Top) The 1st of 2 elevation changes is depicted above. (Bottom) When shooting from BR to TR (uphill, record on top of Form 1) A – B = elevation difference for each shot, when shooting from TR to BR (downhill, record on bottom of Form 1) B – A = elevation difference.

EXAMPLE 2: Measuring elevation change with multiple shots
Very often, you will not be able to measure the reach elevation change with 1 shot. In the following example, 3 shots are required.

When moving the level to the next shooting location, it is imperative to keep the stadia rod on the **exact same** spot. Intermediate rod positions serve as reference points "connecting" level shot #1 to shot #2, and so on (Figure 44). Also, as stated earlier, the rod must be at the water's surface at the BR and TR, but is not necessary for intermediate readings.

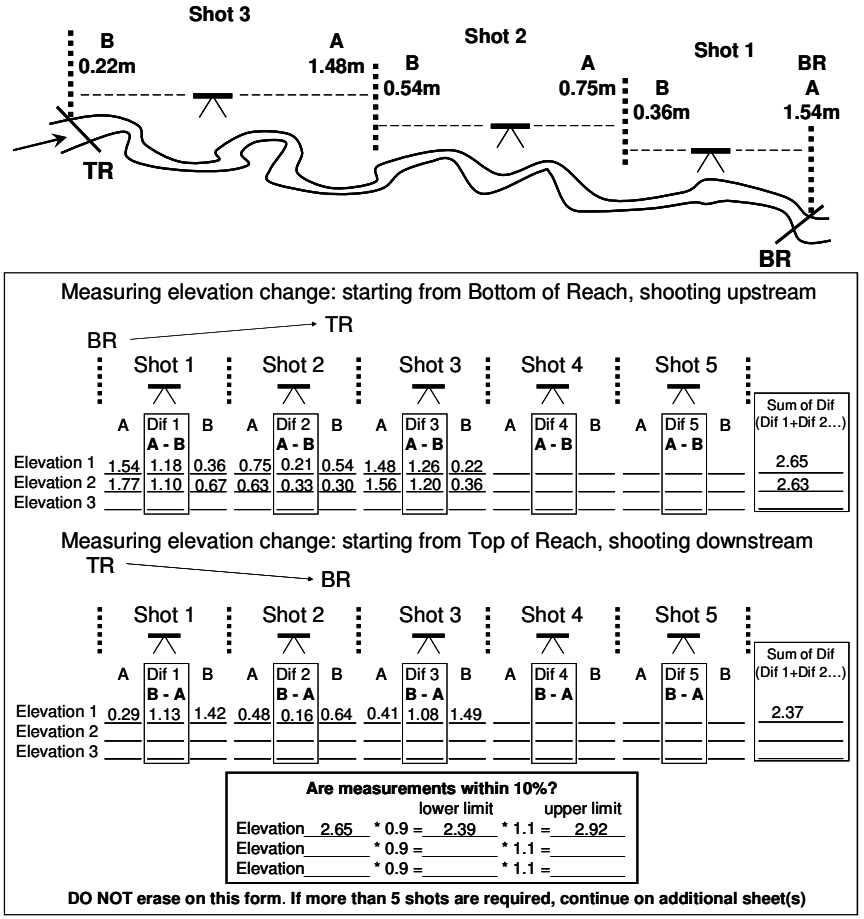


Figure 44: Calculating reach elevation change using three shots. When the first two measurements are not within ±10% threshold, calculate elevation change a third time.

In this example the first elevation change measurement was 2.65m. The ±10% limits were calculated. The 2nd elevation change was 2.37m, which is outside the 10% threshold, so a 3rd elevation change was calculated. NOTE that elevation change measured uphill (from BR to TR) is recorded on the top of the form, and elevation change measured downhill is recorded on the bottom of the form.

EXAMPLE 3: Measuring reach elevation change with multiple shots: how to compensate for shots with negative elevation change.

In some situations you will have a shot with a negative elevation change, shot 2 in the following example (Figure 45). It is **critical to record the numbers in the appropriate area on the form** as shown in the previous examples. This way, the negative elevation change will be accurately recorded.

