PacFish InFish Biological Opinion (PIBO) Monitoring Program

Effectiveness Monitoring Sampling Methods for Stream Channel Attributes

2016

Effectiveness Monitoring Sampling Methods for Stream Channel Attributes

By

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INTRODUCTION

The PACFISH/INFISH Monitoring (PIBO) 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 monitoring 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 Monitoring program during 2015. The methods are a result of 15 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 Monitoring 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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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. Work with the Veg tech to validate the BR and BR marker information
   c. Work with the Veg tech to collect UTMs
   d. Take RchID / Date photo
   e. Take BR photos
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 and the TR location communicate this information to your veg tech
   c. Water chemistry
   d. Record disturbance
   e. Take TR photos
7. Quantify habitat units (pools vs. riffle) 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
    d. Make sure UTMs are collected in the Veg PDA
14. After returning to the truck
    a. Decontaminate gear before going to the next site

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

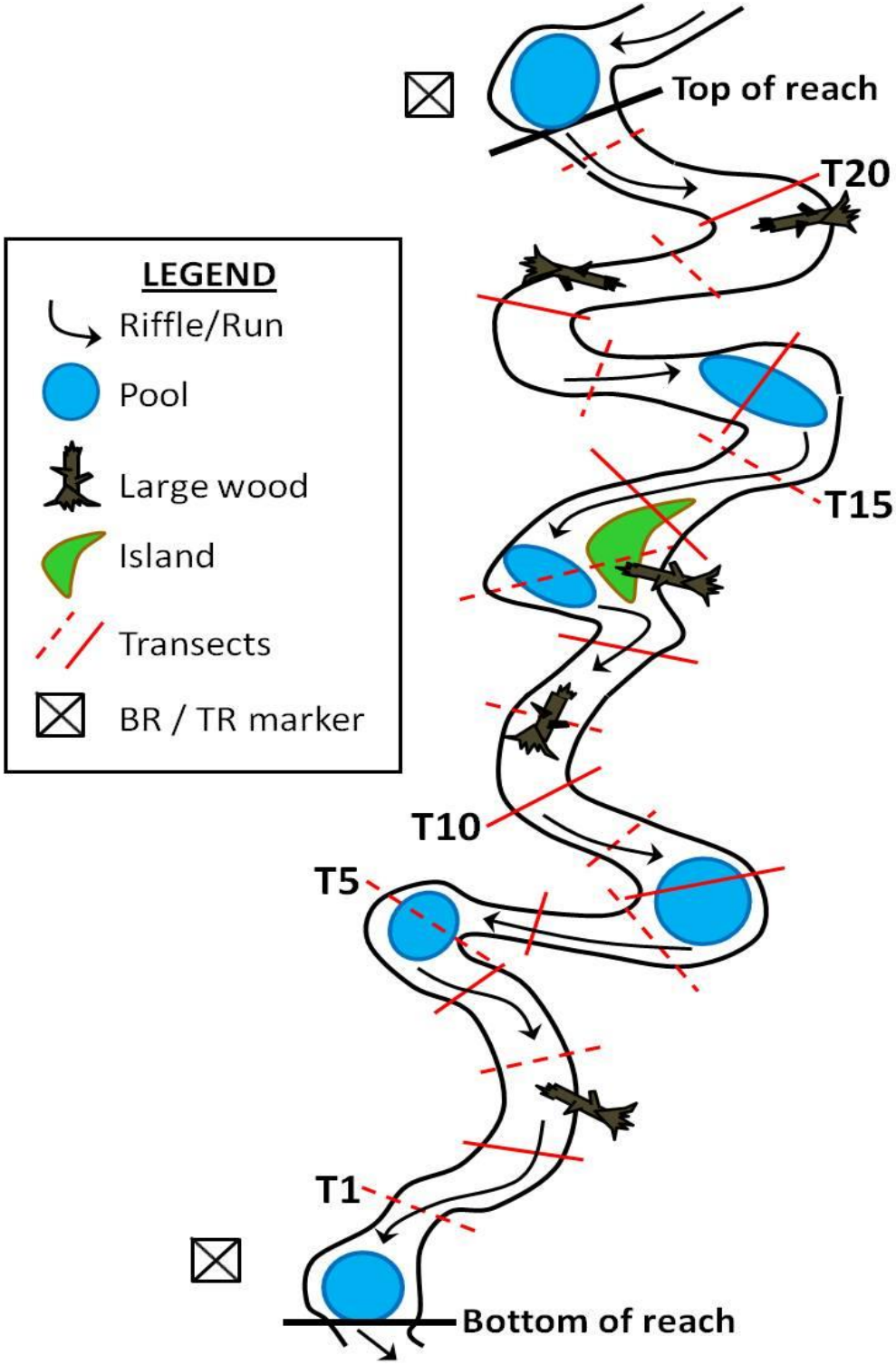


Figure 1: Overview of reach layout showing locations of BR/TR, BR/TR markers, habitat units, large wood, islands, and transects.

SAMPLING SUGGESTIONS

Each reach is unique. No two reaches will ever be sampled exactly the same. Each individual crew will develop a method for achieving the five goals of the PIBO program: safety, quality data, be a positive representative of the USFS, efficiency, and appreciate the job and the opportunities it provides (page 162). Below are some suggestions for sampling efficiency. These suggestions cannot be applied to every reach or crew but should be considered. Speak with your state supervisors for additional sampling suggestions.

Minimize the number of times you walk a reach to improve efficiency. The following tasks can be done at the same time.

1. Set up the reach and bank angles and stability
2. Quantify LWD and habitat
3. Draw reach map and take photos
4. Pebbles, BF widths and cross sections should always be done together

Tasks that can be done by a single person

1. Photos
2. Reach Map
3. Macroinvertebrates
4. UTMs and Site markers etc.

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.
- Vegetative cover >50% is an indicator of the streambank.
- 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.

THALWEG

- Is the path connecting the deepest part of the channel
- It is almost always the fastest flow in any river
- The thalweg moves back and forth across a channel

RIVER RIGHT (RR) AND RIVER LEFT (RL)

- Are always relative to the observer looking down stream
- River right (RR) is to the right of an observer looking downstream.
- River left (RL) is to the left of the observer looking downstream.

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 (6m, 8m, 10m, 12m, and 14m, etc.) in proportion to bankfull width.
- **If info is missing or misleading: Call hotline (435-760-5693)**

ESTABLISHING A WIDTH CATEGORY

At a new site, the crew will have to establish a width category. The only exception will be if the site is a DMA (K site) (see DMA (K) Sites (Large River and Un-Scouted DMAs). (pg. 108).

Collect five bankfull width measurements (Figure 2); the average of these five values will be used to determine the width category for sampling (Table 1). Measure the bankfull width perpendicular to the main channel.

1. Take the 1st bankfull width measurement at a random distance (0-7m) upstream from the BR following thalweg.
2. Take the 2nd-5th bankfull width measurements at 16m intervals following thalweg upstream from the 1st measurement location (Figure 2).
3. Record all five bankfull widths and calculate the average. Use the average to determine the width category from Table 1 on the next page. The width category will determine the spacing of transects per the stream protocol. The minimum reach length has been calculated for each width category and is equal to 21 times the bankfull width.
4. In some instances, a measurement cannot be taken due to dangerous obstacles or a tributary/side channel confluence. Skip that measurement but get at least 3.

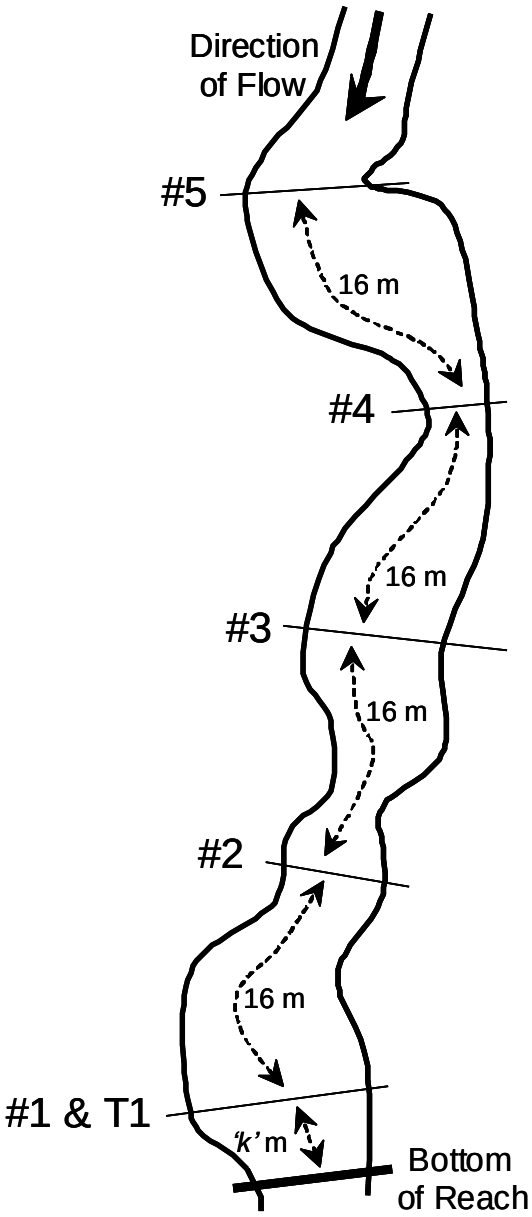


Figure 2: Bankfull width measurement locations for determining the width category.

Table 1: Bankfull width to width category conversion.

Width categories for determining the minimum reach length.		
Average bankfull width in meters	Width category	Minimum reach length in meters
0 to 8	8	168
8.1 to 10	10	210
10.1 to 12	12	252
12.1 to 14	14	294
14.1 to 16	16	336
16.1 to 18	18	378
18.1 to 20	20	420

SETTING UP YOUR REACH: GETTING STARTED

Background:
The PIBO sampling design consists of a 5-year rotation of sites; sites sampled in 2006 were re-sampled in 2011, and will be sampled again in 2016.

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 (see page 16)
2. Scouted NEW SITE (see page 20)

Before setting up your reach, locate the following as a crew:

- Bankfull elevation – page 9
- Where streambed and streambank meet – page 10
- Scour line – page 10

It is unlikely, but you may encounter:

- Beaver activity within site - See Appendix B: Sampling Sites with Beaver Activity page 101.
- High water. If the water is above the scour line (page 10), call before you sample.
- Stream flows through a different channel. Carefully read about 'channel shifts' in the Channel Shift section (page 31).
- 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.

At the first reach each hitch you must create a dataset in the logger.

1. Turn on the handheld device.
2. **Load DPP**: Once the device starts, double click on the icon for DataPlus CE.

3. **DPP Option**: Click on the word Data with your stylus. Choose to Collect Data, and press enter.
4. **Dataset**: Now you are asked to choose between an Old or New Dataset. Select New Dataset for the **first reach of each hitch**. Use the same dataset throughout each hitch.
5. Dataset names consist of 4 characters and should follow the same format: 2 character Crew Code + 2 character Hitch Code. For example: **M1H1**.
6. Once a particular dataset is selected, the logger takes you to the first reach in that set, at which time you are ready to enter data. Note: If you don't enter a reach (reach ID, Group, Order, Type, etc…) when you first create the new dataset the dataset will not be saved and you will have to start again by re-creating the dataset later.
7. To move to a new reach in a hitch return to the reach page and select blue page down.

DIFFERENT TYPES OF SITES

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 (to help crew confirm the BR/TR location)
- Have a 'Scouting' form with specific information about the site, to help you establish it is the correct location

- **Unscouted OLD SITES:**

- Have *not* been visited by a scout earlier in the field season
- Don't have orange flagging at BR/TR (makes it harder to confirm BR/TR location)
- Have a blank 'Scouting Form' form that crew should fill out

NEW SITES have:

- Never been sampled before
- Flagging and 'Scouting Form'
- No photographs, reach maps, or coordinates from a prior sample
- No site markers

Note: HOBO (temperature probes) will be found at most scouted 'I' sites

Information about other site types can be found in DMA (K) Sites on page 108.

OLD SITE: SETTING UP YOUR REACH

Remember: it is absolutely vital that you sample the same section of stream that was previously sampled (for old sites); 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.

The only real difference between a scouted and unscouted site is that for a scouted site, there is flagging hung at the BR and TR which the crew confirms is in the correct location, and scouted "I" sites often have a HOBO (temp probe).

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 'Scouting 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.
- Photos and site markers (which give you a bearing and distance to the BR) will always trump the scouts flagging placement.
    - **Remember, you want the reach to be set up precisely where it was when it was sampled in the past**
    - **The scout's flagging placement will not always be correct relative to BR**
- Question: the 'Scouting 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 and site markers are best for doing this.
    - Often, animals will munch the flagging, look out for small pieces of flagging to indicate you are in the right place

If 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 the 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). **Always place transect flags while looking away from the bank to ensure placement is unbiased and random.**

Before moving to step 5:

1st technician:

- Collect macroinvertebrates (don't walk where you'll collect bugs!) – see Macroinvertebrates on page 36

2nd technician

- Begin filling out forms 1, 2, and 4
- Take RchID/Date and BR photos - see Photos on page 40

With Veg Tech

- Validate BR marker info - see Site Markers on page 34
- Record BR and BR Marker UTMs – see UTM Coordinates on page 26
- Update any Site Marker information

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 on page 23

7. Determine precise location of TR

If site was scouted:

- Carefully read the 'Scouting Form' to determine where the TR is relative to the TR flagging.
    - Remember: **Photos and site markers (which give you a bearing and distance to the TR) will always trump the scouts flagging placement**
- 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. In the rare case the TR falls on the last transect collect data at the TR.

If site was not scouted:

- **Take your time and carefully pinpoint the precise TR location; be diligent, careful, and detailed.**
- Photos are the best piece of information
- Also use: site marker, UTMs, reach map, hiking directions
- 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. In the rare case the TR falls on the last transect collect data at the TR.

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 than 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.
    - You may want to double check BR/TR placement if reach length is different by > 30 meters and there are no obvious changes that indicate why this would be the case.

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

- Water chemistry - see Water Chemistry on page 39
- Take TR photos - see Photos on page 40

With Veg Tech

- Validate TR marker info - see Site Markers on page 34
- Record TR and TR marker UTMs - see UTM Coordinates on page 26
- Update any Site Marker information

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.

1. Navigate to the site using the following information:

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

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

- Locate the orange flagging hung at the BR.
    - Question: the 'Scouting 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.
        - Often, animals will munch the flagging, look out for small pieces of flagging to indicate you are in the right place

3. 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

With Veg Tech

- Place BR marker and record marker information – see Site Markers on page 34
- Record BR and BR marker UTMs – see UTM Coordinates on page 26

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 the BR.

5. Establish a width category (see instructions on page 11) then start setting up transects.

- The only exception in which you will not have to establish a width category at a new site is if it is a DMA (K) site (see page 108)
- 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). **Always place transect flags while looking away from the bank to ensure placement is unbiased and random.**

Before moving to step 6:

1st technician:

- Collect macroinvertebrates (don't walk where you'll collect bugs!) - see Macroinvertebrates on page 36

2nd technician

- Begin filling out forms 1, 2, and 4
- Take RchID / Date photo and BR photos - see Photos on page 40

With Veg Tech

- Place BR marker and record marker information - see Site Markers on page 34
- Record BR and BR marker UTMs - see UTM Coordinates on page 26

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' on page 23

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

- Your TR will be located at the first pool tail upstream of transect 21;
  - If the pool tail falls on a transect above transect 21 then you must collect data at that transect.
  - If the pool tail does not fall on a transect no data is collected at the TR.
- If no pool tail is found US of 21 your TR will be at transect 25. In this scenario where no pool tail is found US of 21 you will collect data at the 25th transect.
- If the stream is dry, stop at transect 25 and collect data at the 25th transect.

While you're at the TR:

- Measure water chemistry - see Water Chemistry on page 39
- Take TR photos - see Photos on page 40

With Veg Tech

- Place TR marker and record marker information - see Site Markers on page 34
- Record TR and TR marker UTMs - see UTM Coordinates on page 26

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.

SIDE CHANNELS

In this section you will find information about how to place transects and what data to collect when you encounter side channels. For specifics on side channels in beaver impacted reaches see the Appendix B: Sampling Sites with Beaver Activity on page 101.

When establishing side channels we must first define bar and island:
Bars are depositional features below bankfull
Islands are raised areas in the channel above bankfull

Side Channels

- The main channel (MC) has the thalweg 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 (T1, T5, and T6 in Figure 3).
- Channels that are separated from the main channel by bars are considered part of the main channel (T4 and T7 in Figure 3).
- Place flags in all side channels that have flowing water through their entire course or would have flowing water at bankfull (see T1, T5, and T6 in Figure 3).
- Areas of island below bankfull are treated like bars - the flag will be placed on the outside bank of the main channel.
- Do not consider tributaries, as separate side channels, though they can be considered part of the main channel at the confluence (T6 in Figure 3).
- SC must be a continuous feature (diverging and reconnecting to the stream along the MC, not necessarily within the reach)

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:

- Imagine water flowing at BF height, include side channels if water would flow continuously through the channel at bankfull flows (Figure 3).
- Another way to think about it is if the side channel is a continuous feature and the thalweg is <bankfull of the main channel.

Establishing Local Bankfull

In some events, the bankfull range of a qualifying SC will not fit in the established bankfull range of the main channel. If you cannot apply the main channel bankfull range to the qualifying SC, take time and establish an independent (localized) bankfull range for the SC and use that for the SC only.

Data not collected in Qualifying Side Channels

- Pools and Habitat Units

Data Collected in Qualifying Side Channels

- Record the widths of side channels during bankfull widths
- Include side channels in cross sections, use the BF method
- Quantify wood in side channels
- Measure pebbles
- Measure bank angles at flags placement

Where to measure in side channels

- Do the best you can
- Measurements follow the same rules in the side channel as in the main channel.
    - Bankfull widths between the flags perpendicular to the local channel
    - Bank angles and bank stability are measured at the flag and perpendicular to the local channel
    - Cross sections can be “wiggled” (page 56) and are always measured perpendicular to the local channel

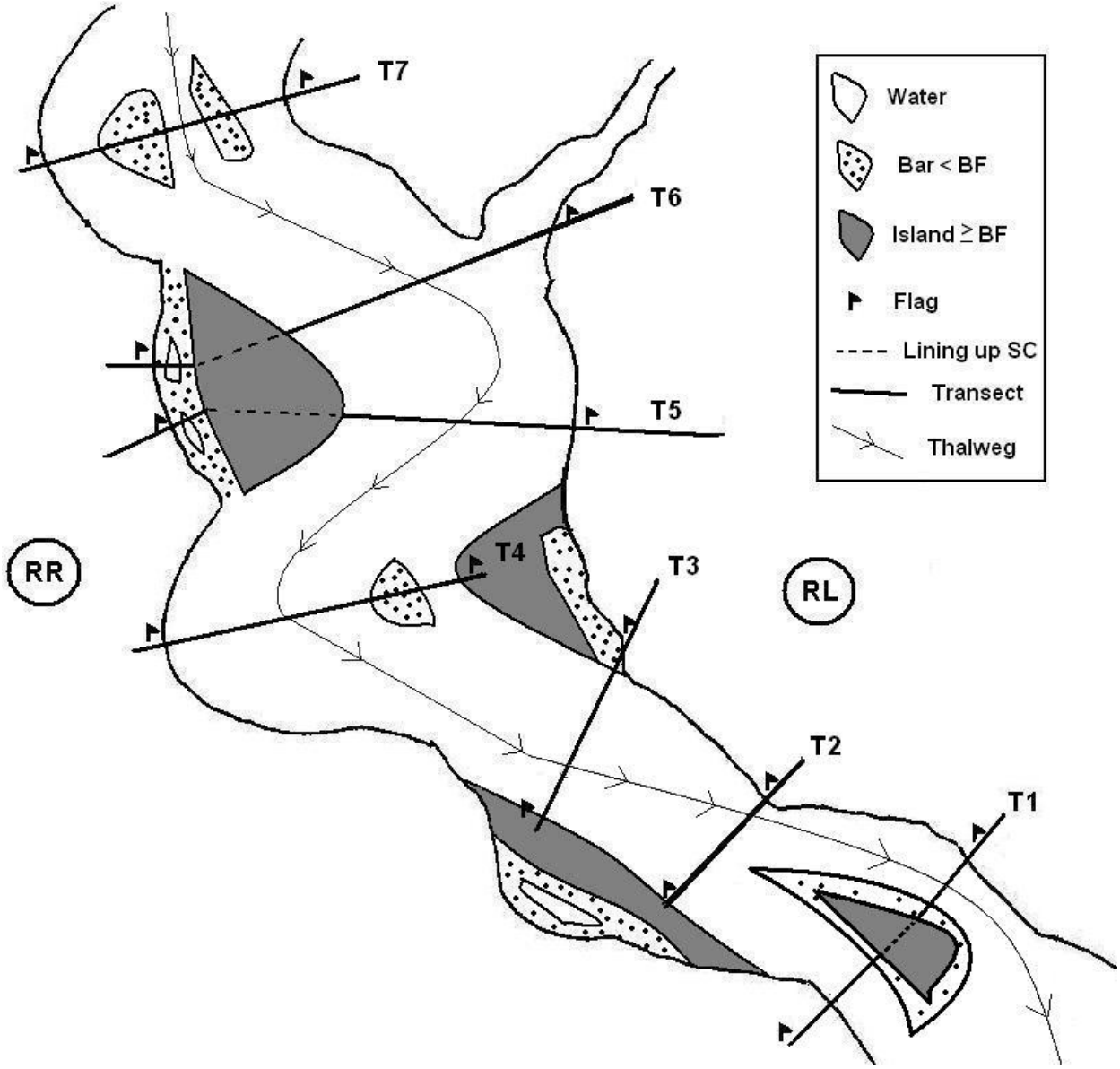


Figure 3: Transect placement when side channels are encountered.

- Place transects across all flowing channels (Transect 1, 7)
- And across non-flowing side channels that are entirely below bankfull elevation (Transect 5, 6)
- In all qualifying side channels, collect data perpendicular to the local channel. (Transect 5, 6)
- DO NOT place transects across side channels whose thalwegs are at any point ≥bankfull elevation (Transect 4, 2)
- DO NOT consider tributaries as separate side channels (Transect 7), though they can be considered part of the main channel at the confluence (Transect 6)

UTM COORDINATES

Objective: **Use the VEG PDAs to record the Universal Transverse Mercator (UTM) coordinates.**

UTMs are used to identify these locations:

- BR and BR marker
- TR and TR marker
- Reach overview photo
- HOBO or Tidbit (only collect if crew is placing or moving, if not placing, the scout has done this already)

When to record UTMs?

- For every site, record UTMs at all locations listed above in the Veg PDA

Procedure: Collecting UTMs with the PDA (page 112)

1. From the main screen (press the home button, bottom left with a house icon) click the start menu (top left corner, or windows button); select "GPS info" from the drop down menu. GPS info is a program with two tabs (which show at the bottom): Setup and GPS info

2. In the setup tab, select "start GPS" and lots of numbers and codes should show up in the main screen. This is continuous you don't have to let it "load".

3. In the GPS info tab you can see if you have a signal by looking at the Lat: and Long: readings. If those coordinates are blank, you might be indoors or without coverage. Blue circles and blue bars equal good satellite connections.

4. Once you have a signal, go back to the "Setup" tab and select "Close GPS" (You can close the "GPS info" program at this point with the x in the top right corner)

5. From the main screen (press the home button, bottom left with a house icon) click the start menu go to "Forms 5.1" This will open Pendragon Forms and give a menu. Highlight Reach and select "New" or "Review" if you have already started the reach in the PDA.