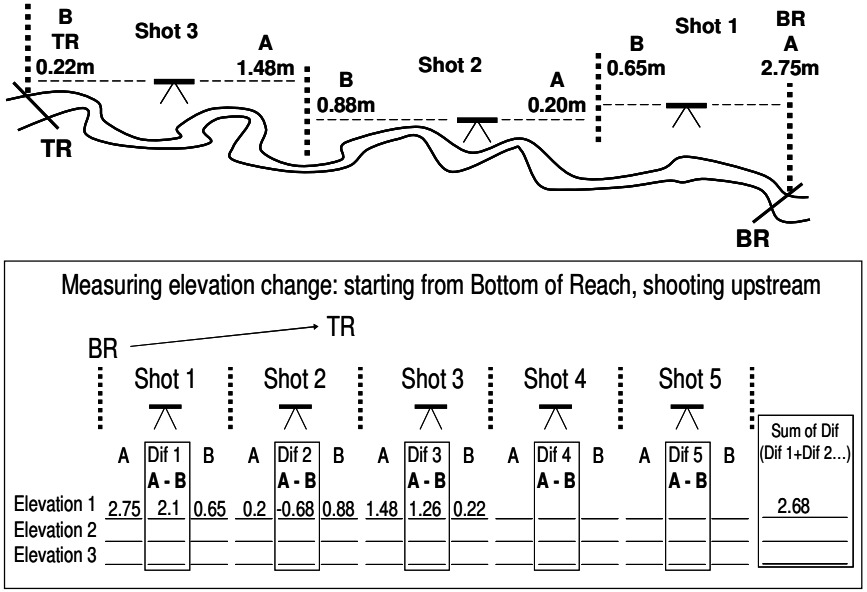


Figure 45. Measuring reach elevation change with multiple shots. In this example shot 2 has a negative elevation change.

REFERENCES

Bauer, S. B.; Burton, T. A. 1993. Monitoring protocols to evaluate water quality effects of grazing management of Western rangeland streams. U.S. Environmental Protection Agency, Seattle, WA.

Harrelson, C. C.; Rawlins, C. L.; Potyondy, J. P. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. Gen. Tech. Rep. RM-245. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 61pp.

Hankin, D. G.; G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences. 45:834-844.

Hawkins, C.P.,; J. Ostermiller, J.; M. Vinson, M.,; R.J. Stevenson, R.J.; and J. Olsen, J.. 2003. Stream algae, invertebrate, and environmental sampling associated with biological water quality assessments: filed protocols. Department of Aquatic, Watershed, and Earth Resources, Utah State University, Logan, UT 84322-5210.

Kershner, J. L.; Coles-Ritchie, M.; Cowley, E.; Henderson, R. C.; Kratz, K.; Quimby, C.; Ulmer, L. C.; Vinson, M. R. 2004. A Plan to Monitor the Aquatic and Riparian Resources in the Area of PACFISH/INFISH and the Biological Opinions for Bull Trout, Salmon, and Steelhead. Gen. Tech. Rep. RMRS-GTR-121. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT.

Lisle, T. E. 1987. Using “Residual Depths” to Monitor Pool Depths Independently of Discharge. Research Note PSW-394m USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

Moore, K.; Jones, K; Dambacher, J. 2002. Methods for Stream Habitat Surveys. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Natural Production Program, Corvallis, Oregon.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G. W. Lienkaemper, G.W. Minshall, S.P. Monsen, R.L. Nelson, J.R. Sedell, amd J.S. Tuhy. 1987. Methods for Evaluating Riparian Habitats with Applications to Management. Intermountain Research Station General Technical Report INT-221. 177 pages.

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

U.S. Department of Agriculture, Forest Service. 2005. Effectiveness monitoring for streams and riparian areas within the Pacific Northwest : stream channel methods for core attributes. Unpublished paper on file at: http://www.reo.gov/monitoring/watershed.htm or http://www.fs.fed.us/biology/fishecology/emp.htm. 18 p.

U.S. Department of Agriculture, Forest Service, Region 5. 1998. Stream Condition Inventory Guidebook. Version 4.0.

U.S. Department of the Interior, Fish and Wildlife Service. 1998. Endangered and Threatened Wildlife and Plants: Determination of Threatened Status for the Klamath River and Columbia River Distinct Population Segments of Bull Trout Final Rule. Federal Register June 10, 1998 (Volume 63, Number 111, Pages 31647-31674) 50 CFR Part 17, RIN 1018-AB94.

Wolman, M. G. 1954. A method of sampling coarse riverbed material. Transactions of the American Geophysical Union 35:951-956.

APPENDIX A: Stream Data Logger Troubleshooting

Troubleshooting: If the data logger locks up and nothing works here is what you do.

1) Performing a hard reboot of the logger should correct any minor glitch. The easy way to reboot the logger is:
    a. Hold the on/off key for ~10 seconds.
    b. When the screen goes blank the logger is rebooting.
    c. Wait for the logger to reload the operating system and software.

    Alternative reboot procedure. Sometimes the reboot will fail if the battery has low power. If the above does not work try again like this:
    a. Open the rear panel where the battery is
    b. Disconnect the battery for 10 seconds
    c. Reconnecting the battery
    d. Connect the Logger to a plugged in power cord
    e. Press the on / off key
    f. Wait for the logger to reload the operating system and software.
    g. If the easy way doesn't work and the alternative does, then you need to let the battery recharge for a while.
2) If neither of the above works make sure you check in and report the issue to the hotline.

Backing Up Data

There is an icon on the desktop called 'backup' or in some cases 'short cut to backup'. Simply double click on this icon to back up all records to a storage card. You cannot restore data in the field.

Contact Tim Romano PIBO / EMP Database Specialist at 435-755-3568 for further trouble shooting assistance

APPENDIX B: Sampling Sites with Beaver Activity

Safety First! Please be careful walking around beaver dams!

Why do beaver dams matter? PIBO-EMP is attempting to assess changes in stream habitat and riparian vegetation due to beavers.

Your supervisor will tell you if you are going to sample a reach with beaver dams, however, beavers may have moved in after the site was scouted.

Setting Up Your Reach

- Follow normal reach set up & sampling procedures with the following exceptions:
- **Placing Transect Flags in Beaver Pools**
    - Place transect flags perpendicular to the beaver pool's thalweg if you can identify it (A in Figure 46)
    - If you cannot locate the beaver pool's thalweg, place transect flags perpendicular to the beaver pool's center line (B in Figure 46)

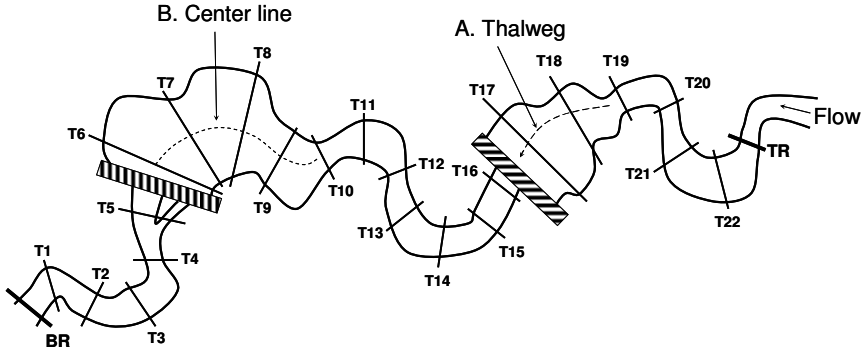


Figure 46. Depiction of reach with beaver dams. In beaver pool A, transects are placed perpendicular to pool's thalweg. In beaver pool B the thalweg cannot be located, so transects are placed perpendicular to the pool's center line.

- **Placing Transect Flags: Side Channels**
  - There are often 'weird' side channels beside and downstream from beaver dams
  - Follow normal procedures for determining if measurements are taken in the side channels (see 'Side Channels' section of protocol)
  - REMEMBER: 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.

Sampling Beaver Impacted Sites

Disturbance											
Beaver: % reach impacted	N	Y*	10	20	30	40	50	60	70	80	90	100
Y* = evidence of beaver, but no dams within reach												

Figure 47. Excerpt from Form 1.

Record % of Reach Impacted
- N = no beaver dams within reach, and no evidence of beavers within the reach, 10m from stream channel on either bank
- Y = evidence of beaver within the reach or on the streambanks with 10m of reach, but no dams within reach
- % reach impacted: select % of reach length impacted by beaver dams and beaver pools.

Alkalinity & Conductivity
- Measure water chemistry at the bottom of the reach, not the top of reach
- If there is a beaver dam / pool at BR, measure water chemistry below the dam / pool even if it is downstream from the reach.