6. If you have a veg tech sampling with you the Reach information should be filled out by them. If you are sampling a stream without a veg tech enter the following:

Date	Automatic
Veg Technician	Enter "X Tech"
Stream name	Enter from site info form
Reach ID	Enter from site info form
Group	Enter from site info form
Order	Enter from site info form
Reach Type	Enter from site info form
Crew	Enter from site info form
Veg XS angle	Enter 0
Valley width	Enter "<50 m"
Flags set up by stream techs	Enter "Yes, stream techs set up…"
2 PDAs, or 2nd Card	Enter "No"
2nd Veg Technician	Leave Blank
Comment	Enter a comment if needed

7. In the Reach information click on one of the two page icons next to Data Collection & highlight “UTMs”.

8. Click “Add” to collect a new UTM. Select a location from the list to review a UTM. On the resulting page hit “Lookup…” and select the UTM reading you are recording (ex. Bottom of Reach).

9. If you collect information for a marker and the marker information (bearing, distance, and description) has changed or is new you must type it in. If the current information is correct you can leave these three fields blank. You still must collect UTMs hit “Next”

10. To collect UTMs hit “Acquire” and wait for some coordinates to show, this may take a few seconds and display “Time out” and “Errors” be patient and wait at least 30 seconds. When HDOP is < 5 select “Fix”.
    To solve Error codes lasting over 1 minute see Troubleshooting below.

11. If you “Fix” the UTMs in the wrong spot:

a. You must go back one page in the program to before the acquire page and proceed from there. The HDOP number will usually change if you collect in a different location.
b. The other option is to go to review and work through the UTM you want to change from the starting menu.

12. Now select “End” or “Next” This will return you to the UTMs sub-form.

13. To record another coordinate, begin again on step six; if the PDA was shut down start at the first step. (You do not have to turn off the GPS info program in between collecting UTMs to save battery life. This program has a very minimal power drain.)

14. When you are done with the stream hold the power button down and select Power Off to turn off the PDA.

Troubleshooting:

- Error (0301): This means the GPS is not turned on. To solve start the GPS (see step 1) and continue from there.
- Error (0302): This means the GPS is collecting data in the “GPS info” program. To solve Close the GPS (see step 5) and continue from there.
- Primary Key Conflict: This means that you have attempted to enter a unique location more than once such as 2 BR Markers.

RECORDING DISTURBANCE

Disturbance		
Evidence of Beaver	N Y* Low Medium High	
Y* = evidence of beaver, but no dams within reach		
Grazing %	N Low Medium High	
Cows Present in reach	N Y	
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

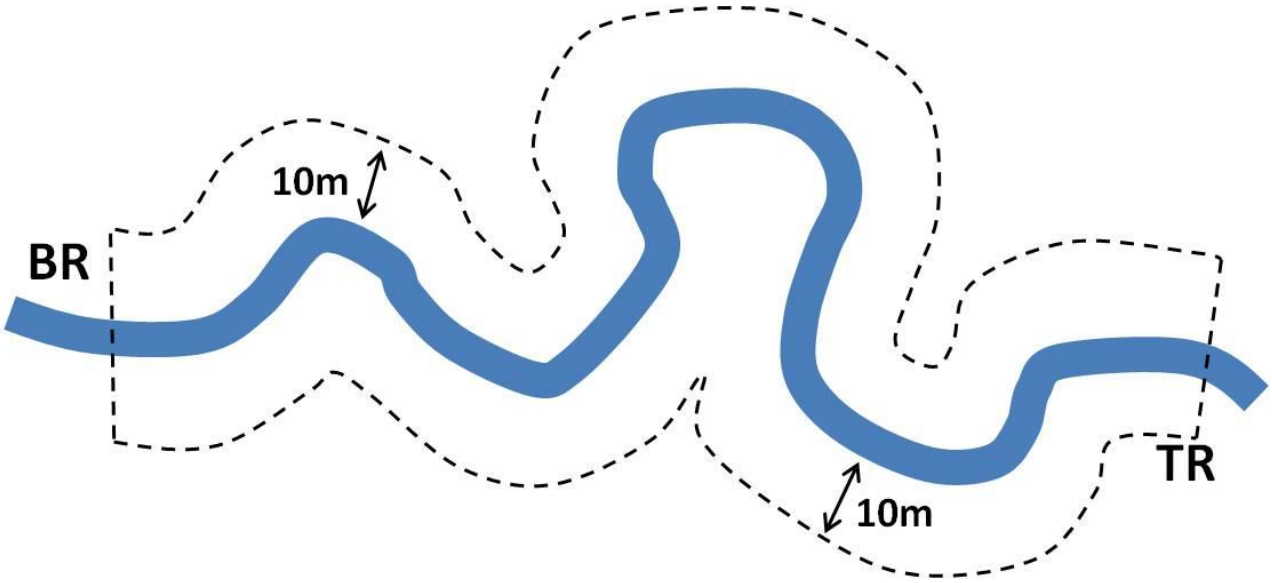


Figure 4: Depiction of where to assess disturbance and excerpt from Form 1. Area of consideration is between the BR and TR, and extends 10m from the stream channel (blue line) on both banks. In this example you would assess all disturbances within the dotted shape.

Record disturbances found within the area depicted above.

Beaver:

- N = No beaver dams within reach, and no evidence of beavers within the reach, 10 m from stream channel on either bank (see Figure 4)
- Beaver evidence = gnawed on branches or beaver glides
- Impacted by beaver = dams and pools are present
- Y*= Evidence of beaver within the area, but not impacted by beaver

- Low = ~10-40% of the reach area (Figure 4) is impacted by beaver
- Medium = ~40-60% of the reach area (Figure 4) is impacted by beaver
- High = ~60-100% of the reach area (Figure 4) is impacted by beaver
- Always draw a new reach map if your site is impacted by beavers
- See Appendix B on page 101 for sampling instructions at beaver sites

% Grazing

- N = No evidence of grazing
- Indicators include: trampling (evidence of hoof prints), trailing, grazed vegetation, cow pies, etc.
- Low = ~10-40 % of the reach area (Figure 4) shows evidence of grazing livestock
- Medium = ~40-60 % of the reach area (Figure 4) shows evidence of grazing livestock
- High = ~60-100 % of the reach area (Figure 4) shows evidence of grazing livestock

Cows Present:

- Y*= There are cows in the reach, close to the reach, or have access to the reach (there is no barrier preventing the cows moving into the reach)
- N = There are no cows in the reach

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 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 Figure 6)
  - Length of the new main channel (50m in Figure 6)

BR looking US Visit 1 BR looking US Visit 2

Figure 5: 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 6).
  - Take new Misc. stream photos showing the change
  - If the channel shift affects the BR or TR, label photos from the new channel and old channel accordingly (see next page)

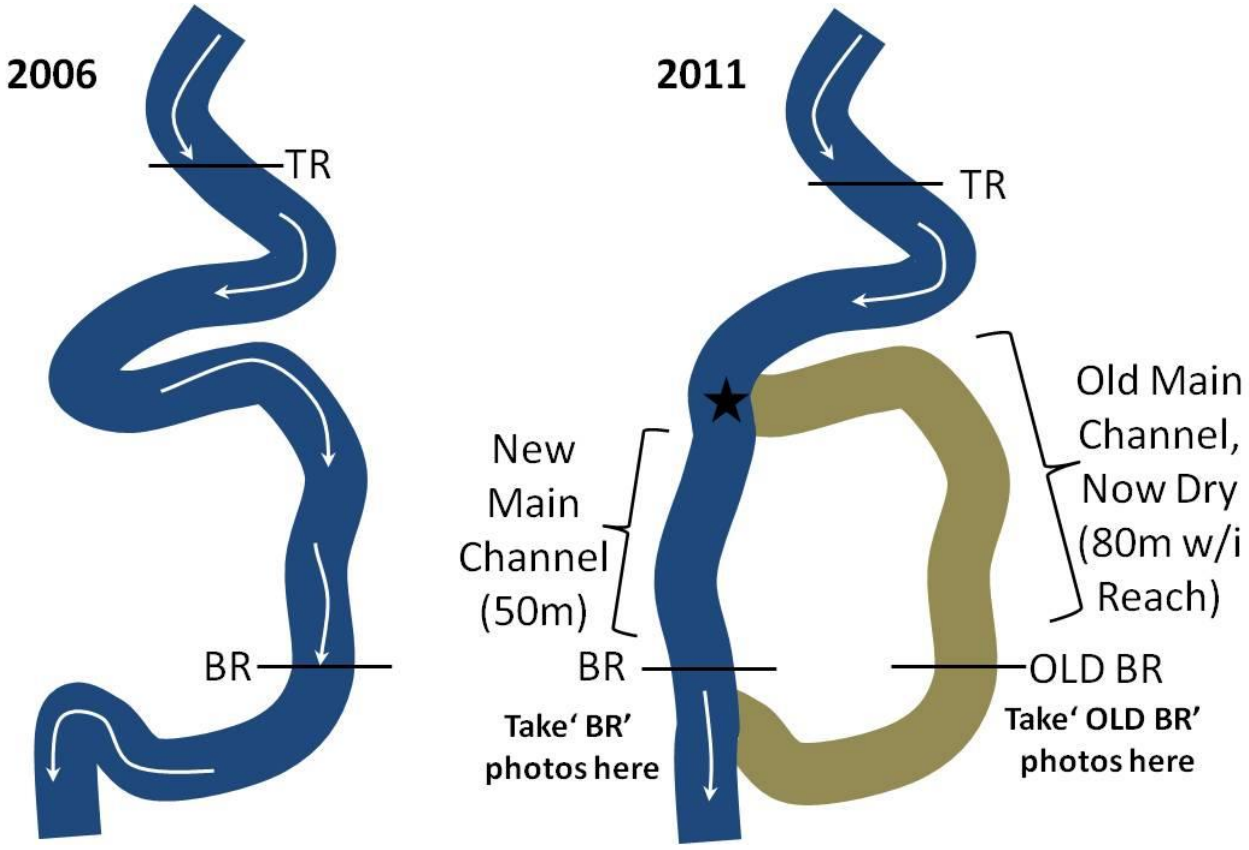


Figure 6: Since 2006, the main channel has shifted and the old BR is now in a dry channel. Move BR to new main channel, perpendicular to valley. Take new Misc. stream photos of where the old and new main channels split (starred location). Repeat any photos in the old main channel and take new ones of 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
- Look for a pool tail within 5m of the perpendicular location
- Move BR/TR marker and update information on Form 1 and in the Veg PDA
- Label old site markers as 'old' and replace if necessary, *do not remove*
- 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

Question: Do I sample the old main channel?
Answer: If it is a qualifying channel - see Side Channels on page 23

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 7: 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 B: Sampling When There Isn't Flowing Water' on page 107 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 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. Have the Veg Tech collect UTM at BR/TR markers in the Veg PDA
3. Validate marker information. 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?

Record the changes on Form 1 and have the Veg tech enter the new marker information into the Veg PDA

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
  - Have the Veg Tech update the Marker information in their PDA.
- If you didn't update marker info circle 'N' in the 'Info Collected' column on the back of Form 1 and don't recorded anything in the Veg PDA.
- 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. Try to place the maker parallel to the BR/TR.
   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.
   c. Bad example: Spanners that will wash out, alder and willow clumps
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 **on Form 1**
   a. Brief description of the site marker location (eg. US of BR 5m on RL attached to trunk of large juniper).
   b. Compass bearing from the BR marker to the BR and from the TR marker to the TR.
   c. Measure the distance from the marker to the thalweg at BR and TR.
5. Make sure your Veg tech records UTM coordinates of the site markers location in their PDA
6. Give Form 1 to the Veg tech to enter the description, bearing, and distance into the Veg PDA

MACROINVERTEBRATES

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

If there is an aquatic invasive in the sample, collect an additional sample of the invasive see 'APPENDIX F: Aquatic Invasive Protocol' (page 137) for specific instructions on creating a label and the descriptions of invasive species.

Special situations:

- Beavers: Yes, collect macroinvertebrates (bugs) in sites with beaver dams, see Appendix B: Sampling Sites with Beaver Activity on page 101 (*simply stated we want bugs collected DS from dams)*
- Partial Flow: 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 B: Sampling When There Isn't Flowing Water throughout the Site (page 107).
- K (DMA) Sites: Do **NOT** collect any bugs at K sites. Exception is if it is an 'IK' or 'IKS' site. See page 108 for more information on DMA sites.

Sampling Overview:

- Collect bugs from the first 4 riffles (fast-water habitat) upstream from your BR.
- Collect bugs at 2 locations within each riffle 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 or using your depth rod.
  - The first number in each pair (multiplied by 10) represents the percent upstream along the riffle'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 net so the mouth is 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 2 gallon bucket, 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. Remove the cup over the top of the bucket and wash it out.

6. Remove and release all vertebrates, including fish and amphibians.

7. 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 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.

8. Once all samples have been processed, fill the jars with 95% EtOH. Immediately label the jars with one label placed inside the jar and one taped onto the 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.

9. Record the number of bug jars on Form 1 and in the data logger.

10. If you notice invasive species in the stream collect them and place them in a separate jar. DO NOT REMOVE them from the sample, rather collect a few separate specimens (see Appendix F 'Aquatic Invasive Protocol').

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

Figure 8: Example of macroinvertebrate sample label.

WATER CHEMISTRY

Conductivity and Temperature

- Measure conductivity (PPM) and temperature (°C) directly above 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. Here are instructions on how to recalibrate our conductivity meters.

1. Open up a conductivity NIST Traceable Solutions pouch.
2. Take the top of the meter off so you can see the batteries and two white buttons (the INC and DEC buttons)
3. Swirl the meter in the liquid inside the punch and then turn on the conductivity meter.
4. Press the left white button and watch the screen blink 1pt calibration for a couple seconds. Then it will show a number.
5. You want it to read 300. Press the INC or DEC buttons until the meter reads 300. You need to act fast or the meter will go back out of calibration mode.
6. When 300 is showing wait for a few seconds for the meter to show a CO at the bottom of the screen and then it will go back into measurement mode after a successful calibration.
7. It seems you need to do this 2-3 times more so it will read 300 after being taken out of the juice. If you don't, it may read 290 or 310 after being taken out of the juice only once.

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 (even stagnant water). 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 the BR, measure water chemistry below the dam/pool even if it is downstream from the reach.
- K (DMA) Sites: Do not collect water chemistry (temperature and conductivity). Exception is if it is an 'IK' or 'IKS' site.

PHOTOS

Background: Photos are important for relocating sites and detecting change through time.

General photo rules:

- **Do not take photos displaying unprofessional behavior.**
- **You must be wearing a shirt and boots/shoes (no sandals) if you are in a photo.**
- Avoid having personnel in photos when possible.
- Do not zoom-in at all
- 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).
- Take photos in landscape orientation even if you are repeating photos that are in portrait orientation.
- A depth rod should be in the following photos: BR, TR, & Misc. stream
    - Try to duplicate rod location from old photos, however, make sure the rod is always visible
- 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 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 in meters (use transect flags to estimate if taking photos alone).
  - Bearing to Rod – Use a compass and record the bearing from the photo point to the depth rod.

NOTE: Record Reach Overview UTMs in the Veg PDA

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)
- The photo should include the marker and the BR (see Figure 9)

Figure 9: **Good examples of site marker photos.**

- Don't zoom in too close or be too far away (see Figure 10)

Figure 10: **Bad examples of site marker photos**

Above are bad site marker photos. Imagine you are sampling the reach in the photograph on the left. Does this marker photo on the right 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**
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.
  - If you cannot locate a misc. photo, take a new misc. photo and label it with a different misc. photo number

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 of this protocol
- 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 2001-2002 photos: You may be** given BR/TR from 2001 or 2002; these photos were usually taken standing on the BR/TR, not standing back looking at the BR/TR. Do not repeat these 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' on page 29 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 6 pg. 32).
  - 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: Sampling Sites with Beaver Activity on page 101

Figure 11: Example of 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

Repeat the old photo and take an extra better one if:

- Old photo is horribly out of focus
- Old photo was taken from incorrect/unsuitable location (i.e. can't see both banks, doesn't depict the stream channel)
- There should be a minimum of 5 Misc. stream photos per reach. Take additional Misc. stream photos if there are less than 5. Make sure the new photos are of the stream channel and 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

Note: If you take extra BR/TR photos because you think the repeat photo is bad quality, label them as, 'Top of Reach DS 2' and 'Bottom of Reach US 2'.

Take 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 with the Veg tech in the Veg PDA
- The BR and TR: Take a photograph looking both upstream and downstream. Stand parallel to the channel at a distance where you can see both banks.
- 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

Classify habitat units within the main channel of a reach as pools or riffles. Measure habitat units as sections of thalweg length. Habitat units don't overlap. If there is no flow or partial flow in the reach see page 107 for additional information on measuring habitat units.

Habitat:

- Classify formation as Riffle or Pool (scour, dam, plunge, or beaver*)
- Pools: must also be classified as either 'full' channel pool or a 'partial' channel pool
- Measure:
  - Habitat unit length along the thalweg.
  - Count the number of pieces of wood within the habitat unit
  - For pools: pool tail depth and maximum depth

*Appendix B on page 101 describes how to quantify beaver pools

General pool

- Pools are depressions in the stream bed
- Pools are bound by a 'head' crest (upstream break in streambed slope) and a 'tail' crest (downstream break in streambed slope).

Pool Qualification Requirements. To be classified as a pool the habitat unit must meet <u>all</u> the following requirements.

- Pools are concave in profile, laterally and longitudinally.
- At least one location in a pool must span 50% of the **wetted** channel width. Disregard side channels when making this distinction. (see Side Channels on page 23)
- Maximum pool depth is at least **1.5** times the pool tail depth.
- Only consider main channel pools where the thalweg runs through the pool. Main channel is defined as the channel with the greatest amount of flow. Also where the thalweg is present.
- Do not measure pool where the thalweg is not present.
- Pool length (measured along thalweg), is greater than the width of the widest point of the pool's concavity (measured perpendicular to thalweg), at the pool's widest point. Unless the thalweg drops vertically over an obstruction at the pool head crest (see pool key for definition of a plunge pool)
- **Side channels:** Only consider pools in the main channel; don't measure pools in side channels.(see Side Channels on page 23)
- **If all pool criteria were not met, it is a riffle, not a pool.**

If all criteria were met for the habitat to be classified as a pool use this key to establish the type of pool

If a beaver dam is slowing down and backing up water go to Appendix B on page 101 and classify the formation as beaver pool.

1. Pool length (measured along thalweg), is greater than the pool's width measured at the widest point of the pool's concavity (measured perpendicular to thalweg), at the pool's widest point.
   - No = length < width. Proceed to 3
   - Yes = length > width. Proceed to 2

2. Is the pool tail a wood obstruction, not created by beaver?
   - Yes =
     - **all** water is flowing over the obstruction, none of the water is flowing under or beside it, formation = dam pool
     - water is flowing around or under the obstruction, formation = scour pool
   - No = the tail was created by beaver go to Appendix B on page 101

3. Thalweg drops vertically over an obstruction (log, boulder, etc) at the pool's head crest.
   - No = not a pool, formation = riffle
   - Yes = The max depth must be within the first 20% of the pools total length. Example: if the potential plunge pool is 10m long, then its max depth must be 2m or less from the obstruction.
     - Yes, max depth is within first 20% of length = formation = plunge pool
     - No, max depth is not within first 20% or length = not a pool, formation = riffle

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

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

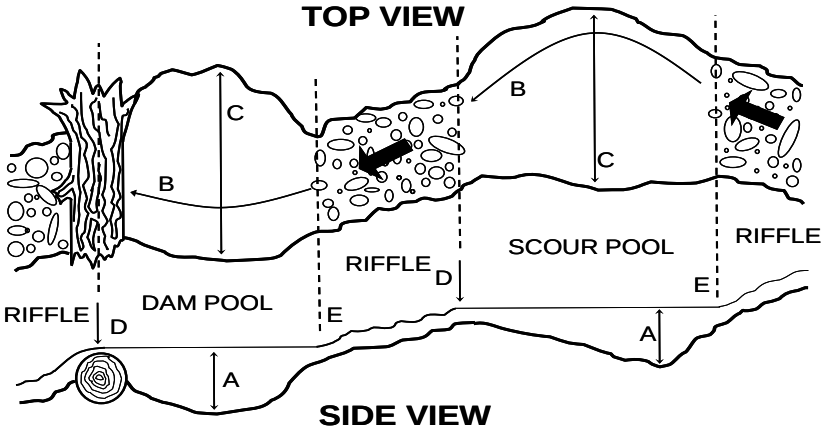


Figure 12: Top and side views of scour and dam pools. Max depth (A), length (B), width (C), tail crest (D) and head crest (E) are labeled.

Pools Data to Collect

- Length
  - Measure length along thalweg, beginning where the thalweg crosses the head and ending where the thalweg crosses the tail crest
  - 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 (In the comment note that these are estimates)
- Count pieces of LWD in habitat unit.

Riffle Data to collect:

- Measure length along thalweg
- Count pieces of wood in habitat unit

COUNTING LARGE WOOD IN POOLS AND RIFFLES

Things to remember about LWD:

- 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.
- 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.

To be counted in a Pools

- Only count qualifying pieces of large wood (see Large Wood on page 85)
- 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.

To be counted in Riffles

- Only count qualifying pieces of large wood (see Large Wood on page 85)
- No specific length of the piece must be within the riffle
- 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 (the logger changes the ranges for larger number of pieces into the average number; thus 11-15 will read as 13):

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

#	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		

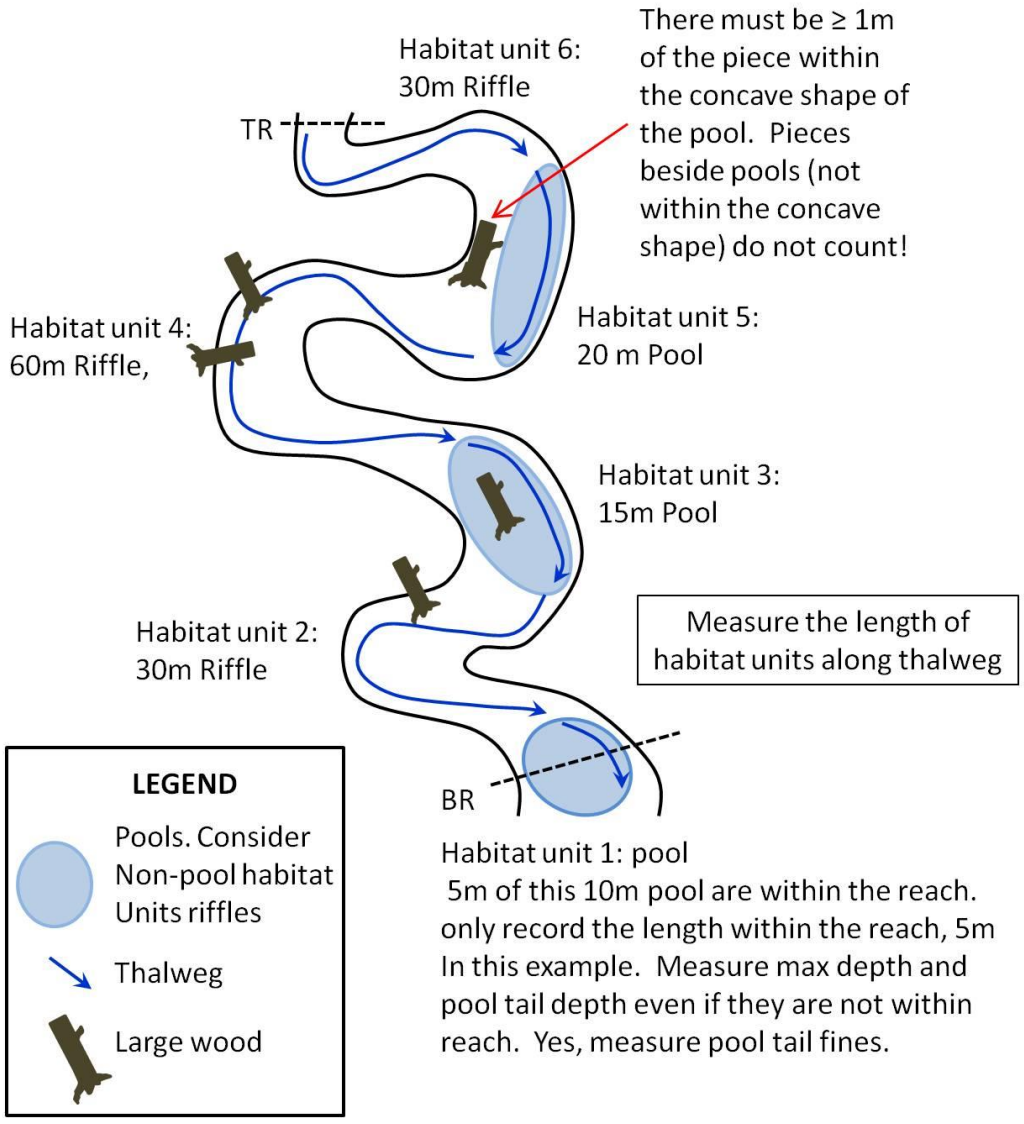


Figure 13: How to record habitat unit information.