Reach Map
- Draw a new map
- In addition to normal procedures, draw and label beaver dams, beaver pools, and beaver side channels.

UTM Coordinates: follow standard procedures

Macroinvertebrates

- Collect macroinvertebrates downstream, but in close proximity to dams. If your reach doesn't fit into one of the following scenarios perfectly, do the best you can!
- Locate the most downstream beaver-impacted area within the reach and take samples downstream from this location.
  - If there are 4 or more riffles in between the BR and the first beaver impacted area, collect 8 samples within the first four riffles downstream from the impacted area.
  - If there are between 1 and 3 riffles between the most downstream beaver-impacted area and the BR, evenly distribute your 8 samples within the available riffles
  - If there are no riffles between the BR and the most downstream beaver impacted area, or the BR is impacted by beavers:
    - Collect 8 samples from the 1st four riffles downstream from BR.
    - **OR,** Evenly distribute samples in riffles found within 50m downstream from the impacted area.
    - Select the option which results in samples being collected closest to the beaver impacted area.

Streambank measurements, cross-sections, bankfull widths, pebble counts, large wood
- Follow normal procedures in unimpacted areas
- Within beaver pools / impacted areas:
  - Use normal procedures when possible
  - These measurements are based off of bankfull. If bankfull cannot be located or is underwater, then use water's edge for determining:
    - Upper limit of bank angle and stability plots
    - Boundaries for establishing cross-sections, measuring bankfull widths, collecting pebbles, and determining if wood qualifies

Change in elevation
- Measure elevation change
- Write a comment on Form 1 and in the logger is there is a beaver dam or pool impacting the BR and / or TR

Temp probe

- Locate the most downstream beaver-impacted area within the reach and place temp probe downstream from this location.
- Examine Figure 46, you would ideally place your probe transect 4 or 5.
    - Question: 'What if there is a beaver pool at my BR extending downstream?'
    - Answer: Place probe downstream of your reach, make sure the probes location is clearly identified on probe form.

Pool tail fines: Don't measure pool tail fines at dam pools

Photos

- In addition to standard procedures, do the following:
- Repeat all photos:
    - The stream looks dramatically different, stream is difficult to wade, your transect numbers may not correspond to the OLD transect numbers. Do your best!
    - Even if the location is now in a beaver pool, or conversely if the photo was in a beaver pool and now the pool / dam is now gone
    - Maintain consistent names with old photos. For example, the 'misc stream 3' photo you are provided with is from a location that is now in a beaver pool. Retake the photo as well as you can and label it 'misc stream 3'.
    - Conversely, if you are provided with beaver dam 1 photos, but the dam is gone, retake the photos as well as you can and label them 'beaver dam 1'
- Take these additional photos:
    - The following photo descriptions are in the logger, write them on form 4 beside 'misc stream' photos.
    - Record transect (rod location), camera facing, distance and bearing to rod at each photo.

    - 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.
        - Hold the 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 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 photo of each beaver pool / impacted area.
        - These photos 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 criteria when evaluating a beaver pool
- Beaver pool criteria
    - 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 above Figure 48
- **How to measure beaver pools:**
    - Formation = beaver
    - Full or partial: follow standard procedures
    - Length: measure the beaver pool's length along the thalweg. If you cannot locate the thalweg, measure along the beaver pool's center line.
    - Max depth:

- Measure the maximum depth.
- Estimate if the pool is too deep or dangerous. If you estimate max depth, enter the comment, 'maxdepth estimated'

- Pool tail depth: enter '0'
- Large wood in pools
  - 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.

Beaver Pools:
- Low / zero water velocity
- Wide wetted width
- Elevationally <u>below</u> beaver dam height
- Fine substrate
- Level water surface

Is best indicator!