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 13. 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. Measure pool tail fines even if the pool tail falls outside the reach. Comment pool started or ended outside the reach.

Reach length discrepancy

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

No pools

- Question: What if our whole reach is a riffle?
- Answer: Enter habitat unit it as 1 riffle and select "no pools present" on the main reach page.

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 **flowing** water (even a trickle) 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. See Appendix B on page 107 for more information on partial flow.

No flow, the stream is dry

- Question: What do I measure if the stream is dry?
- Answer: Don't measure habitat units, mark "dry no flow" on the reach page and move on. See Appendix B: Sampling When There Isn't Flowing Water throughout the Site on page 107 for more information on dry reaches.

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.

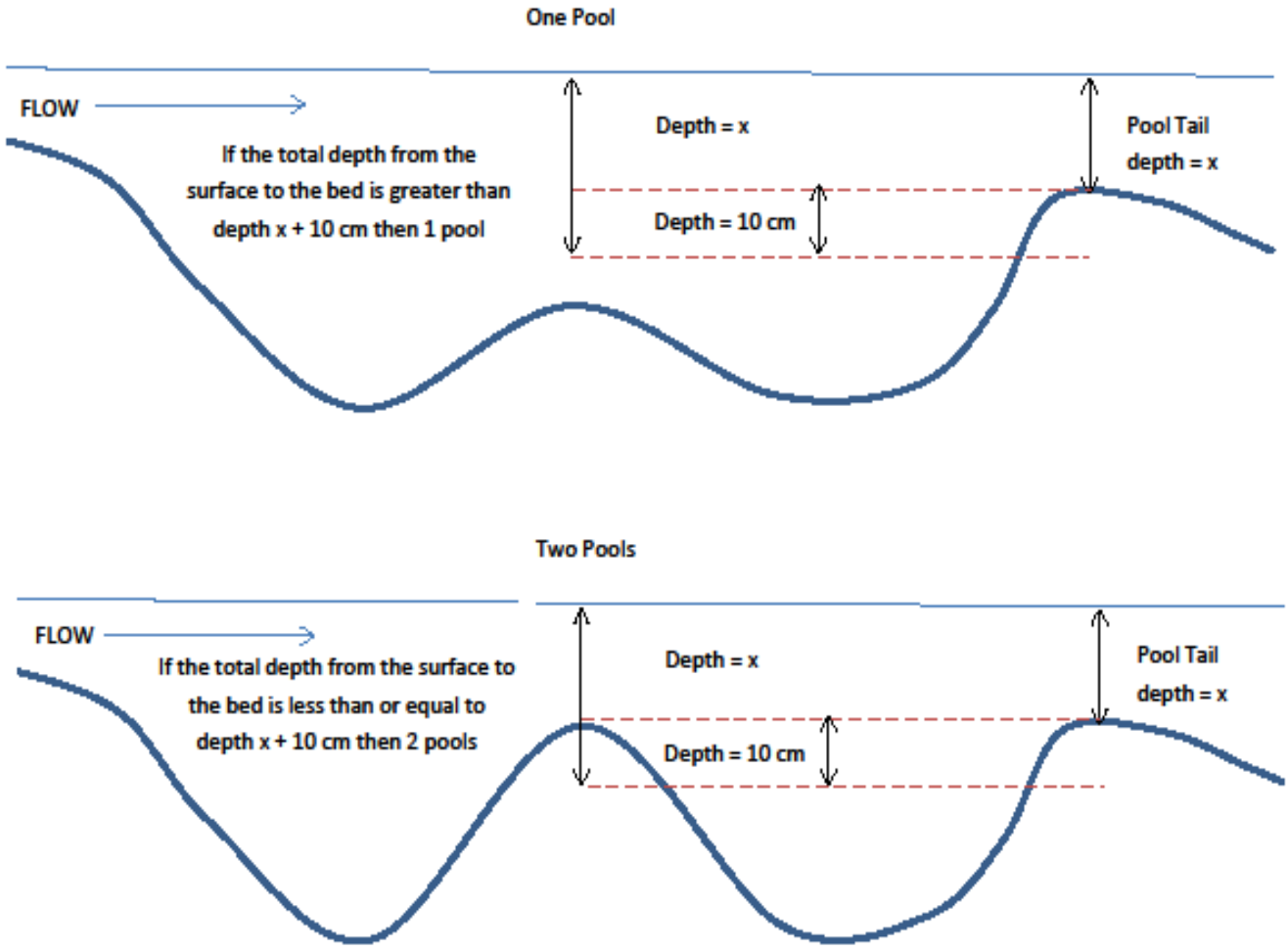


Figure 14: Example of lumping and splitting pools.

POOL TAIL FINES

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

Sampling method:

- Measure the first ten scour and plunge pools, beginning at the BR and working upstream. Exclude dam and beaver pools.

- 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.

- Take 3 grid measurements per pool.

    - Sample within the wetted channel

    - 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 (Figure 15).

    - 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.

    - Grid placements are estimated visually and may overlap.

    - If the fines grid lands on a boulder (≥512 mm b-axis diameter), record intersections on the boulder as 'non-measurable' (Figure 16).

    - In narrow streams, it is OK if grid placements overlap

- 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.

- Then count and 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.

- Record the number of non-measurable intersections. 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.

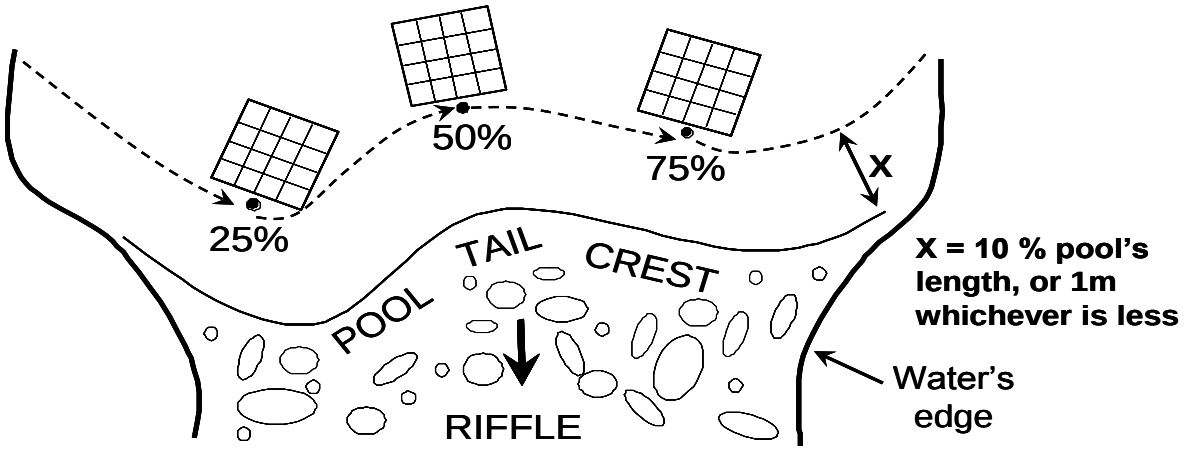


Figure 15: Location and orientation of pool tail fines grids relative to the pool tail crest

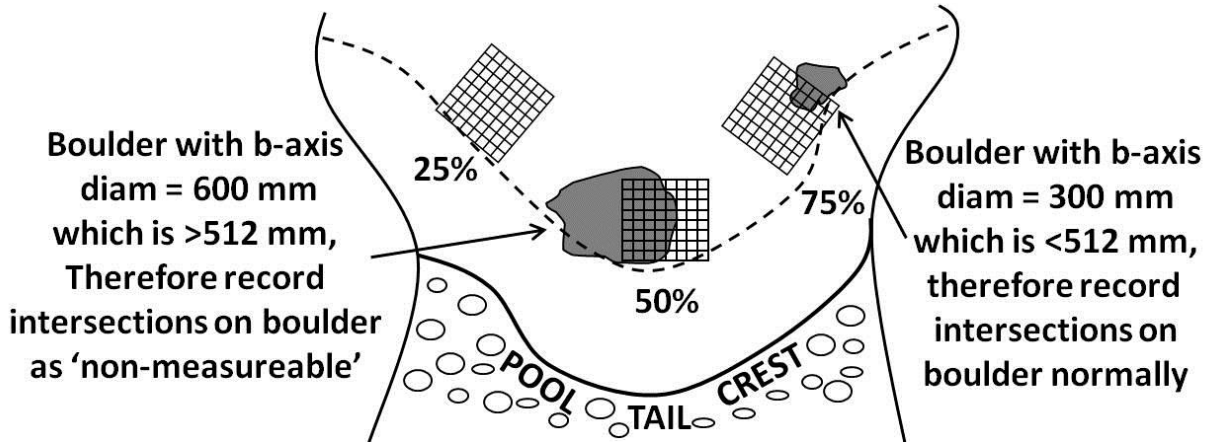


Figure 16: Record intersections of the fines grid that land on boulders ≥512 mm (b-axis diam.) as 'non-measureable'.

Reminders

NOTE: The number of fines <6mm must be a equal to or a higher number than the number of fines <2mm

- 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.

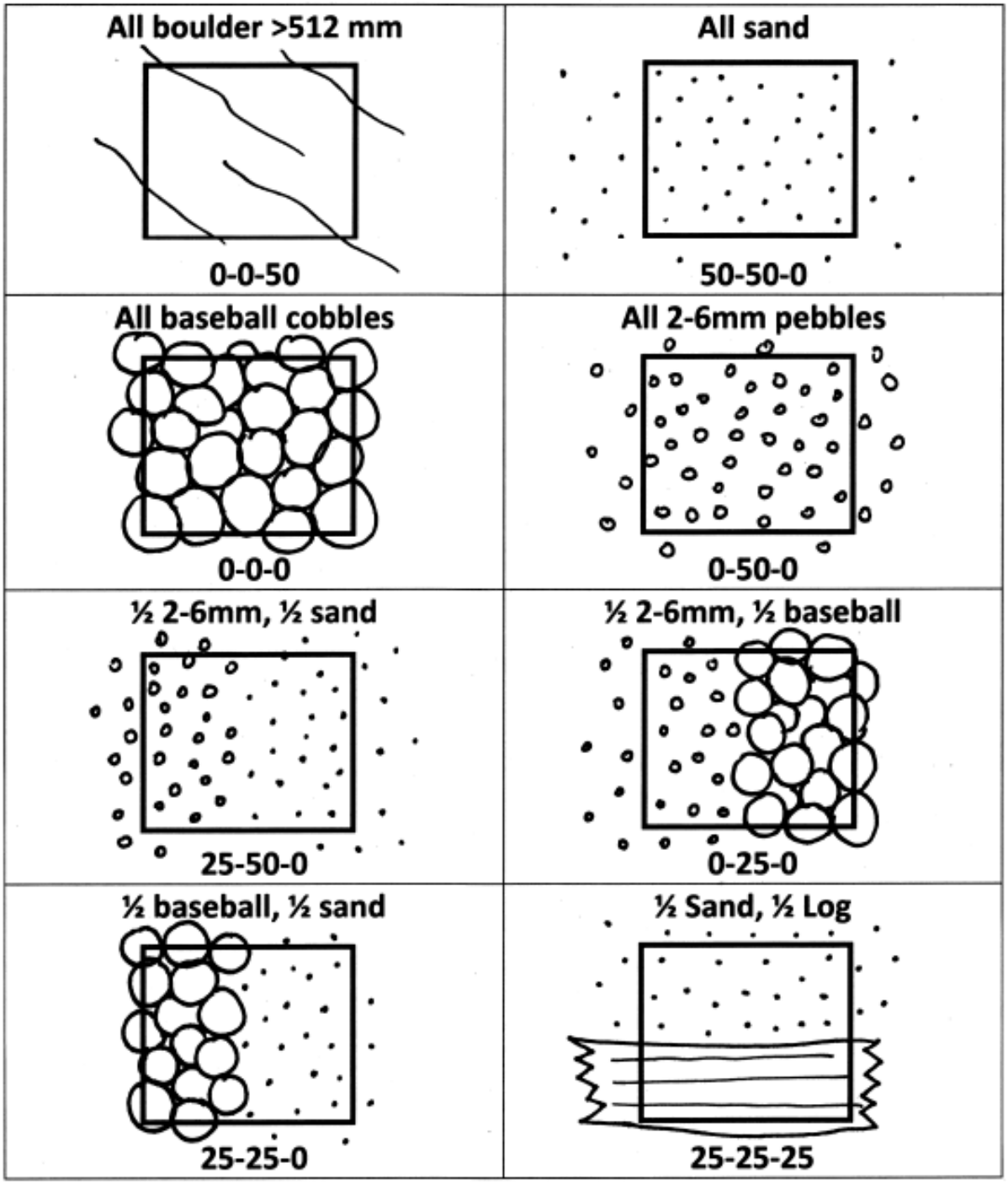


Figure 17: Pool tail fines measurement examples for different scenarios. Bottom of each box indicates # <2 mm - # <6 mm - # Non-Measurable and top of each box indicates the scenario pictured.

CROSS SECTIONS

Gear:

- 30m 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 67).
3. Pebble counts: at all transects - see 'Pebble Counts' (pg 65).

You will measure 10 cross sections per 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 18).
- If the width category is 14m, you can go up / downstream 7m.
- Find the most suitable location within this area, try to avoid:
  - Undercut banks
  - Islands and Bars
  - Boulders
  - Brushy banks
  - Logs & Log jams
  - Uneven water surface (pitched riffle)

Question: What if you cannot find a suitable cross section within +/- half the width category (m)?

Answer: Do the best you can and select or write comments to explain less than ideal measurements.

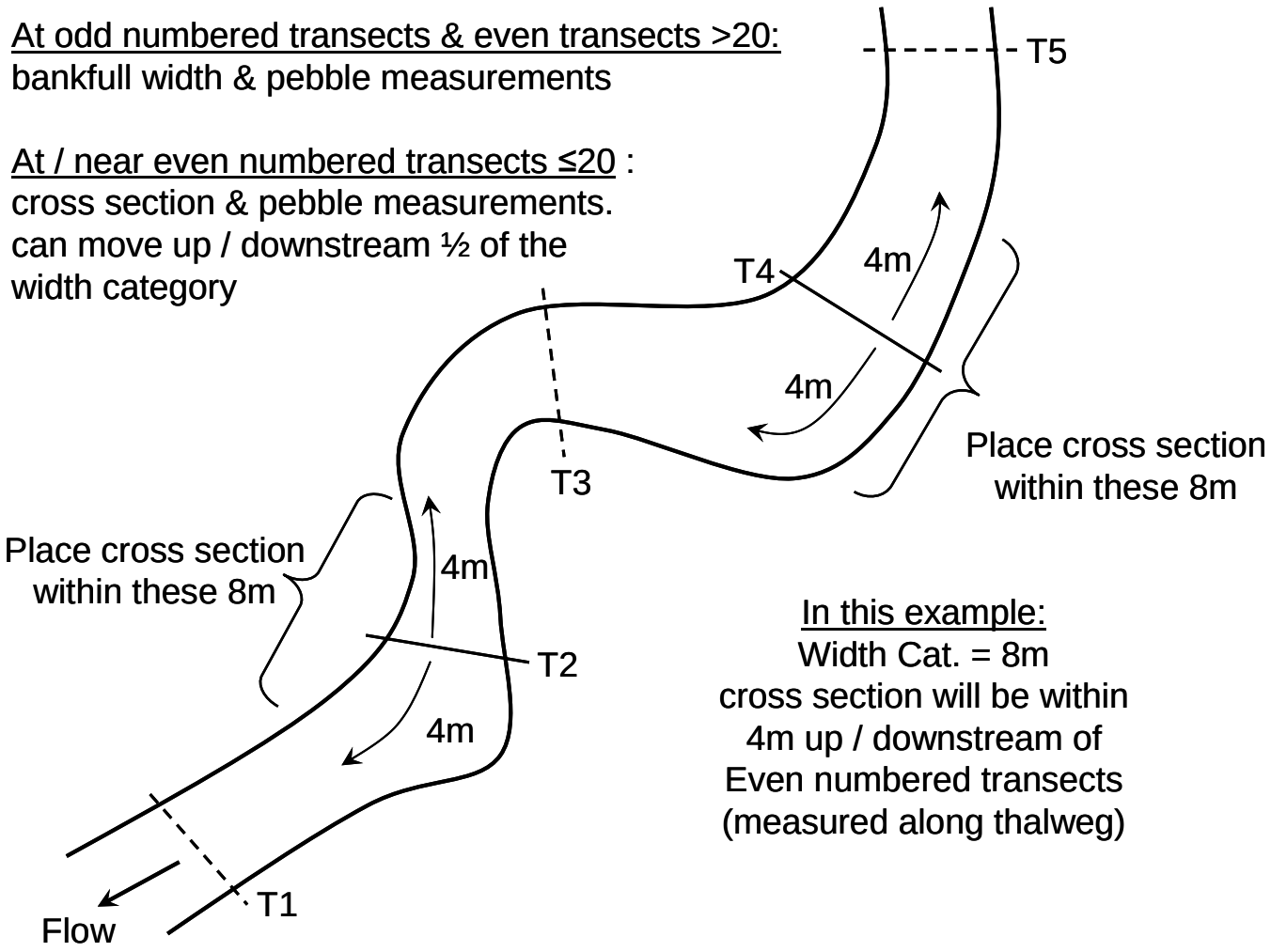


Figure 18: Determine precise location of each cross-section in relationship to even-numbered transect.

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, pool or beaver 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 (Left Edge of Water) distance
    - Bankfull depth at LEW – distance from water’s surface to bankfull
    - REW (Right Edge of Water) 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: Bankfull heights on LEW/REW must be within 3cm.

5. 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 19)

6. Measure pebbles before leaving this location - see Pebble Counts on page 65

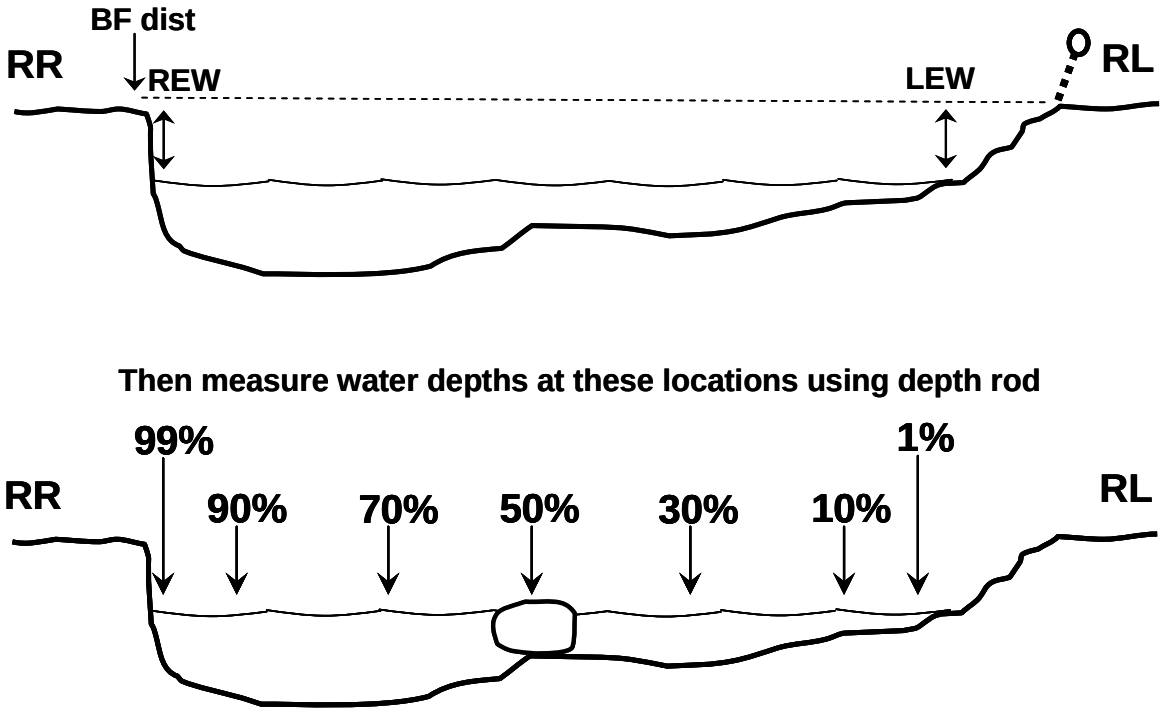


Figure 19: Depiction of water-based cross section method facing upstream. Notice that the 50% measurement falls on a boulder. Measure how high the boulder is above the water's surface and enter this depth as a negative number.

- 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 bankfull. 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 19)
- Answer: Use two depths rods to measure the distance from the water's surface to top of feature as a negative number.

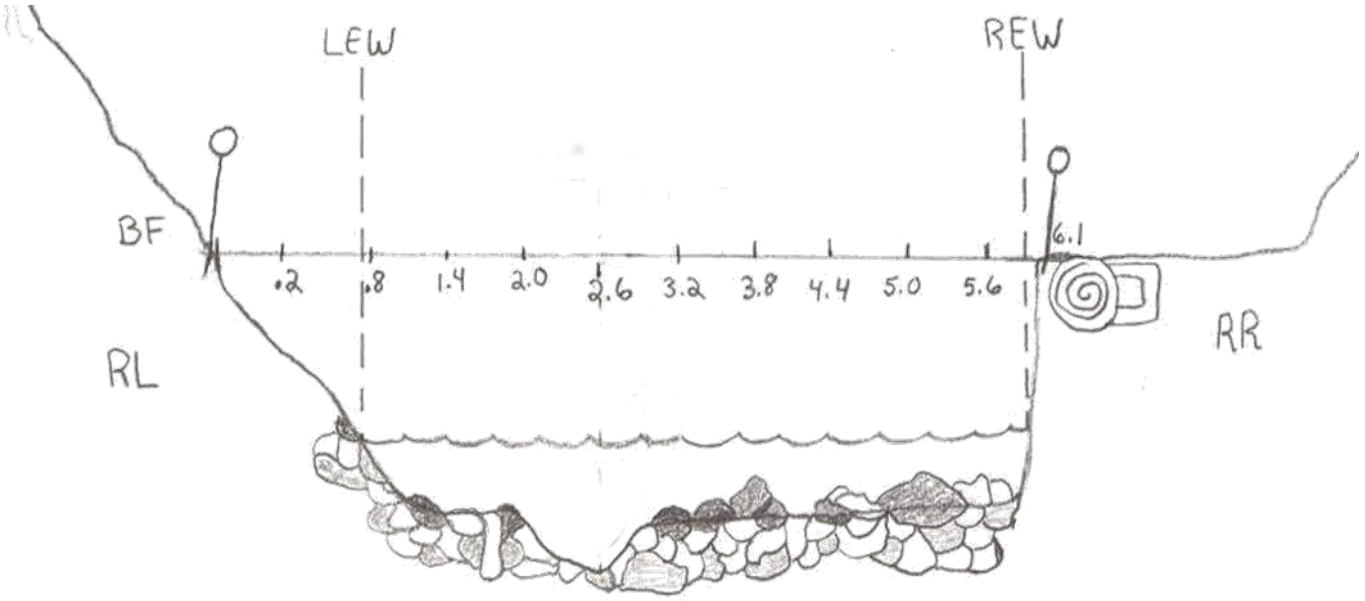
CROSS-SECTIONS: BF

How to take measurements:

1. Record if cross section is located in riffle, pool or beaver 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 river 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 or depth rod) between bankfull on the left bank and the distance of the interval calculated above (Figure 20).
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
ON_BAR	On bar or island
ON_BLD	On a boulder
REB	Right edge of bar/island
REW	Right edge of water

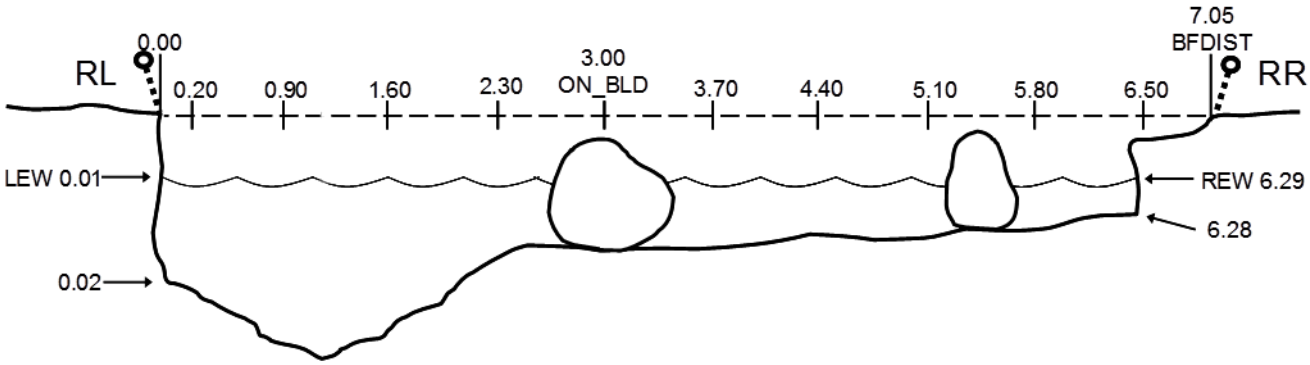
6. If your cross section is dry, enter 'Dry X-sec' as a comment, and don't record LEW/REW measurements.
7. If your cross section has an uneven water surface (LEW and REW heights differ by 3cm or more) use the drop down to enter 'Pitched riffle surface' as a comment.
8. Measure pebbles before leaving this location - see Pebble Counts on page 65



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	
3.20	40	
3.80	35	
4.40	33	
6.00	30	
6.08	30	
6.09	20	REW
6.10	0	BFDIST

Figure 20: 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 bankfull distance.