Upstream of Beaver Pools:
- Flowing water
- 'Normal' wetted width
- Elevationally <u>above</u> beaver dam height
- 'Normal' substrate

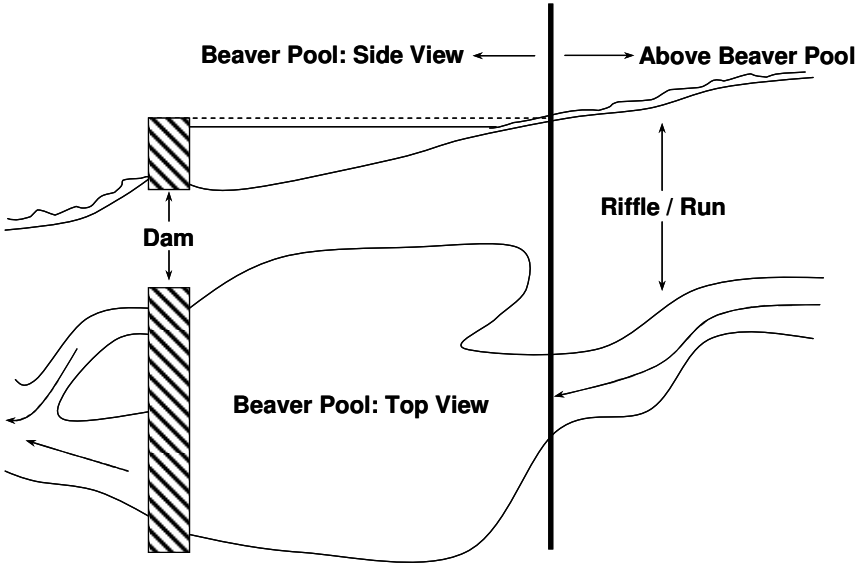


Figure 48. Top and side views of a beaver pool and how to distinguish the upstream boundary.

APPENDIX C: Sampling When There Isn't Flowing Water throughout the Site

This appendix provides additional sampling instructions for sites that don't have water flowing throughout the reach. These sites fit into 2 categories (recorded on Form 1 and in the logger):

- <u>No flow (completely dry):</u> there is no water within your reach it is 'bone dry'
- <u>Other (make detailed comment):</u> this can describe a wide variety of flow conditions, so please write a thorough, detailed comment on Form 1 and in the logger.

Make a comment explaining 'weird' flow issues. For example: 'partial flow in reach. Water was flowing from BR to transect 12, US from transect 12 to TR, there was water in pools, but no flowing water'. In this example you would measure pools between BR and transect 12 only.

In general, sample normally with the following exceptions:

No flow (completely dry), this means the reach is ***bone dry***!
- Can't measure <u>water chemistry</u>
- Can't collect <u>macroinvertebrates</u>
- LEW / REW measurements when doing cross sections. You cannot use the 'water' method
- Can't quantify <u>pools</u> (consider the entire reach a riffle / run)
- Measure <u>elevation change</u> by holding stadia rod in line with BR / TR, at the channel's deepest location

'Other' flow: the reach doesn't have water flowing throughout but is not completely dry
- Measure <u>water chemistry</u>. Measure in flowing water near the TR, otherwise, measure it in any flowing water. If the isn't any flowing water, measure it in stagnant pools. Comment where water chemistry was measured.
- Collect <u>macroinvertebrates</u>. The rule is, if there is enough water in any part of the reach to move bugs into the net, collect them those areas
- <u>Cross sections</u>: quantify LEW / REW measurements at cross sections with water, even if it isn't flowing.

- Pools: Measure all qualifying pools that have water (even a trickle) flowing into and out of them. Don't measure stagnant pools.
- If there is not flowing water at the BR and / or TR, position the stadia rod in line with BR / TR, at the channel's deepest location when measuring elevation change

Where to start / stop:

- OLD Sites: use normal procedures, start and end at the old BR / TR.
- NEW Sites: follow scout's instructions regarding BR location.
  - If there is not flowing water, the TR will be transect 21
  - If there is flowing water at the TR, use normal procedures (page 9)

APPENDIX D: Un-Scouted DMA Site

Some DMA sites you sample may not have been scouted; if this is the case your supervisor will provide you will information about how to locate each un-scouted DMA.

- DMA site locations are pre-selected and you will be given UTMs and / or directions to locate them.
- Often DMA sites are marked with a green T-post, but you will not always be able to find one.
- DMA sites may be up or downstream of T-posts, this information should be provided to you.
- DMA sites are exempt from criteria used to select integrator sites. This means a DMA might have high gradient, numerous side channels, tributaries, etc.
- All DMA's are sampled using 6m transect spacing, so sites will be ~120 m long.