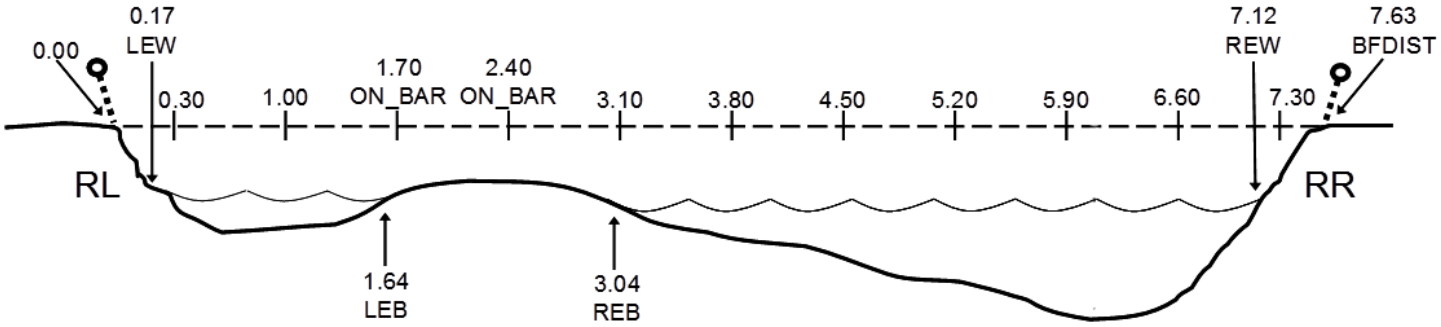


Random # =	0.2 m
BF Width =	7.05 m
Interval =	0.7 m

XsecNum	2	
BFDist	BFDepth	MeasType
0.01	20	LEW
0.02	37	
0.20	39	
0.90	50	
1.60	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 21: 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 21). Only measure to the edge of the bank when an undercut exists. Do not measure beneath the undercut.

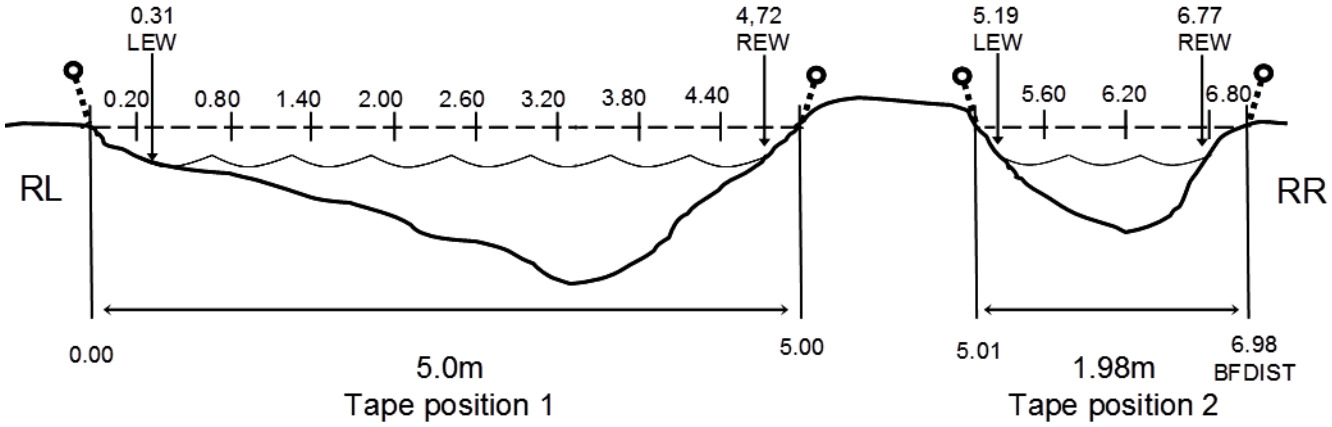


Random # =	0.3 m
BF Width =	7.63 m
Interval =	0.7 m

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	
6.60	40	
7.12	20	REW
7.30	13	
7.63	0	BFDIST

Figure 22: Channel cross-section with bar below bankfull.

Measure islands lower than the bankfull elevation as illustrated above (Figure 22).



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	
3.80	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 23: Cross section with island ≥bankfull height. Enter 'Island present' as a comment

When an island is present measure the 2 channels separately (Figure 23). Make sure to record a "0" depth at bankfull for both channels. **Record two REW and two LEW**. 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 each transect (including qualifying side channels).

Sampling Method:

1. Five particles will be sampled across each transect, from bankfull to bankfull.

2. At even transects collect at same location as cross sections and odd and all transects >20 collect at the same location as BF widths.

3. Samples will be taken at 10, 30, 50, 70, and 90% of the bankfull channel width, starting from river left (Figure 24). It does not matter what order the samples are entered into the logger.

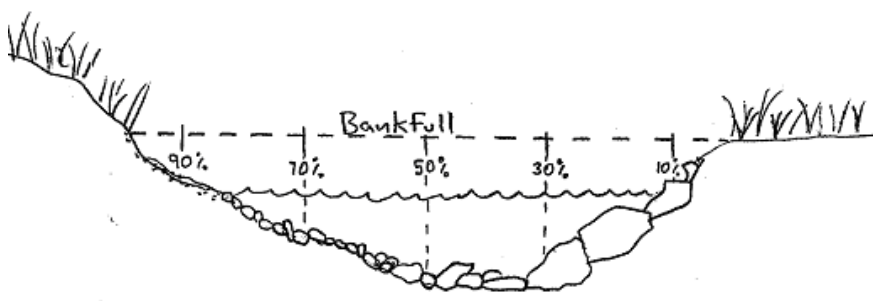


Figure 24: Location across transect for pebble count sampling.

4. Do not include the width of islands that are ≥bankfull elevation.

5. Visually estimate the sample locations prior to walking across each transect.

6. 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 (Figure 25). Visualize the B axis as the smallest width of a hole that the particle could pass through.

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

8. Also record whether the particle was found on the streambed (bed) or streambank (bank). See Where Streambed and Streambank Meet on page 10.

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

10. If unable to measure or 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)

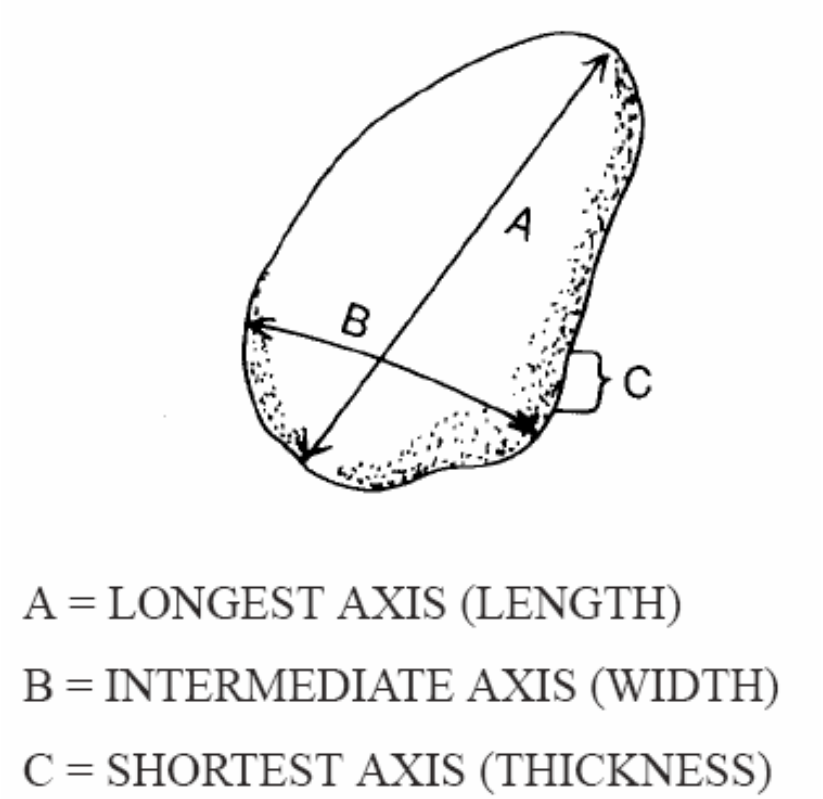


Figure 25: Example of different axes.

BANKFULL WIDTH

Objective: Determine the average bankfull width for the reach.

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

Sampling Method:
1. Measure the bankfull width to the nearest 0.1 meter 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 situation, record '-99' in the logger:
    - At tight meanders where the transect may cross a point bar without intersecting the actual bank (located behind the point bar).
    - Measurement is unsafe

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 as 'SC 1', and the second channel as 'SC 2' from river left to river right
- Record the widths of additional channels in the comment field (ex: 'SC 3 = 1.2 m')
- Do not include the width of islands that are above bankfull.
- When moving into a new channel adjust the angle at which you measure the BF width. Move the tape so that it is perpendicular to the local stream channel.

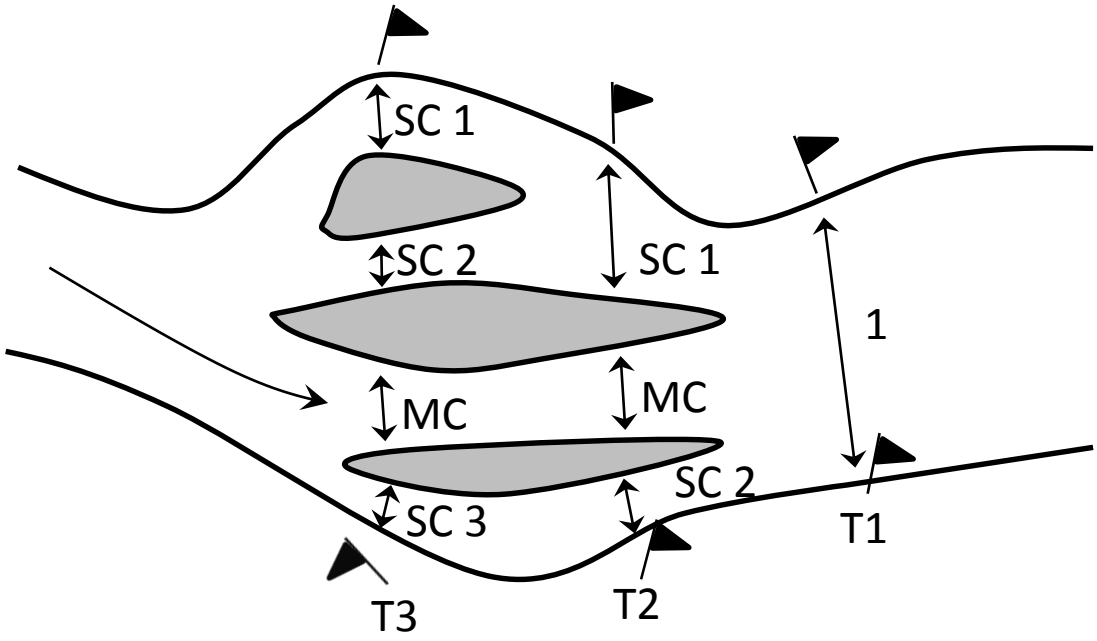


Figure 26: Depiction of how to record bankfull widths when side channels are encountered. How to label bankfull widths in this example:

- Transect 1: MC = 8.3m
- Transect 2:
  - MC = 2.4 m
  - SC 1 = 2.6 m
  - SC 2 = 1.8 m
- Transect 3:
  - MC = 2.2 m
  - SC 1 = 1.4 m
  - SC 2 = 2.0 m
  - SC 3 = 1.6 m

NOTE: The logger only allows you to enter MC, SC 1, and SC 2, record the widths of additional channels as a comment.

TRANSECTS

BANK ANGLE

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.

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 – page 10
- Scour line (SL) – page 10
- Bankfull elevation - page 9
- First flat depositional feature – page 9

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 or 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 feature: when deposition of streambed material extends above the scour line, the lower limit of measurements is where deposition meets the streambank. Read page 76 for more information.
  - Exemption: slump blocks, logs, rocks: when the connection point (i.e. where the top of the slump block, log, or rock meets the bank) is below the scour line, the lower limit of your measurement is there. Read Bank Angle section starting on page 69 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 (

  - Figure 27).

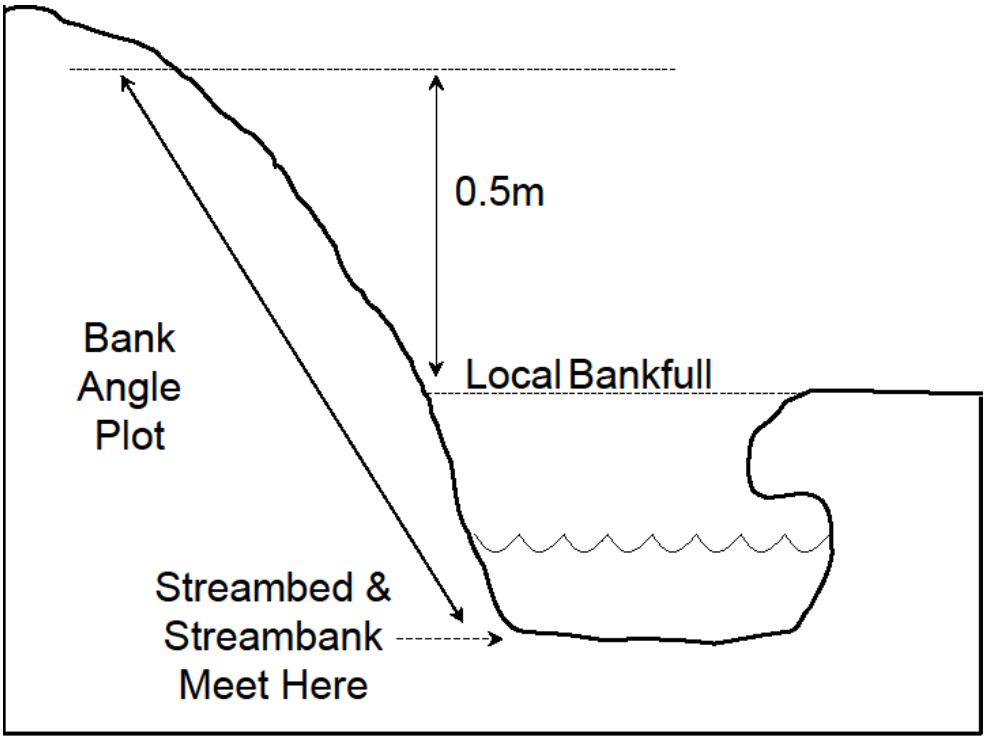


Figure 27: Bank angle plot showing when a flat depositional feature is absent. The upper limit of bank stability plot is 0.5m above the bankfull elevation.

Bank Angle: Undercut Banks

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

Measure the angle of undercut banks 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 (Figure 31)
- Undercut bank angles are measured from the deepest point of the undercut up to the ceiling of the overhang (Figure 28).
  - Occasionally the back of the undercut will be a consistent depth, thereby lacking a deepest point (Figure 30). 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 above the ceiling of the undercut (Figure 29).
- 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.

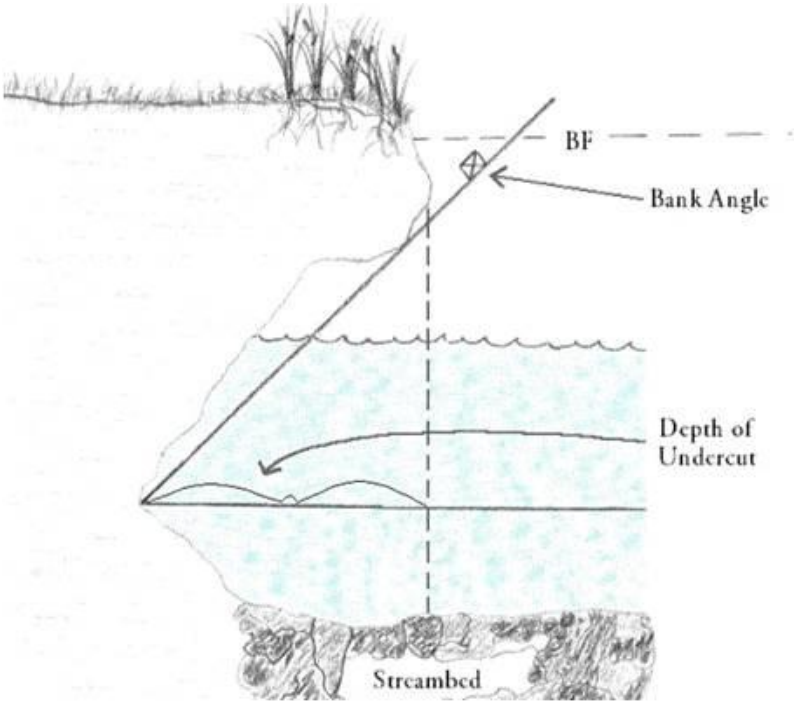


Figure 28: Measure undercut bank angle from the deepest point to the ceiling of the undercut; determine if the undercut has a qualifying depth (≥5 cm) by lowering your depth rod until it is horizontal.

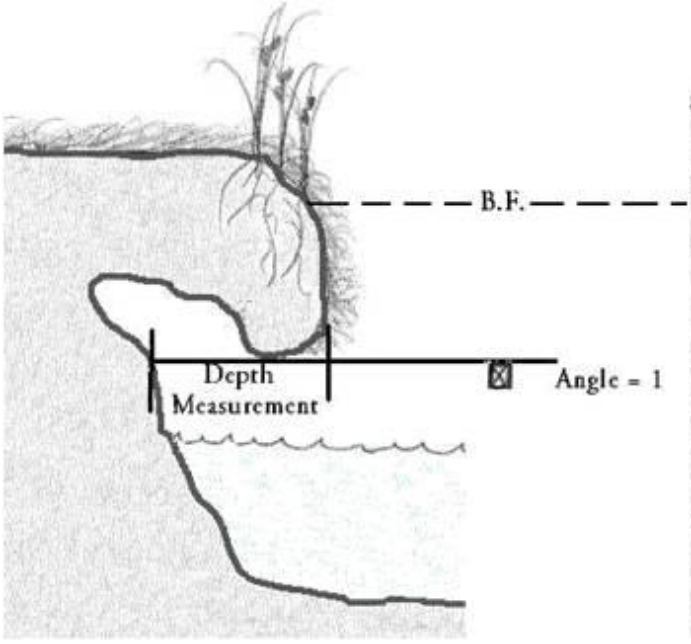


Figure 29: When the deepest point is above the ceiling of the undercut, determine if the undercut is 'qualifying' by holding the depth rod horizontal and directly underneath the ceiling. Record the angle as 1°

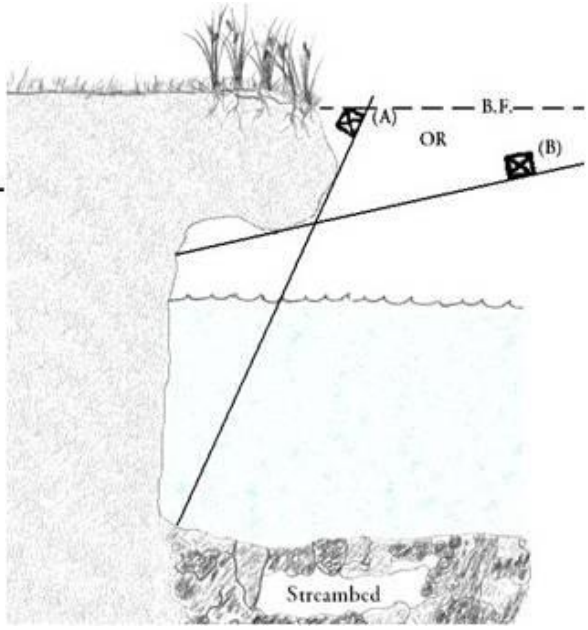
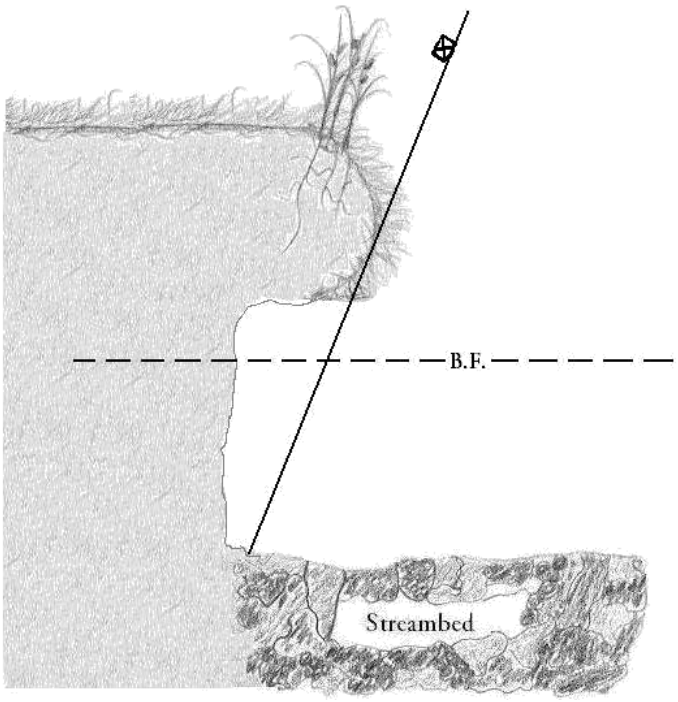


Figure 30: Undercut banks with a constant depth are measured with the base of the depth rod at the highest elevation (angle B, not angle A)



< 90° Undercut
Depth = NA
ceiling above
bankfull

Figure 31: Undercut banks with the ceiling above bankfull are measured from bed meets bank to the outside edge of the undercut. In this example the angle is less than 90°; record as NA ceiling above BF

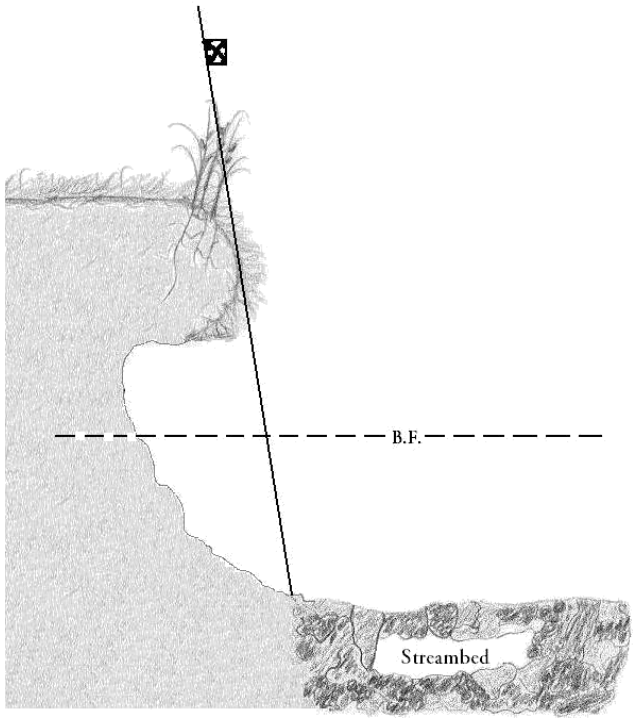


Figure 32: Undercut banks with the ceiling above bankfull are measured from bed meets bank to the outside edge of the undercut. In this example the angle is >90; record the measurement as 180-measured angle.

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 depositional feature 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 33). Similarly, measure the angle of the upper portion of the bank if it is taller (Figure 33).

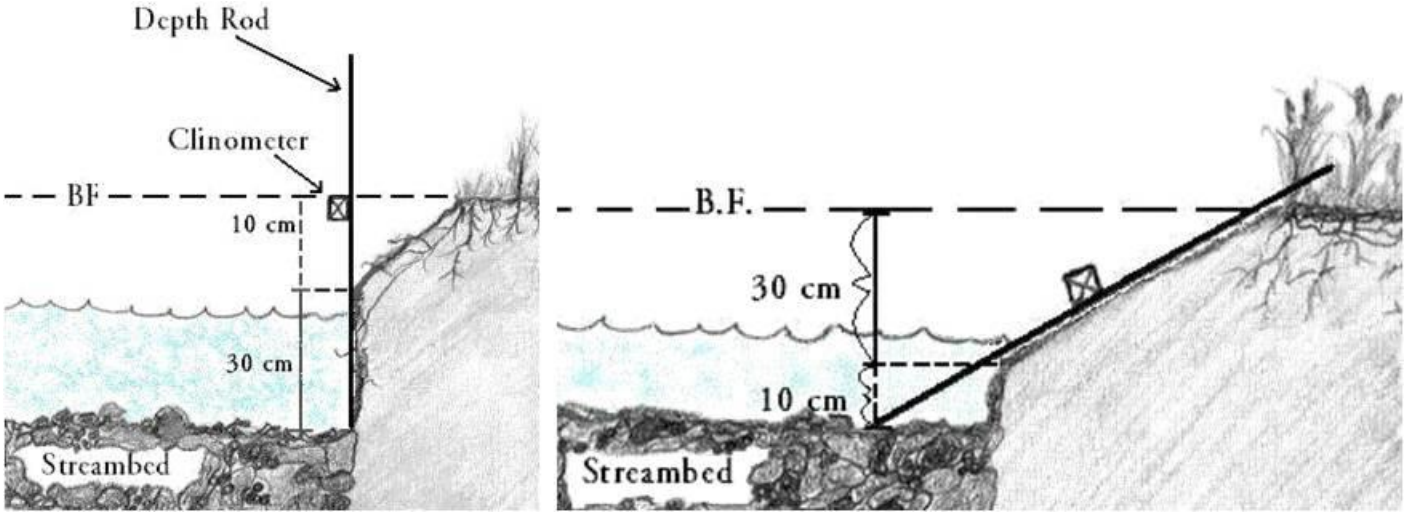


Figure 33: Measure the tallest angle when the bank has two dominant angles.

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

- Measure the average angle by laying the depth rod along the outer corner of the steps (Figure 34).
- Strive to represent the bank angle as accurately as possible with one rod placement.

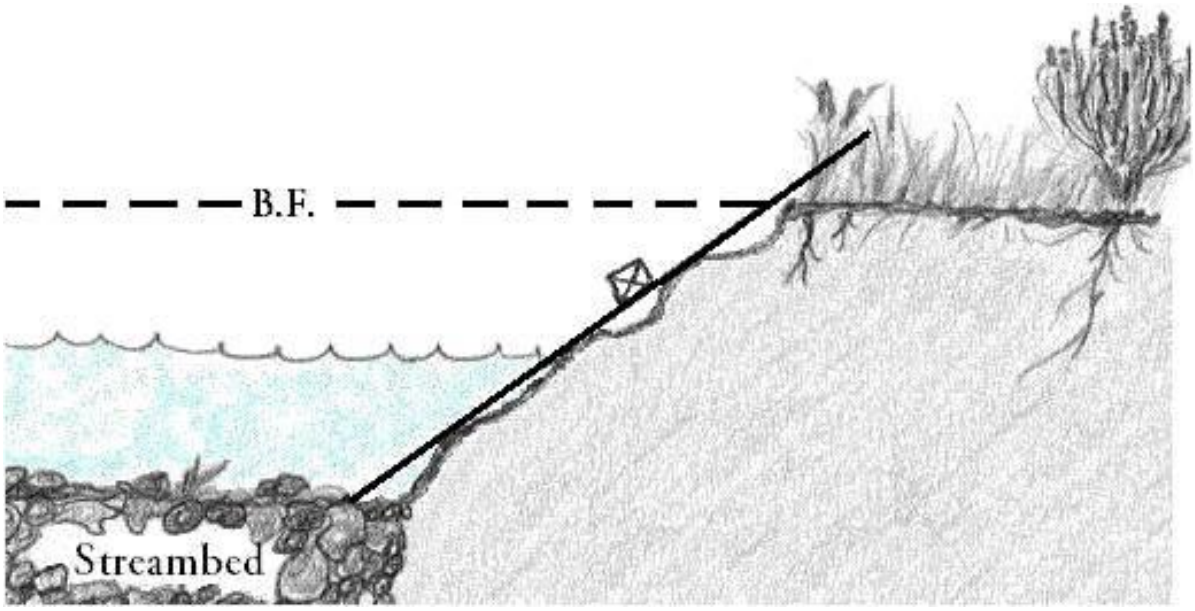


Figure 34: Measure the angle of banks with 3 or more angles by laying the rod along outer edges.

Bank Angle: Depositional Features

Depositional features are not considered part of the bank. Start your 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 35).
- If deposition ends at or above the first flat, floodplain-like feature (Figure 36), 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.

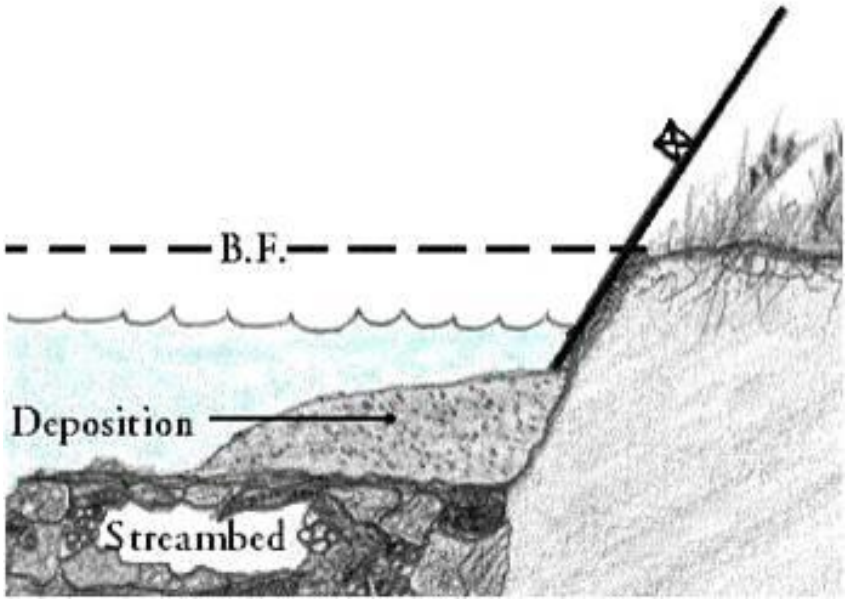


Figure 35: Begin measuring the angle from the point where the deposition and bank meet.

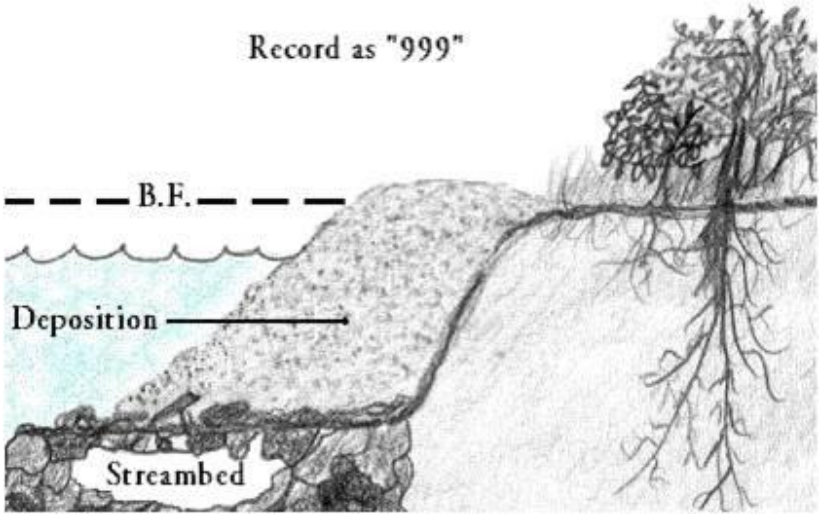


Figure 36: Do not measure an angle when the deposit covers the first flat, floodplain like feature. Record -99 for bank angle.

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 37)
- If the connection point is above the scour line, the lower limit of your measurement is where bed meets bank (Figure 37)
- Do not consider slump blocks that are not attached to streambank

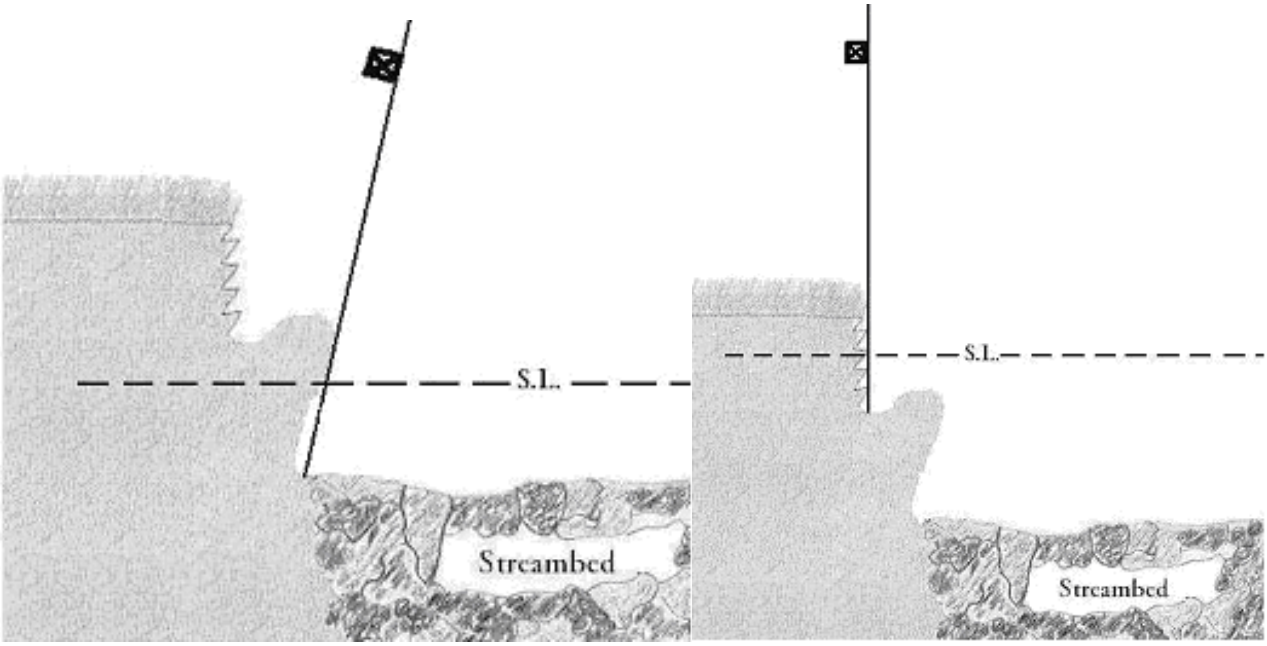


Figure 37: Location of bank angle measurements with a slump block still attached and relative to the scour line.

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 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

Be sure to set compass is set to 90/270. This is not a standalone key.

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. Is a deposition feature present?

Yes. Depositional extends above bankfull.... record -99

Yes. Deposition extends above SL but below bankfull. Only evaluate portion of bank above deposition go to 3

No. Deposition not present, evaluate from bed meets bank go to 3

3. Is there a slump block, an embedded log (≥10cm diam.), or embedded rock (≥15cm b-axis diam.) at your transect location?

No. go to 4

Yes. Connection point of the slump block/log/rock below SL.
Only consider the bank from the connection point up to the first flat depositional feature go to 4

Yes. Connection point of the slump block/log/rock above SL.
Consider the entire bank from where bed and bank meet up to the first flat depositional feature go to 4

4. Is there an undercut bank?

Yes undercut go to 5

No undercut go to 8

5. Is the undercut qualifying (i.e. ≥ 5 cm deep, ≥ 10 cm in height, and >10 cm in width)?

Yes. Qualifying undercut present go to 6

No go to 7

6. Is the ceiling of the undercut above BF?

Yes. Measure the undercut from bed meets bank to the outside edge of the undercut. If resulting angle is acute classify as NA ceiling above BF. If resulting angle is obtuse enter the angle do not classify as an undercut. See page 74 for special instructions.

No. Measure the bank angle, which must be acute (>90°), first boot check, measure from the deepest point of the undercut to the ceiling. See Bank Angle: Undercut Banks for special instructions.

7. Is the non-qualifying undercut the tallest angle?

Yes. Measure the bank angle as acute and classify as a non-qualifying undercut. See page 69 for special instructions.

No go to 8

8. 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.
  - 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.
- 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 (Figure 38).

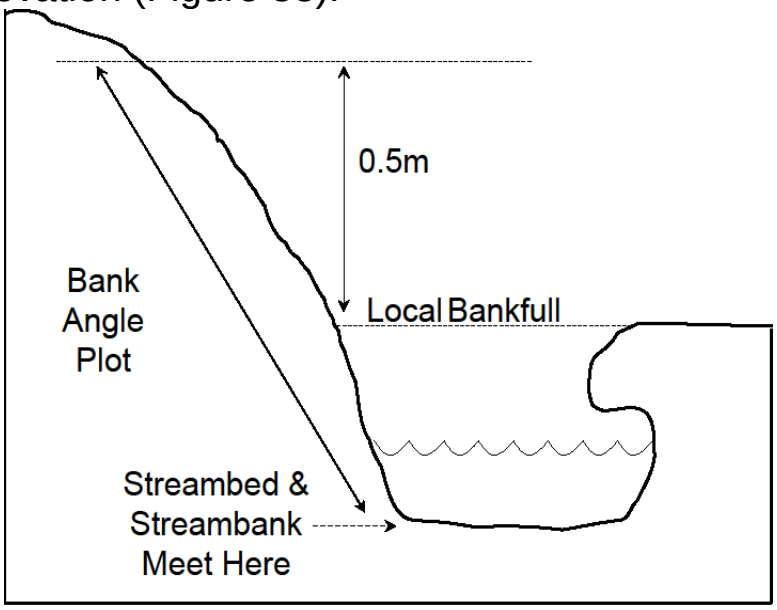


Figure 38: Bank stability plot when flat depositional feature is absent. The upper limit of bank stability plot is determined by adding 0.5m to the bankfull height. The lower limit of the stability plot is the scour line.

Streambank Stability Classification Key - Terminology

Depositional Feature - Loose, unconsolidated material, recently deposited and extending above the SL (Depositional features turn into banks when interstitial spaces between larger particles become filled with smaller particles and the feature becomes consolidated).

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 10).

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

Slump Block - 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 feature present (Figure 39 II)
Deposition at or above bankfull ____ **2**
Bank covered (deposition above SL but below bankfull ____ **3**
Bank not covered (deposition above SL but 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 39 III). Consider the slump block unattached if only gravity/friction is keeping it in place.
A. The bottom of the fracture feature is below the SL. View only the fracture feature behind the slump block (Figure 39 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 above the SL (view the bank as the slump block and the fracture feature the vertical, exposed bank) (Figure 39 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 39 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

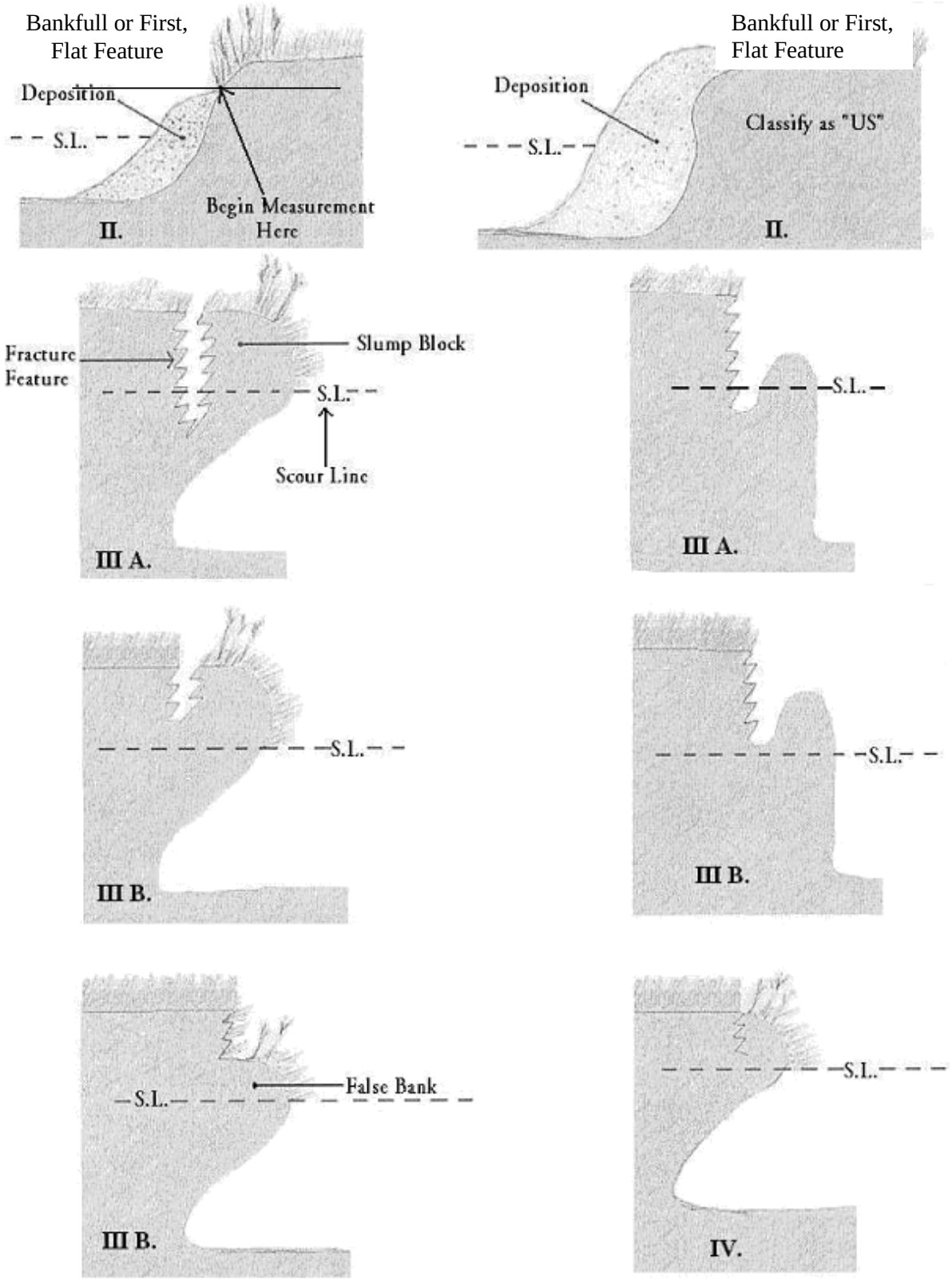


Figure 39: Examples of bank stability types described in sections II, III, and IV in the classification key. The Roman numeral and letter combinations above correspond with the bank stability key on the previous page.

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 5 categories based on association with erosion or deposits, pool or non-pool habitat units, and the relation to the thalweg (Figure 40). Also identify transects were data is collected in beaver pools.

1. Determine whether the transect lies within a pool or riffle. Consider all non-pool habitats as riffle.
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 40).
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 are classified as “PIE” for pool inside, erosional (Transects 1, 2 & 4 in Figure 40). Depositional banks that have deposits which extend above the scour line are classified as “PID” for pool inside, depositional (Transect 5 in Figure 40).
5. For transects where both banks are beside non-pool habitats, record both banks as “R” for riffle.
6. In situations near a pool head or tail or side channel, one bank may be within the pool and one in a riffle; use the pool classification for both (Transect 2 in Figure 40). For example, you will never have one bank be ‘PO’ and the other ‘R’.
7. Record all measurements in a side channel as ‘SC’.
8. Identify all transects that fall in beaver pools by marking yes in the beaver impacted section, if the transect is not impacted by beaver leave blank.
9. In dry streams where fluvial processes cannot be determined use “NA”

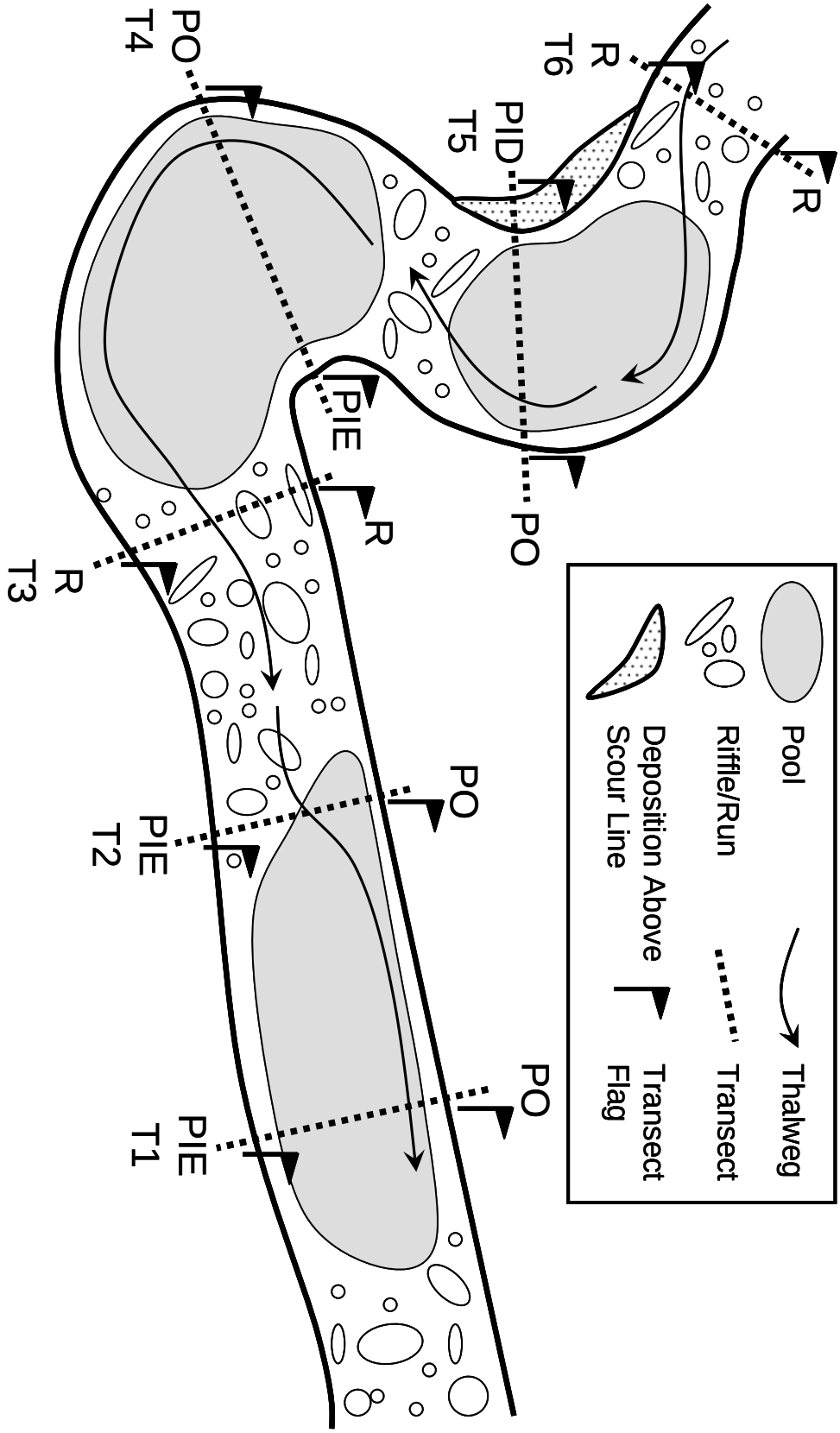


Figure 40: Example of stream showing the four classification categories for bank type.