Appendix E: Placing a Temp Probe

Special situations: appendix B has instructions for placing temp probes in beaver impacted sites

Temperature loggers (a.k.a. Hobos) will be placed in all Integrator sites before July 15th. The main objective is to place the logger in the stream where it will be submerged all summer collecting accurate temperature data until a technician comes back to retrieve the logger in the fall.

Your objectives:

- Place temp probe
- Record info about temp probes on back of 'Site Revist' or 'Site Scouting' form.

Temp probe placement considerations:

There are many things to consider when placing the probe:

- Place probes in / near the thalweg, not in backwaters or eddies
- High flows: Attach temperature logger to something secure (ex: tree trunk, root wad, etc) that won't wash away in high flows.
- Low flows: You don't want the temperature logger in too shallow area that may not have water at a later date.
- Use rocks to hold probe in place if necessary; place the rocks on the cable not the probe, if the flow drops, the rocks can absorb heat.
- Camouflage probes in high traffic areas. Use grass, dirt, / moss to conceal the wire if you are placing probe in a high traffic area. The better you hide the probe, the better your map and description need to be
- Avoid areas just downstream of tributaries and obvious groundwater seeps, as water temperatures in these areas will not be representative of the stream temperature.

Recording Info about Temp Probes

- Place BLUE flagging with 'PIBO HOBO' written on it with a sharpie.
  - Place the flagging somewhere close to the hobo, but not at the exact location to avoid drawing attention from people.
- Record the Group,Order, reach type, stream name, Region, your name, Forest, District, State, and County in the spaces provided on the back of the scouting sheet.
- Record the Hobo number carefully and check to make sure it is correct, and check again!
- Record the date the Hobo was placed in water.
- Record the location of the Hobo relative to the blue Hobo flagging (direction and distance).
- Record the location of the Hobo relative to the bottom of the reach.
  - Is the Hobo on River Right or River Left?
  - Use landmarks (e.g. wire attached to roots of enormous Ponderosa Pine, logger hidden underneath undercut bank).
- Record UTM coordinates for the logger.
- Record a **detailed** written description of the location of the Hobo (e.g. The Hobo is located ~5m upstream from the bottom of the reach on river right. The Hobo is attached to a piece of LWD (~15cm diameter) and is tucked underneath the bank. The cable is covered with moss.).
- Draw a **detailed** map of the hobo location so we can efficiently relocate them during retrieval.
  - Use pencil and depict at least 20-30m of the stream. Include the Hobo, direction of flow, North arrow, flagging, and any features that will help to quickly relocate the logger (i.e. if the bank is covered by alders, don't just draw alders on the map without additional detail).

Appendix F: Gear Decontamination

Objective

To prevent the spread of invasive species (namely New Zealand Mud Snail),

- **Gear MUST be decontaminated after every sample**, before you leave the site!
- The only exception to this is if two or more sites are being sampled on the same stream (integrator and key site for example).

Equipment and Procedure:

Safety: When handling Sparquat 256, be sure to use proper personal protective equipment (rubber gloves and protective eyewear).

1. Use a scrub brush to remove all visible mud / organic material from boots and waders before decontamination.
2. Use the large Rubbermaid Roughtote provided to make a solution of Sparquat 256 that is at least 4.7%. To do this, fill the Roughtote with 6 gallons of water and add 36oz. of Sparquat (or 6oz. of Sparquat 256 for every gallon of water).
3. Soak any gear items that have been in contact with the water for at least 10 minutes.
4. When decontamination is complete, put the used Sparquat 256 solution back into the labeled 7gal Aquatainer and rinse the waders, boots, and other gear with water.
5. Determine if the Sparquat 256 solution may be reused. To check for potency, Use the "Quat Check 1000" test strips that have been provided. When the test strip reads below 600 ppm, you need to make a new solution.
7. Discard the Sparquat solution when it is no longer effective, it will need to be discarded down a drain that flows to a treatment facility.

TIP: Gear should be decontaminated by one crew member while another crew member fills out forms, and enters data into the logger, etc.

NOTE: A Material Safety Data Sheet for Sparquat 256 can be found in the Manual of Manuals (MOM).