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. riffles) (see Habitat Units on page 46).

Equipment needed:

30m tape
Depth rod
Logger
2 stream techs (one could be a well-trained veg tech)

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 42).
- 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 (Figure 43 and Figure 44).

- 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.

Method

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.

    Don't tell the estimator when a piece is going to be measured it must be random.
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 45 to determine what large wood to count.
8. Large wood in isolated side channels, pools or depressions <bankfull elevation is not measured.

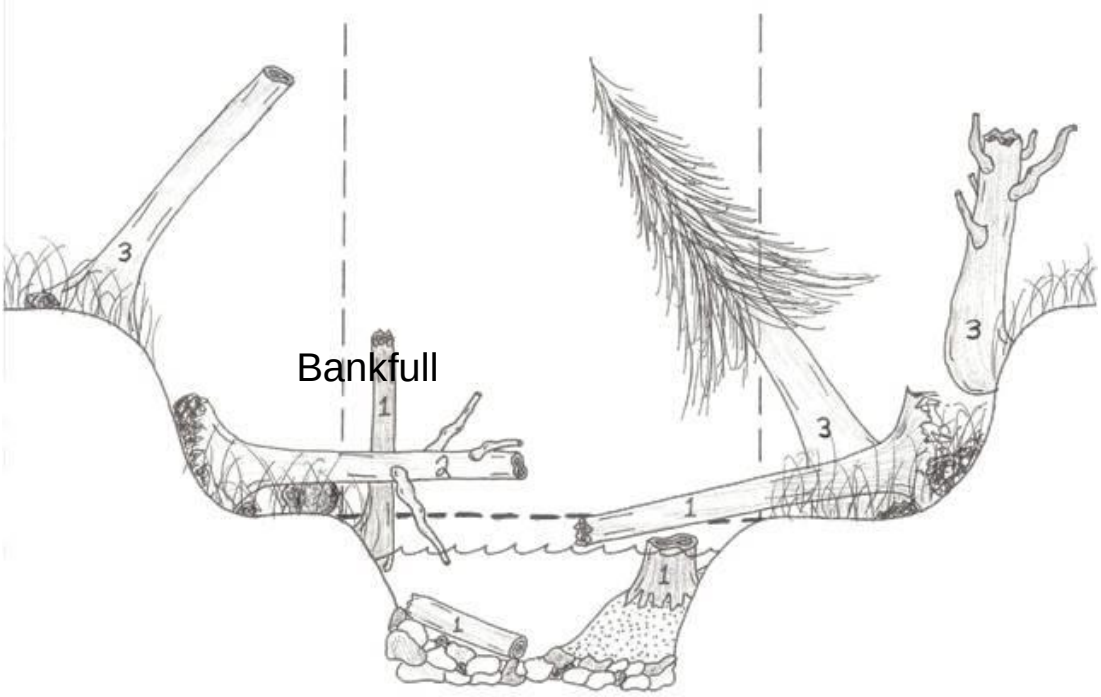


Figure 41: Large wood. Pieces numbered 1 are counted; pieces numbered 2 and 3 are not.

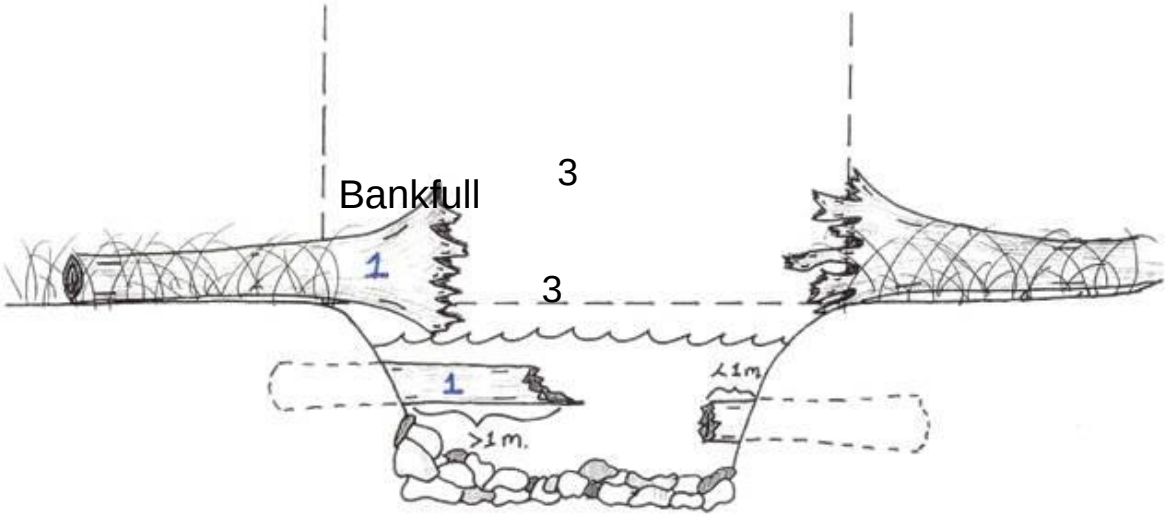


Figure 42: Examples of qualifying large wood (1). The pieces on the right side (3) are not counted because only the roots extend over the bankfull channel (upper) and the exposed section is ≥1 m in length (lower).

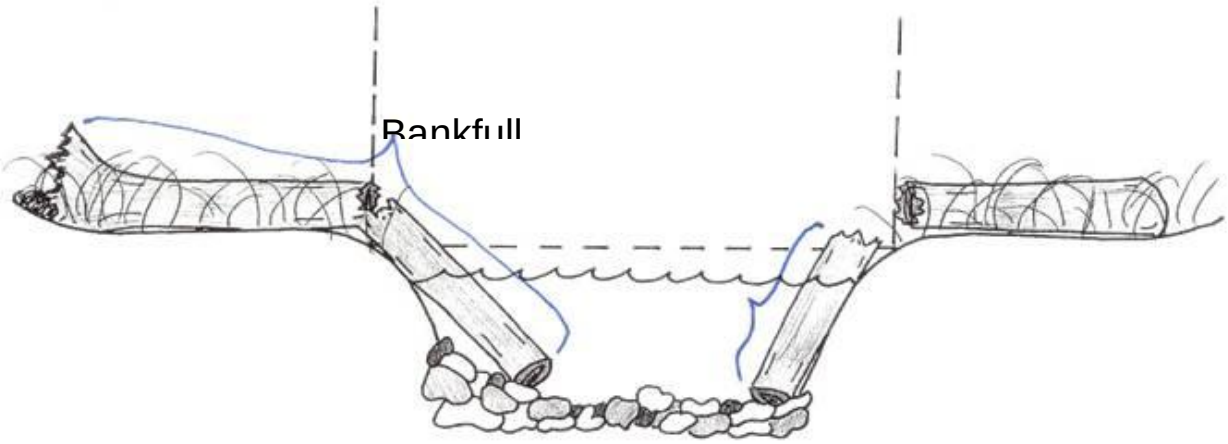


Figure 43: Examples of how to measure the length of broken pieces. Measure the length of the entire piece on the left (pieces still connected). Only measure the piece within the bankfull channel on the right.

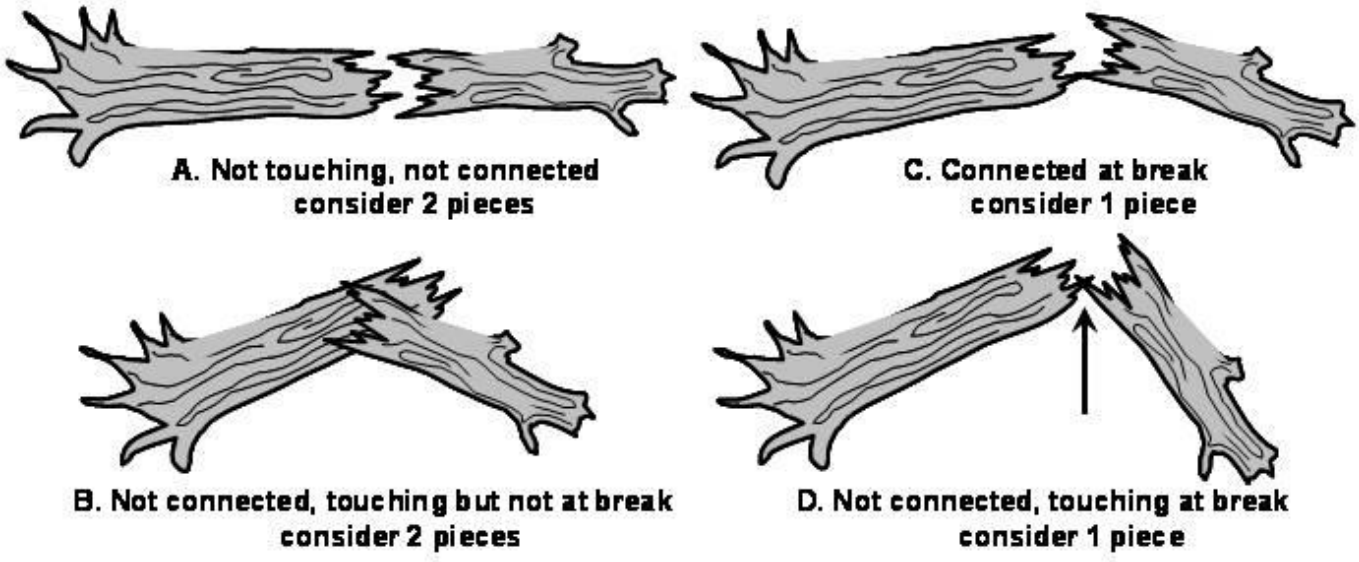


Figure 44: Is it one piece or two? Variations of touching vs. not touching along the break.

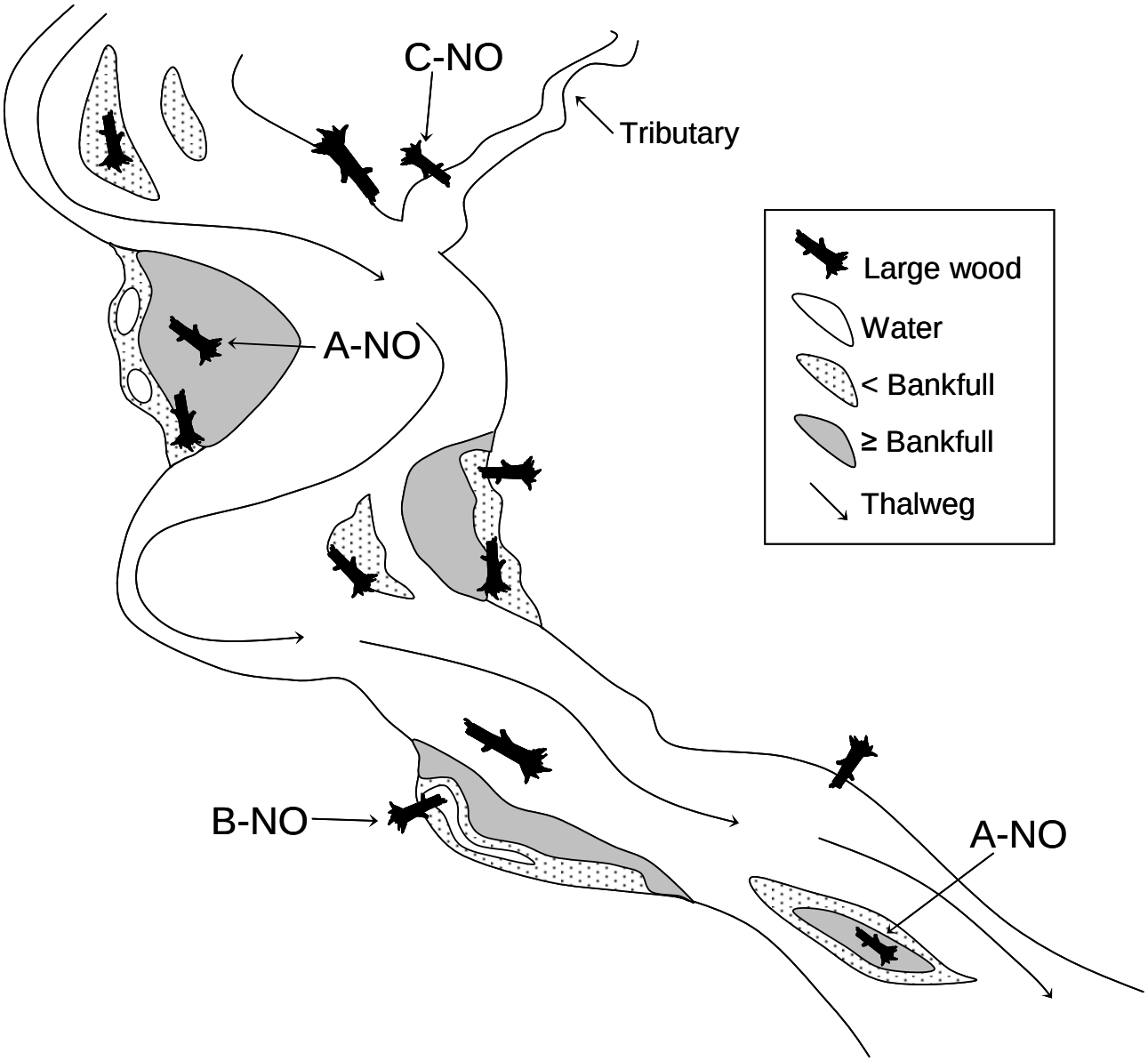


Figure 45: Depiction of qualifying and non-qualifying large wood. Unlabeled pieces qualify because they are within bankfull channel. Large wood on islands ≥bankfull elevation is not measured unless it meets category 1 requirements (A). Large wood in tributary streams is not measured (C). To determine 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 >bankfull elevation does not qualify (B).

REACH MAP

The reach map is drawn on Form 2 to show important features that 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 thalweg) 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.
- Are simple and not overcrowded, but include important features

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
- Previous map is poorly drawn and/or unclear

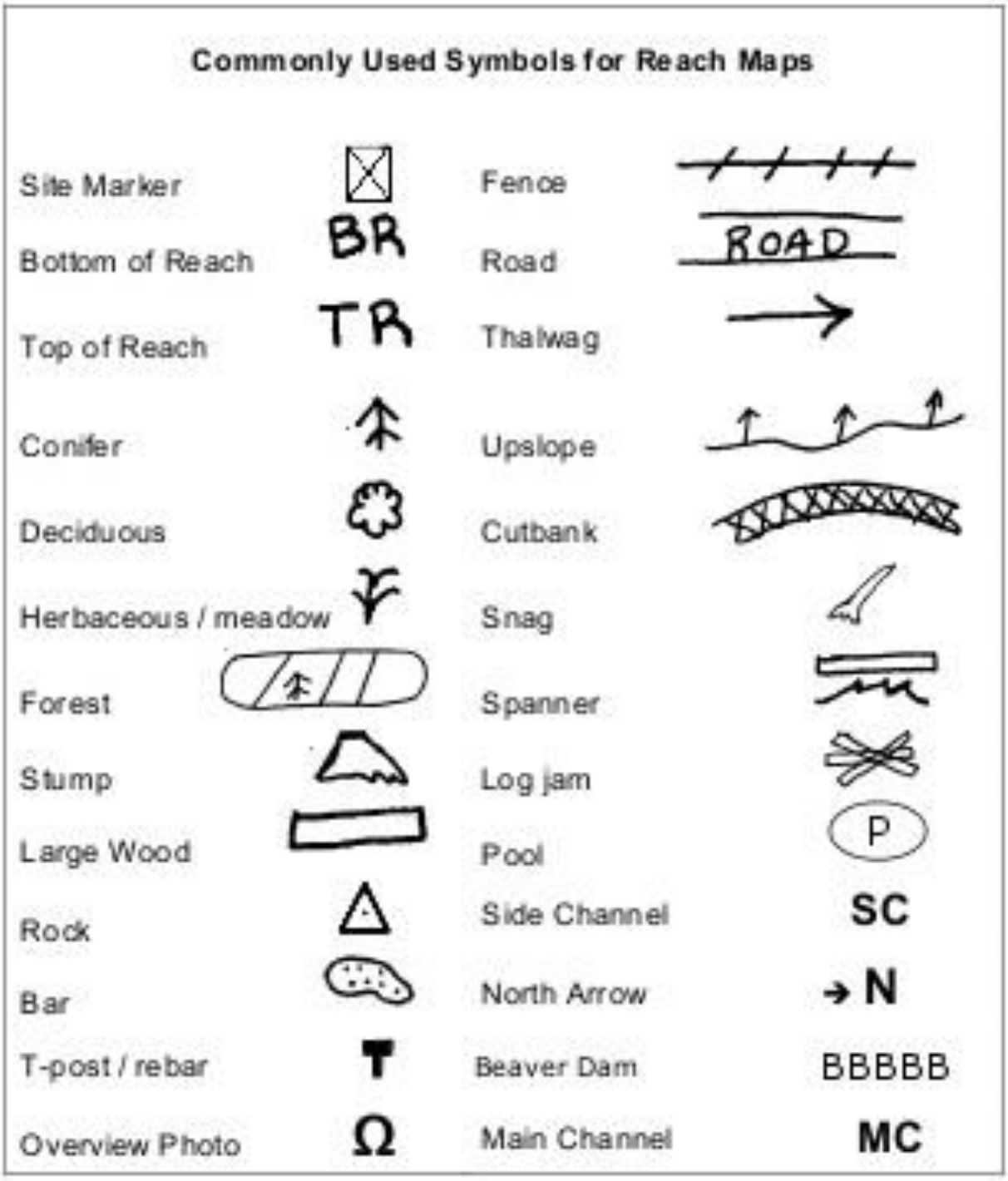


Figure 46: **Commonly used symbols for reach maps.**

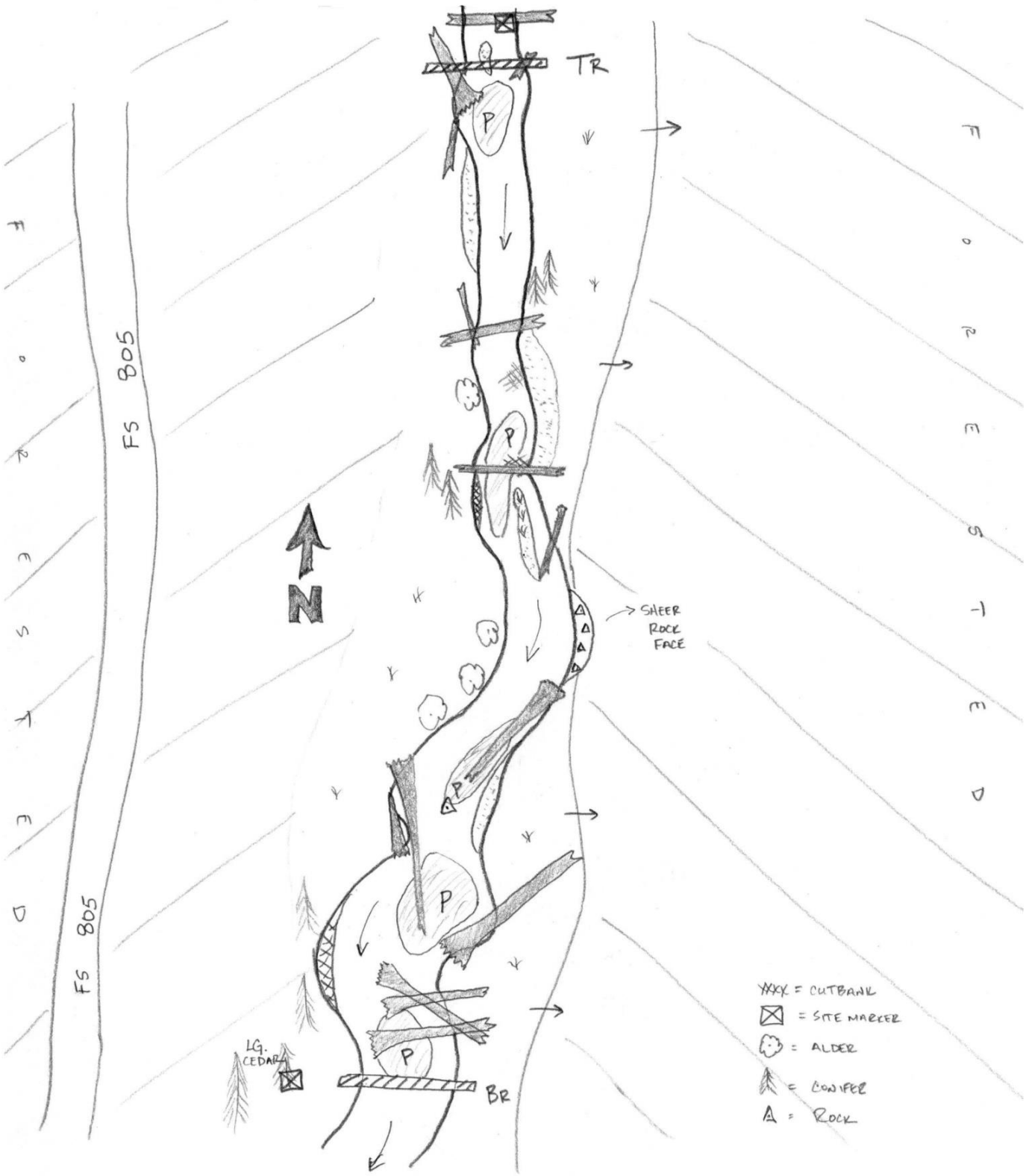


Figure 47: Example of a well-drawn reach map.

MEASURING CHANGE IN REACH ELEVATION (GRADIENT)

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 within ±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 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 independently 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 49 shows how to record individual shots and calculate elevation change.

You must measure the elevation change 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 within ±10% of one another. For example, in Figure 48 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 49). Because the second elevation change was within the ±10% range (1.19m), a third measurement was not required.

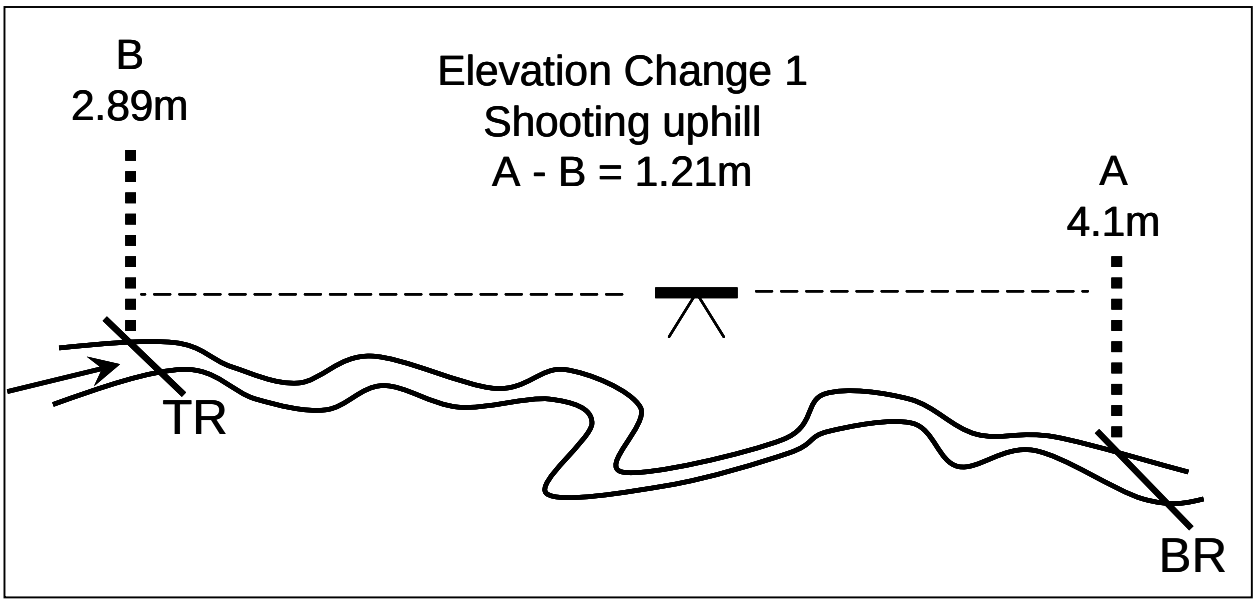


Figure 48: Measuring elevation change using a single shot. The 1st of 2 elevation changes is depicted above.

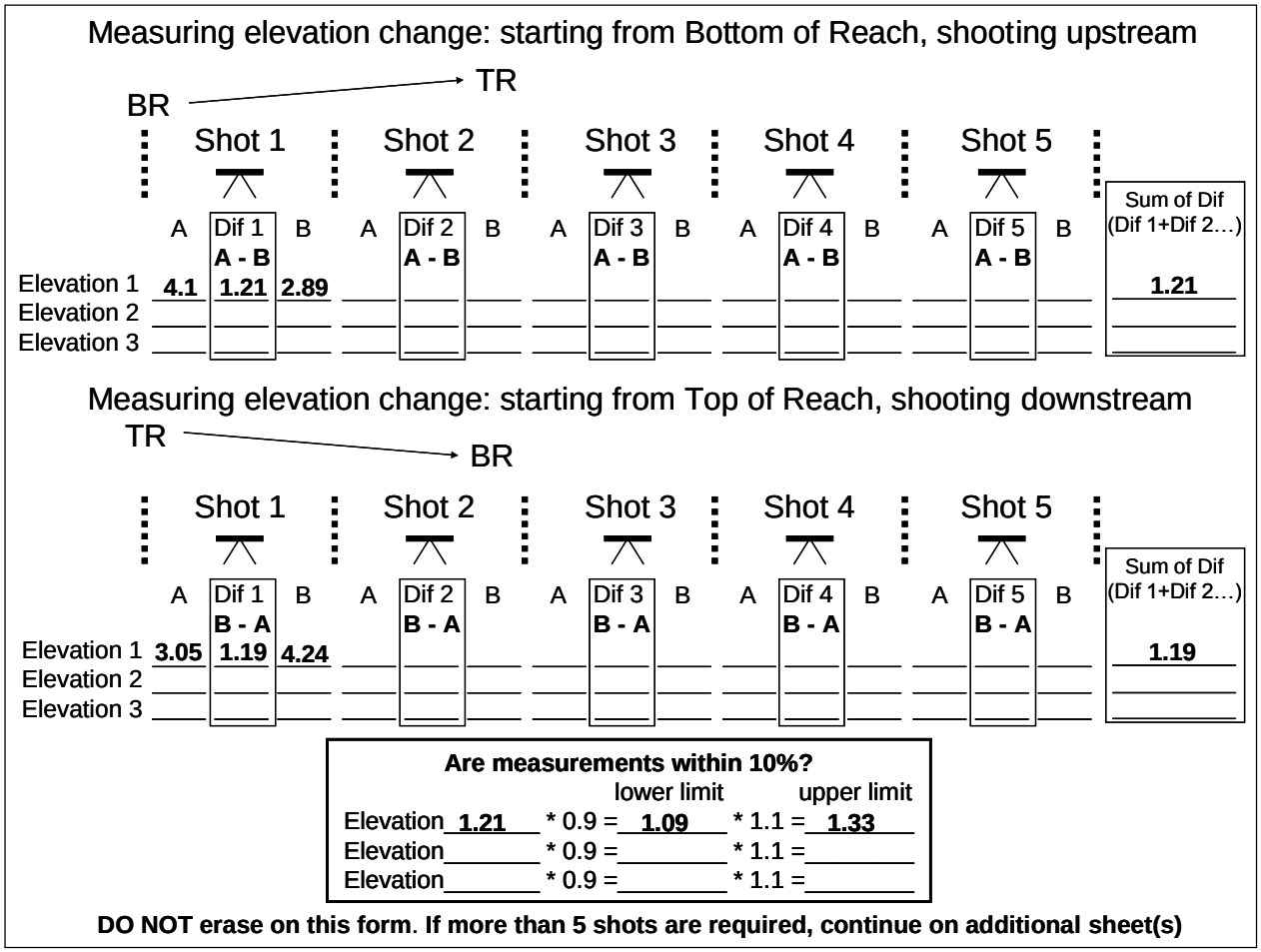
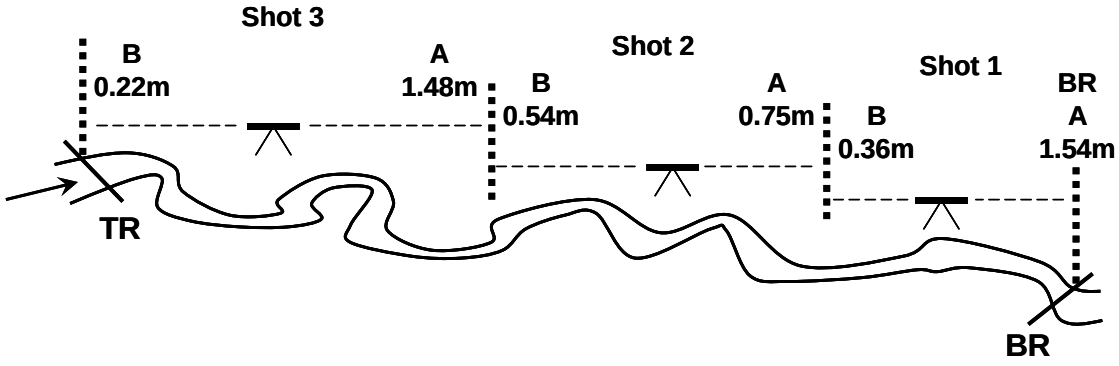


Figure 49: Measuring elevation change using a single shot. (Top) The 1st of 2 elevation changes is depicted above. (Bottom) When shooting from BR to TR (uphill, record on top of Form 1) A – B = elevation difference for each shot, when shooting from TR to BR (downhill, record on bottom of Form 1) B – 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 50).

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.



Measuring elevation change: starting from Bottom of Reach, shooting upstream

BR → TR

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

Measuring elevation change: starting from Top of Reach, shooting downstream

TR → BR

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

Are measurements within 10%?

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

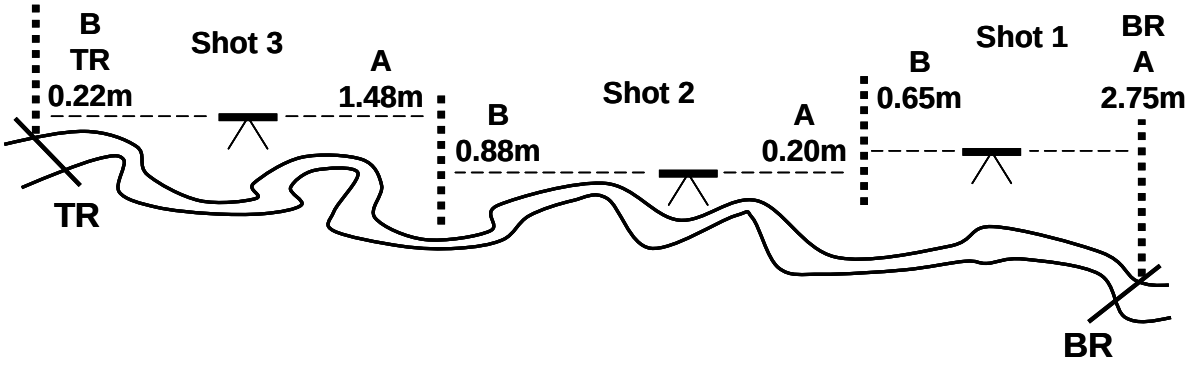
DO NOT erase on this form. If more than 5 shots are required, continue on additional sheet(s)

Figure 50: 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 51). 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.



Measuring elevation change: starting from Bottom of Reach, shooting upstream

BR → TR

	Shot 1			Shot 2			Shot 3			Shot 4			Shot 5			Sum of Dif (Dif 1+Dif 2…)
	A	Dif 1 A - B	B	A	Dif 2 A - B	B	A	Dif 3 A - B	B	A	Dif 4 A - B	B	A	Dif 5 A - B	B	
Elevation 1	2.75	2.1	0.65	0.2	-0.68	0.88	1.48	1.26	0.22							2.68
Elevation 2																
Elevation 3																

Figure 51: Measuring reach elevation change with multiple shots. In this example shot 2 has a negative elevation change.

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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. Reconnect 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.

Contact the hotline for further troubleshooting assistance

APPENDIX B: Special Cases

SAMPLING SITES WITH BEAVER ACTIVITY

Safety First! Please be careful walking around beaver dams!

Why do beaver dams matter? PIBO 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**
  - If you cannot locate the thalweg follow the center line
  - Place transect flags as normal perpendicular to channel (A in Figure B1)

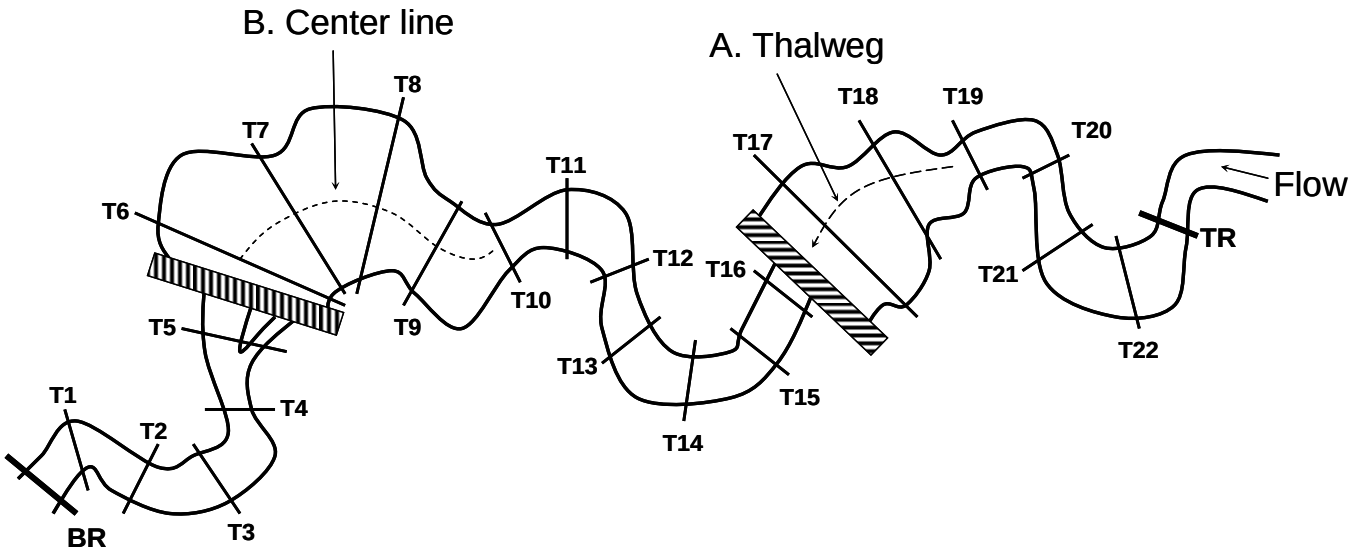


Figure B1: Depiction of reach with beaver dams. In beaver pool A, transects are placed perpendicular to pool's thalweg. In beaver pool B the thalweg cannot be located, therefore transects are placed perpendicular to the pool's center line.

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 on page 23)
- 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*	Low	Med	High
Y* = evidence of beaver, but no dams within reach					

Figure B2: **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 i.e. gnawed on branches or beaver glides within the reach or on the streambanks with 10m of reach, but no dams within reach
- Low if about 0-40% of the reach is impacted by beaver i.e. dams, pools
- Medium if about 40-60 % of the reach is impacted by beaver
- High if about 60-100% of the reach is impacted by beaver

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! Remember to collect the first sample at the most downstream riffle and work up.
- 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 those first four riffles.
  - 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 un-impacted areas
- Within beaver pools/impacted areas:
  - Use normal procedures when possible
  - These measurements are based off bankfull height. 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 B1, 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 the best 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 Figure B3

- **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.

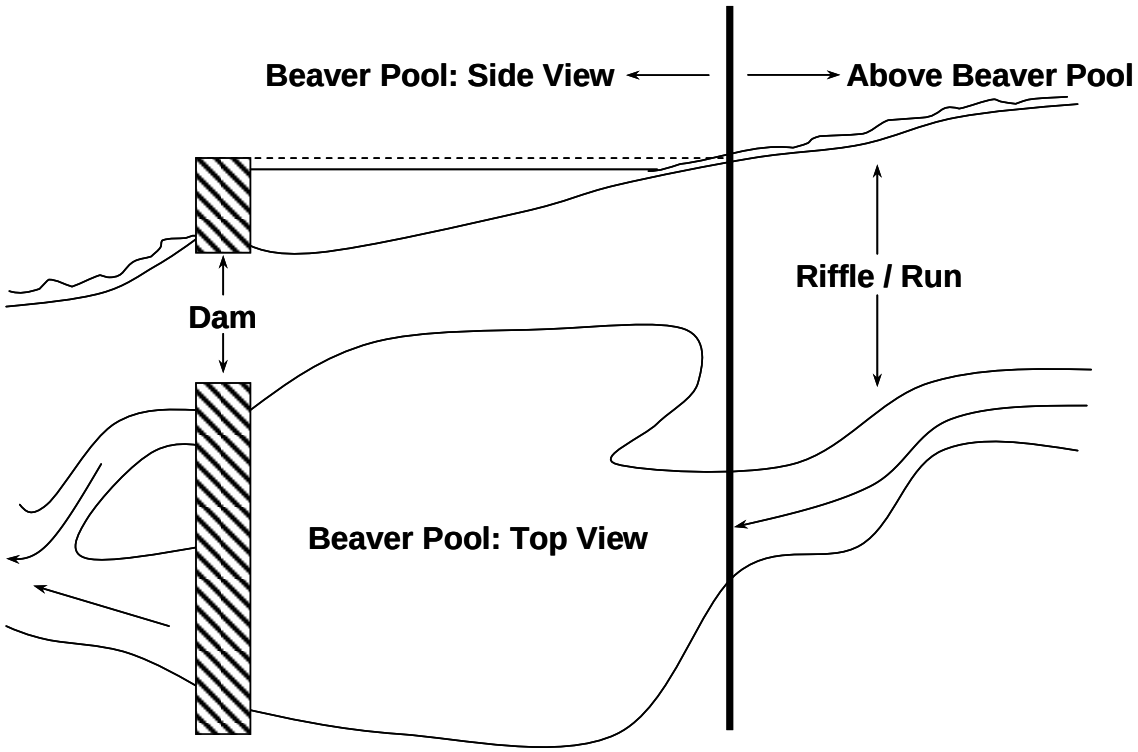


Figure B3: **Top and side views of a beaver pool and how to distinguish the upstream boundary.**

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

Cross Sections

- Identify and record cross sections that fall in beaver pools. Enter beaver pool for the habitat type when recording cross sections.

Transects

- Identify and record transects that fall in an area geomorphology altered by beaver. Enter yes in the beaver impacted section of the logger.

SAMPLING WHEN THERE ISN'T FLOWING WATER THROUGHOUT THE SITE

This section 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):

- 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.

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.

Establish BF based on localized indicators. Try to create a bankfull range based on the distance from scour line to BF.

In general, sample normally with the following exceptions:

No flow (completely dry), this means the reach is ***bone dry***!

- Can't measure water chemistry
- Can't collect macroinvertebrates
- Can't collect LEW/REW measurements when doing cross sections.
- Can't use the 'water' method
- Can't quantify pools (consider the entire reach a riffle)
- Measure elevation change 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 water chemistry. Measure in flowing water near the TR, otherwise, measure it in any flowing water. If there isn't any flowing water, measure it in stagnant pools. Comment where water chemistry was measured.
- Collect macroinvertebrates. 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
- Cross sections: 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.

DMA (K) SITES (LARGE RIVER AND UN-SCOUTED DMAS)

- DMA sites are designated as site type 'K'
- **DMA sites are always sampled using 6m transect spacing** for 21 transects, therefore reaches will be ~120m long
- Macroinvertebrates, temperature, and conductivity are not collected at DMA sites.
- DMA sites are sometimes also Integrator ('I') sites. The site type will be 'IK' or 'IKS'. In this case, the site is sampled like any 'I' site, with a width category determined by stream width. Also, you will collect macroinvertebrates, temperature, and conductivity at 'IK' or 'IKS' sites.

Un-Scouted DMA Sites:

Some DMA (K) sites you sample may not have been scouted; if this is the case your supervisor will provide you with 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.
- When sampling an unscouted or a new site always fill out a site scouting form include driving directions with town from and time, hiking directions with miles or meters and camping. Include any important notes about the site.

Large River DMAs:
Although this is a rare occasion, some DMA sites (reach type 'K') are located along large rivers (for example, the John Day, Grande Ronde, and Deschutes Rivers) on BLM land in Oregon and are sampled in a different way. Only one side of the river is sampled. The side you should sample is indicated on the Site Info Sheet. If it is not, look at the photos or call the hotline. Approximately 42 transects will be set up with a spacing of 6 m per transect.

Sampling techniques are the same for the following methods during large river DMA samples except that data is collected from only one side of the river. Collect only the following:

- In the reach page & Form 1 indicate what side of the river you sampled in the comment section.
- Gradient
- Photos
- Recording Reach Length
- Bank Angle and Bank Stability
    - Evaluating bank angle and stability will be the same however recording the data will be different. Work from the BR to the TR and enter the data one after the other no matter what side/transect the logger says you should be on (e.g. You are only sampling RL. The first entry the logger asks for is RL transect 1 - enter the first set of measures in this space. The second entry is for RR transect 1 - enter the second set of measures in this space even though it is now RL transect 2). Do not skip any spaces. Make a comment in the comment section indicating every 10th transect (e.g. this is transect 20).

Not Measured:

- Habitat
- Large Woody Debris
- Pool Tail Fines
- Cross Sections
- Pebble Counts
- Bankfull Width
- Temperature, Conductivity, and Macro-invertebrates are not collected.

APPENDIX C: CROWN Sampling

The Crown project is focused on 4 watersheds in northern Montana. This project is designed to quantify the relationships between roads and channel conditions. The sampling will be done according to PIBO stream protocol, EXCEPT:

1. The crew must determine the width category (see 'Establishing a Width Category' on page 11 for instructions)
2. Collect additional pebbles at each reach.
3. Collect sediment samples from the streambed.

Data must be collected in the STRM_CWN data application. To switch applications:

a. Turn on the handheld device.
b. **Load DPP**: Once the device boots, double click on the icon for DataPlus CE or click start>Programs>DataPlus CE.

c. Go to Application>Select Application>STRM_CWN>OK.
d. **DPP Option**: Click on the Word **Data** with your stylus. Choose to Collect Data, and press enter.
e. Chose Data>Collect Data
f. A box will pop up "New or Old Dataset"
g. Follow the data naming convention in the stream protocol

Collect Additional Pebbles:

Crews will collect pebbles according to PIBO protocol (at each flagged transect) and collect additional pebbles between each flagged transect. All particle size and location (Bed vs Bank) measurements should be done according to PIBO protocol.

1. Collect pebbles according to PIBO protocol. Remember to sample the entire bankfull channel width across, including qualifying side channels.
2. Collect addition pebbles:
    a. Start collecting additional pebbles after measuring the bankfull width and collecting pebbles at transect 1, continue until you reach the TR.

b. To establish the distance between additional pebble measurements divide the Width Category by 5. Therefore the width category is 8 the distance between pebble sub-transects will be 1.6 meters.
c. Walk up stream along the thalweg the distance determined in step *b* above, this will be your first sub-transect, collect 5 particles at the sub-transect, measure each particle according to PIBO protocol.
d. Enter the data in the CrwnPebb table. Access this table from the main screen in WDXsec by hitting F5 than select CrwnPebb. Enter:
    i. SubTrans – A number 1 to 4, representing the sub-transects between the flagged transects.
e. PebbID- A number 1 to 5, representing the five particle samples collected at each sub transect.
f. BDiam – B-axis diameter as measured according to PIBO protocol
g. Loc - Bed or Bank according to PIBO protocol

Notes:

- You must have 4 sub transects between each flagged transects and collect 5 particles at each sub transect, resulting in a total of 20 particles collected between flagged transects.
- At the top of the reach collect pebbles from your last flagged transect to the TR. Fitting in as many sub-transects as you can.
- If you wiggle your Cross section and it overlaps with a sub-transect that is ok, collect pebbles at the cross section and the sub-transect according to protocol.

APPENDIX D: Archer PDA

Power Button:
The device is turned on by pressing the Power Button (The bottom right of three buttons.)
To turn the device off press and hold the power button. Then select Power Off.
Pressing the power button will suspend the device this is useful when moving through brush or in between quadrats.

Start Menu:
From the main screen the programs are accessed from the Start Menu (top left on screen.)

Battery Life and Batteries:
Battery life can be viewed from the battery icon in the top right of the screen.

Batteries are changed by removing the back plate, sliding the battery door lock open, and removing the battery cover. At this point the battery can be changed. Note that if your device losses power quickly settings may have been changed such as back light, or you may be suspending the device instead of shutting off the device.

Keyboard:
A Keyboard can be accessed by pressing the blue keyboard icon in the bottom right or center when present.
Screen Lock: An optional screen lock is available on the main screen. This also activates automatically when the touch screen senses issues. To unlock the device click unlock in the bottom left of the screen and then okay.
Stylus:
Only use a plastic tipped mechanical pencil or stylus.
Do not use: Pens, Sharpies, sticks, car keys, or metal tipped writing implements, these damage the screen.

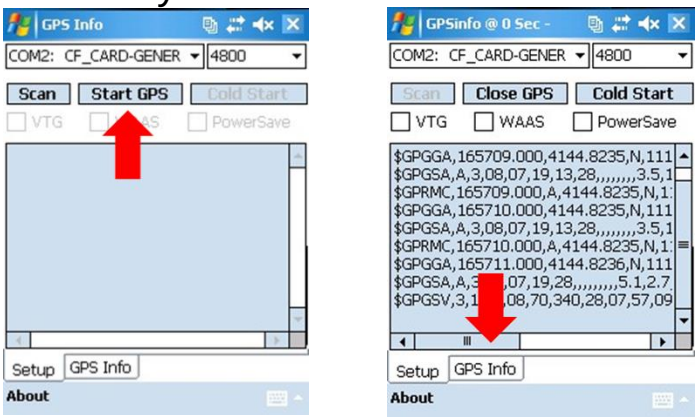
Three Programs are used by PIBO:
GPSinfo – This is used to turn on the GPS card in the PDA.
Forms 5.1 – This is where collected data is entered.
Sprite Backup – This is used to backup data.