Preventing spread of invasive plants

If your truck gets especially muddy during a hitch, please take the time to rinse the wheel wells and undercarriage thoroughly before traveling to another group. If your truck is especially muddy when you return from a hitch, you will need to rinse the mud off before you clock out. Plan your last work day to include this duty (if necessary) along with the normal 'End of Hitch' duty of making sure the inside of the trucks are relatively clean (wipe the dashboard, etc. and vacuum if necessary).

Equipment List

Item	Qty.
Sampling Action Packer	1
Flags – stream	60
Flags – veg	20
Blue pool flags	20
Bleach Spray Bottle	1
Bleach Bottle	1
Bug Net	1
Bug Spray Bottle	1
Pool Tail Fines Grid	1
Pool Tail Fines Viewer	1
Conductivity Meter	1
Alkalinity test kit	1
Clipboard w/ complete set of waterproof forms.	1
Field Vests	1
Data Logger	1
Extra logger battery	1
Logger car charger	1
Logger wall charger	1
Compass w/ compass	2
Survey Level	1
Level Tripod	1
Stadia Rod	1
Hand Level	1
Tape - 50 m	1
Tape - 30 m	1
GPS Unit w/ case	1
Digital Camera w/case	1
Memory Flash Cards for Camera, 96 or 128 and 16 MB	2
NiMH Battery Charger, AA / AAA	1
NiMH Rechargeable Batteries AAA	16
Clear Plastic Ruler for Pebble Measure	2
Hand Calculator	1
Candy Canes	4
2 Gallon Bucket for Bugs	1
White Pan for Bugs	1
500 um Sieve	1
Forceps	2
Plastic spoon	2
Bug Jars w/ lids	50

Item	Qty.
Camping Gear	
Propane Stove w/ Hose	1
Propane Tank	1
Table	1
Chairs	3
Tent - 3 person	1
Tarp	1
Water jug 5 gal.	2
Cooler	1
Kitchen Gear	
Plates, Bowls, Glasses, Forks, Spoons, Knives	3 each
Can Opener, Cutting Board, Cutting Knife,	1 each
Spatula, Serving Spoon,	1 each
Dish soap & Sponge	1 each
Stock Pot	1
Saucepan	1
Skillet	1
Back of Truck	
1.5 m staffs w/ cm increments	2
Yardstick for Veg. Work	1
Backpacks	3
Safety	
Fire Extinguisher	1
First Aid Kit - Hard Case	1
Shovel	1
Ax	1
Saw	1
Crew Items	
Waders, Boots , Wader socks for each person	3 sets
Macroinvertebrate Jar Labels	50
Repair Kit for Field Equipment	1
Backup Disposable Camera	2
Water Filter	1

Beginning of Hitch Checklist for Crews

Electronics, charged?

- Data logger w/ backup battery
- PDA w/ memory card & backup, & backup battery
- Camera w/ memory card & backup, & backup battery
- Sat phone
- SPOT w/ backup lithium batteries

Sampling folder for each site

Summary forms

- Macroinvertebrate summary
- Photo summary
- Veg. summary

Maps

- Atlas
- Gazatteers
- Forest maps

Do you have?

- Safety equipment
- Newspaper & unknown labels for veg. specimens
- Bug jars, labels, and alcohol for bug samples
- Sparquat
- Water
- Reach markers & nails
- Backup alkalinity reagent

Gear issues?

Calibrate conductivity meter at morning meeting

End of Hitch Checklist for Crews

Turn in Electronics & Specimens

- Logger
- PDA
- Photo card
- Plant specimens
- Macroinvertebrate samples placed in appropriate location

Alert supervisor of any data issues

Summary Forms: Checked & Turned In

- Macroinvertebrate summary
- Photograph summary
- Vegetation summary

Forms for each site: Checked & Turned In

- Form 1
- Form 2
- Form 4
- Any additional forms you filled out
- Enter data collected on forms into logger (best to do this on the drive home)

Gear Issues

- Do you need any replacement gear?

Misc. Duties to Complete

- Turn in all gas receipts
- Corrections for driving directions
- Replenish forms
- Return forest maps
- Take bug jars for next hitch (you should have 15 jars per hitch)
- Sign time & travel sheets, check for mail
- Clean and re-pack truck for next hitch
- Charge batteries
- Decontaminate waders and sampling gear
- Clean, dry, and repack cook set
- Replenish vegetation specimen labels and
- newspaper