Figure D1: Example of the Archer PDA buttons and home screen.

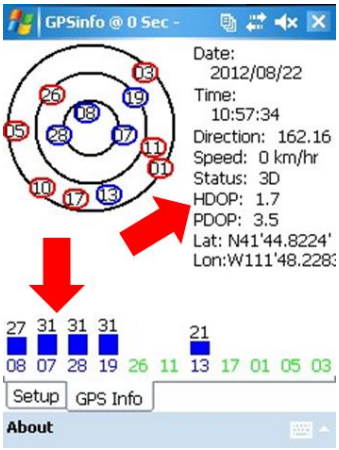
GPSinfo

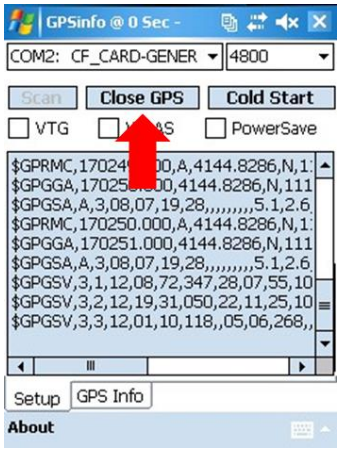
It is recommended that after starting the PDA the GPSinfo program is activated so the internal GPS card is functioning before using Forms 5.1

1. To use GPSinfo: Click the Start Menu in the top left and select GPSinfo.
   (If GPSinfo is not in the start menu you will have to navigate to it in Start Menu>FileExplorer>My Device>GPS Information>GPSinfo)
2. To activate the GPS Card click the “Start GPS” Button. Lines of Code begin to fill the screen. Clicking on the “GPS Info” tab on the bottom will take you to the information screen.



3. On the information screen a blue bar on the bottom indicates a good connection to a satellite. The HDOP number indicates the accuracy of the measurement we consider below 5 to be acceptable but below 3 is ideal. When you have acquired satellites click the Setup tab to return to the first screen. Click “Close GPS” this stops this programs interactions with the GPS card.

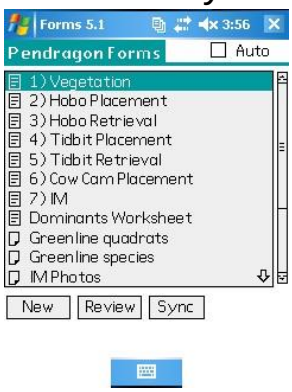




4. Your GPS card is now ready to work in Forms 5.1 you can exit GPS info by clicking the x in the top right corner.
5. This only needs to be performed when the PDA is turned on. If the PDA is turned off these steps will need to be run again before using the GPS card. Suspending the PDA does not turn off the GPS card.

Forms 5.1

1. To use Forms 5.1: Click the Start Menu in the top left and select Forms 5.1
   (If Forms 5.1 is not in the start menu you will have to navigate to it in Start Menu>FileExplorer>My Device>Program Files>Forms51>Forms5)
2. From the Main Forms 5.1 screen select the Program to record the information you are collecting.



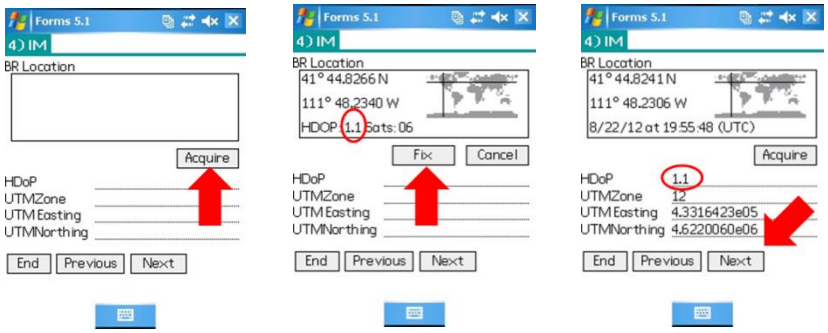
(Note the blue Key board icon which makes the keyboard appear or disappear)

The Programs listed in Forms 5.1 are:
1) Vegetation – This is the PIBO Vegetation sampling program
2) Hobo Placement – This is the Seasonal Temperature data logger (Hobo) placement program
3) Hobo Retrieval – This is the Seasonal Temperature data logger (Hobo) retrieval program
4) Tidbit Placement – This is the Multi-Year Temperature data logger (Tidbit) placement program
5) Tidbit Retrieval – This is the Multi-Year Temperature data logger (Tidbit) retrieval program
6) Cow Cam Placement – This is the Seasonal Cow Camera placement program
7) IM – This is the PIBO-IM Stream bank alteration sampling program
(There are a number of other forms below, they run in the above programs.)

3. Data Collection:
   1. To collect new data in one of these forms select it and click the "new" button.
   2. To resume collecting data in a previous data set select the program and click review.

Collecting GPS data with the Archer PDA

1. Use the GPSinfo program to activate the GPS card. You must do this one time when you turn the device on.
2. When a Program in Forms 5.1 asks you to collect UTMs you will receive a screen which has an acquire button. Click the acquire button at this point you need to wait a moment for the satellites to be acquired (if this takes more than 30 seconds see the errors section). When the HDOP (in circles) is ideally below 3 and you are in the correct location click the fix button to record that point. If the HDOP is above 5 or shows "--.-" you need to collect the point again.



3. If you need to collect a point again or collected a point in the wrong location you need to hit the previous button and then the next button. This will allow you to write over the incorrect data. Check that the HDOP or UTMs change when you try to do this.
4. When finished continue working through the data form.
5. To record another coordinate follow these same steps. If the PDA was shut down you need to restart the GPS card using the GPSinfo program. (You do not have to turn off the GPSinfo program in between collecting UTMs to save battery life. This program has a very minimal power drain.)

Error Messages when collecting GPS data

1. Error (0301): This means the GPS is not turned on.
   -To solve follow the GPSinfo program instructions.
2. Error (0302): This means the GPSinfo program is still collecting data from the GPS card.
   -To solve follow the GPSinfo program instructions starting on step 3.
3. A solid blue screen which stops the PDA from functioning.
   -Call the hotline and proceed to collect data on paper forms.
   -Let your Supervisor know when you return to the bunkhouse and flag your PDA with a description of the error.

Archer PDA Troubleshooting

If the main Windows screen is displayed check that the device is not locked.

If you are in the middle of an application, hit the Applications Manager (leftmost) button, and try closing all applications. Re-launch the desired application. (If you were in the middle of entering a record, you may have to return to it and edit or delete it.)

If the problem persists, try a soft reset. To do this, hold the power button down until the Power Button screen appears. Select “Reset”. [No data will be lost with a soft reset, but if you were in the middle of entering a record, you may have to return to it and edit or delete it.] If the touchscreen is not working, you can perform the soft reset using only the power button: hold the power button down (up to 30 seconds) until the screen goes dark and the green LED lights up.

If the device won’t turn on, first experiment holding the power button down for up to 30 seconds. If this fails to turn on the PDA, replace the battery to see if the battery was too low to power up the device. When it powers up, it

will have performed a soft reset, so if you were in the middle of entering a record, you may have to return to it and edit or delete it.

HARD RESET AND RESTORE INSTRUCTIONS: as a last resort, you can perform a hard reset. Before resetting the device, you should perform a backup of the PDA and write in your field notebook information about when you performed the hard reset- date, time, and if you have begun a reach, where you are in your sampling (i.e., what you've sampled so far). To do the hard reset, hold the power button down, and when the power button screen appears, and continue holding the power button until the screen goes dark. The green LED to the right of the buttons should come on. Release the power button, and simultaneously hold down the **home**, **up direction** on the central button, and **context** (far right) buttons until an image appears on the screen. You'll need to go through the setup steps [if it doesn't ask you to go through a setup, you probably only did a soft reset, so try again], and then use File Explorer (explained below) to open the PIBO_Restore file on the SD card.

Launch File Explorer. You'll need to close/exit any open applications or screens. In the main Windows screen of the PDA, select Start, then Programs, then File Explorer. The main heading for the File Explorer screen is, appropriately, File Explorer. Directly below that is the display of where you are exploring/ navigating. The main locations are My Device, Storage (in My Device), and SD Card; these are always listed for convenience. The downturned triangle to the right of the name points down to the list of files and folders contained within. **Select the SD Card, then select the PIBO_Restore file.** Opening this self-extracting file will launch Sprite Backup.

The screen for Sprite Backup should have the heading Restore Data Selection. This allows you to select what you want to restore. A check in the box means selected for restoration. The check in the Pocket PC box means everything on the handheld (that was backed up in this file) will be restored. This is what you want, **select Next** in the lower left part of the screen to continue**.** When the Device Reset Required screen appears, **Select Next to continue**. Now, be patient while the restore proceeds. The handheld will reset. After performing the restore, the handheld will reset a second time. When it is finished, it will allow you to look at a report. The Restore has been completed.

To confirm this, find and open the Forms 5.1 application and check that all the forms are listed. Also, check that Sprite Backup is present on either the Start menu or the Programs page of the PDA. At this point, you will need to make checks of the basic PDA settings and may need to reenter the name of your handheld as the correct Device ID.:
Enter your Device ID/user name (Settings-System-About-Device ID) A1, A2 ... A18 (Correct ID is Important!)
Power – turn off if not used (Settings-System-Power-Advanced) Battery – 2 min, External – 5 min
Backlight – turn off if not used (Settings-System-Backlight) Battery – 1 min
Brightness level (Settings-System-Brightness)
Battery: Keypad - Off, Screen Backlight – Medium High
Date and Time (Settings-System-Clock&Alarms or Today/Home screen)
Correct Date is Important!!!

ERROR MESSAGES: If you get an error message where it asks if you want to send in a report, you can click “don’t send”. If you keep getting the message, you can try a soft reset. If that doesn’t help, you can disable error reporting.

If you get an error message relating to a Forms file, worded something like “Error parsing file...” a forms data file has been corrupted, and you will have to perform a hard reset. Do a backup of data (you may have to do a soft reset first). Document the problem before doing the hard reset. At the end of the hitch tell your area supervisor that you had to perform a hard reset and note it on the End of Hitch form. If you are able to use the PDA to enter Forms data, the data should be secure.

Forms Data Backup using Sprite Backup (Archer Handheld)
Overview: You will use the application Sprite Backup to save a backup file to the SD card. You will name the file with the date and time the backup was done, and save it to the correct hitch folder. The handheld will reset twice during the backup process, then report to you that it has finished.
Backup Instructions:
Launch Sprite Backup. Select the Start menu, (then Programs, if necessary) then Sprite Backup. To get to the Start Menu, you can use the Start button on the handheld, or go to the main screen for Windows. The main screen for Sprite Backup has the Backup, Restore, Schedule, and

Options icons (Figure D1). **Tap on the Backup Icon** [selecting Next is the same as selecting Backup].
The next screen “Backup Data Selection” (Figure D2) allows you to select what you want to back up. A check in the box means selected for backup. The default setting is that everything on the PDA is selected for backup (the box for the Pocket PC is checked gray, and the folders and files on it are checked red.) We will go with this setting, so **confirm that the Pocket PC box is checked, and select Next** in the lower left part of the screen to continue.
On the new screen titled “Save As” (Figure D2)
In the Name field, **Enter a new name with the correct Date and Time in the following format: 3Jul9AM.** The correct date is necessary; the time can be rounded to the hour.
Using the Location and Folder fields, you will save the file to a folder for the current hitch on the SD card.
Select the following fields, or check that they are correct:

The **Location** should be **\SD Card**.

The **Folder** should be the named folder for the current hitch (for example, “H1Jun9-16’).

In the lower left part of the screen, **select Next** to continue.

If the Device Reset Required screen appears, select Next to continue. Now, relax and let the application do its thing. The handheld will reset. After performing the backup, the handheld will reset a second time. When it is finished it will tell you that the backup is completed and allow you to look at a report. The data backup is complete!

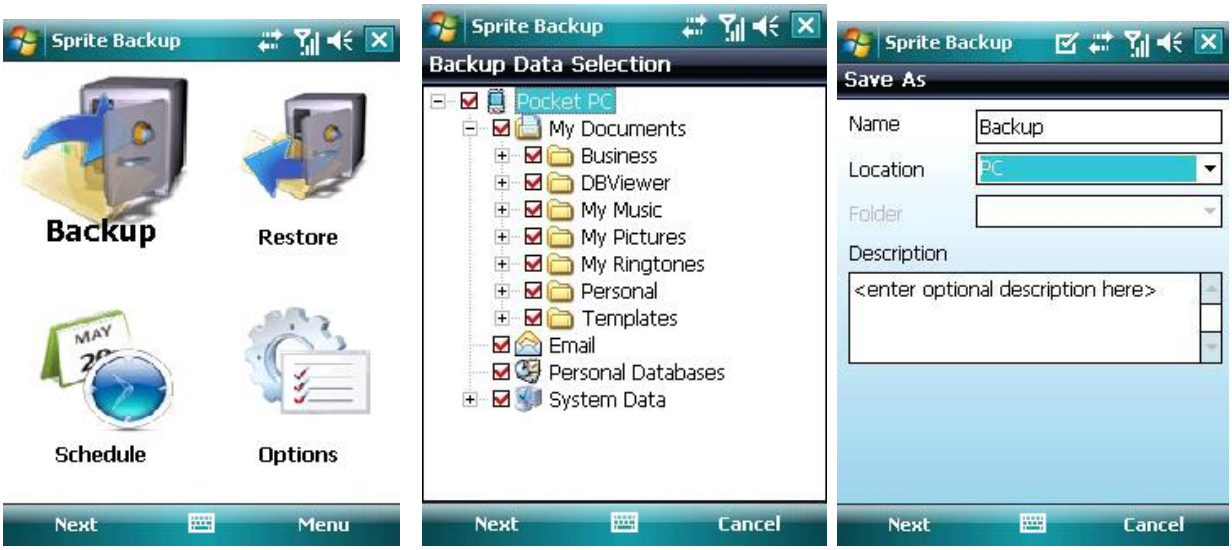


Figure D2: Backup Icon Backup Data Selection Save As screen

You can use File Explorer to confirm that the backup file is on the SD card as you expect. To do this, go to the Start menu (then Programs, if necessary) and select File Explorer. In the File Explorer window, select SD Card to view the files and folders on the card. If you do not see “SD Card” listed, select the icon directly below the Windows Start icon and “SD Card” should appear as an option. Select the folder for the current hitch to view its contents. Your new backup data file should be listed for that folder. If it is not, it may have been saved elsewhere on the SD card, or in “Storage” or “My Documents” in internal memory. If you find it in any of these places, leave it there, and be sure to save future backup files to the correct location.

APPENDIX E: Instrument Placement and Retrieval

HOBO (Seasonal Water Temperature Logger) Placement

Hobo temperature loggers will be placed at all Integrator sites before July 15th. The main objective is to place the Hobo in the stream where it will be submerged all summer collecting accurate temperature data until a technician comes back to retrieve the hobo at the end of the field season.

Objective

- Place Hobo Seasonal Water Temperature Logger.
- Record info about the Hobo and its location using the Instrument Form.

Establish the best location for the Hobo at the site

- Find where the thalweg flows through a deep pool in the reach.
    - Water must flow through this pool (no backwater or side channel).
    - This pool should be one of the last to hold water if the rest of the reach goes dry.
    - Avoid areas just downstream of tributaries and obvious groundwater seeps, as water temperatures in these areas will not be representative of the stream temperature.
    - If there is a steep bank on one side of the stream, try to place the logger near the opposite side such that runoff from the hillside does not influence the temperature readings.
    - Avoid very strong currents.
- Make sure there is a secure anchor point close to the pool. Good anchor points include:
    - A small tree close to the bank.
    - A root wad overhanging the stream bed.
    - LWD along the bank or hanging over the stream that is not going to be swept away.
    - A rock secure in the bank with a way to loop the cable over or through it.
- Make sure the location is camouflaged from people when in high traffic areas.

- Try to prevent the Hobo from getting stolen.
- Avoid high traffic areas such as camp sites or trails on open ground.

Place the HOBO

- Make sure to record the ID# before placing the Hobo in the water.
- Wrap the cable around the anchor and feed the Hobo through the loop to secure it.
  - You may need to use an extension cable to ensure the Hobo lies deep in the pool.
- Use rocks to hold it in place if necessary.
  - Place the rocks on the cable not the probe, if the flow drops, the rocks can absorb heat.
- Use grass, dirt, or moss to cover the wire if you are placing it in a high traffic area.
- Hang a Blue flag with “PIBO HOBO” written on it in sharpie in a near-by location.
  - Place the flagging somewhere close to the hobo, not at the exact location to avoid drawing attention from people.
  - In highly trafficked areas, flagging should be farther from hobo, or on opposite bank.

Record HOBO information:

- Record hobo placement in PDA using Forms 5.1 **Completely** fill out the required areas of the form **before you leave the site**.
- Enter probe ID# (double check that it is correct), all reach info, all probe location information (distances should be in meters).
- Collect GPS coordinates for the hobo’s location.
- **No Marker information is required** because you will only place flagging, not a marker.
- Write a detailed description of the Hobo’s location.
  - Ex: “The Hobo is anchored to small pine tree (~20cm diameter) on RR, in large pool DS of huge boulder, 6m US from Hobo flag. ~25m US from BR tucked under overhanging bank. The cable is covered with moss.”

- **The better you hide the temperature logger, the better your map and description need to be!**

- **No Photos are required.**
- Draw a **<u>detailed</u>** map of the Hobo location **so we can efficiently relocate them during retrieval**.
  - 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).

Placing a Hobo at Beaver Impacted Sites

- Locate the most downstream beaver-impacted area within the reach and place temp probe downstream from this location.
- In Figure E1 below, you would ideally place your probe below transect 4 or 5.
  - If there is a beaver pool at your BR extending downstream then place the probe downstream of your reach, make sure the probes location is clearly identified in the probe form and map.

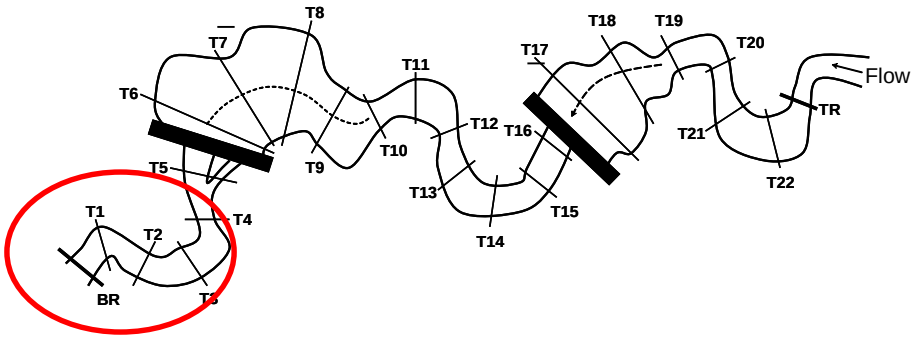


Figure E1: Depiction of reach with beaver dams. Place the probe below the most downstream beaver impacted area within the reach.

HOBO (Seasonal Water Temperature Logger) Retrieval

Hobo temperature loggers were placed at integrator and sentinel sites, (sometimes other sites), in the spring by scouts and some crews. These devices will be retrieved for data download this fall. **Hobos cannot be removed from the stream before September 1st**. Information relating to the processing of the data on the Hobo will be collected by the crew when the device is removed.

Objective:

- Retrieve Hobo temperature loggers
- Record information relating to probe condition, stream flow, and associated reach information in the Archer PDA unless there is a malfunction in which case it is recorded on the temp probe Retrieval form. See the PDA section for help with the PDA.
- Remove reach flagging.
- Label Hobo appropriately with flagging.

1. Navigate to the reach using site information.
2. Record all reach information in the PDA Forms 5.1 Hobo Retrieval (or on paper if the PDA is malfunctioning).
3. Walk the whole reach, you must do this first to determine flow and pick up BR/TR flagging.
   Examples of Stream Flow:
   - 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.
   - 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"*

4. Locate the temperature probe:
    - Use all available information: Blue flagging, BR, TR, and Probe UTMs, Hobo map and description.
    - If you cannot locate the Hobo make sure you have thoroughly searched the area. One probe costs $250 and contains a large amount of data and cost of time to deploy it.
    - Crews sometimes move probes during stream sampling and the new information is not passed on. Take extra care to search the stream in spots you would place a hobo; deep pools with good anchors.
5. **Before removing the probe, record probe condition and stream flow in the PDA**; or on the form.
    a. If the probe is buried, make sure to enter the depth it is buried.
6. Make sure that the probe ID is entered correctly, this is important (enter the probe ID off the HOBO directly, not off the instrument sheet).
7. Remove all flagging at the reach.
8. Tie the reach flagging around the probe cable or use new flagging then label the flagging with: your name(s), date retrieved, stream name, reach ID, probe ID, and G-O-T.
9. Keep your probes organized together, do not mix them with other probes at the bunkhouse. It is easiest to coil the Hobos to keep them organized and manageable.
10. Give your probes to your supervisor at the end of the hitch, and any paper data you may have collected.

There are some cases where a hobo needs to be retrieved early or moved during an EM sampling:

- If the stream is completely dry, remove the hobo. Be sure to follow hobo retrieval procedures listed above.
- If there are only stagnant pools in the stream, if possible, move the hobo to the deepest point of the deepest pool (if it is not there already), so that it remains in water for the rest of the season.

- If the hobo is buried, in a dry spot, out of the reach, or in non-flowing water (i.e. in a side channel, tributary, backwater, etc.) it needs to be moved to a better spot.

When moving a hobo:

- Take note of this movement on Form 1 and in PDA
- Fill out an instrument form (this includes drawing a new map)
- Notify supervisor at bunkhouse so there is no confusion when the hobo is picked up at end of season.
- See the hobo placement procedures above for more info.

Tidbit (Multi-Year Water Temperature Logger) Placement

The main objective is to place the Tidbit, epoxied directly to a rock, in the stream where it will be submerged for up to 5 years collecting accurate temperature data until a technician comes back to retrieve it.
Your quality of work placing the tidbit and documenting the location should allow for the device and a different technician to return to the rock and retrieve the tidbit in five years. **Don't rush this process a quality installation and correct information allowing for returning to this device is very important.**

Equipment:

- Wire Brush to scrub rock with
- Nitrile gloves
- Epoxy (A and B)
- PDA and Camera
- Backup Tidbit Placement Form
- Marker supplies
- Tidbit
- Sunshield with weights and zip ties for attachment

Objective:

- Epoxy Tidbit to rock where appropriate.
- Photograph Tidbit location.
- Take UTMs of Tidbit and marker location.
- Draw a map of the Tidbits location.
- Record info about the Tidbit and location in the Archer PDA; or on Tidbit installation form if the PDA is malfunctioning.

Establish the best location for the Tidbit at the site:

Walk the entire reach length. If no good location is found, walk ½ mile US of TR or DS of BR to find an appropriate location; take your time to find a good tidbit location.

A good tidbit location can be:

1. A large anchor rock within the reach or ½ mile US of TR or DS of BR and with the proper criteria (listed below).
    a. The rock must be **large enough to not be swept away** during high flows. (One way, *but not the only way* to determine this is if the rock extends at least 15cm above bankfull it is likely large enough).

b. The rock must have **a flat, approximately vertical surface facing directly downstream**.
c. The downstream surface of the rock should be **in a pool or underwater during low flows**.
d. **Avoid areas just downstream of tributaries and obvious groundwater seeps**, as water temperatures in these areas will not be representative of the stream temperature.
e. Place the tidbit at a depth where it will still be underwater at low flow, but it **will not be covered with sediment**. The tidbit should be several cm above the streambed.

2. Bridges or other features that fit the above criteria.
    a. Take caution when using man made anchor points.
    b. Wood will not work with the epoxy.
    c. Culverts are stable but can alter the temperature readings and funnel rocks into contact with the tidbit.

Make sure the location is camouflaged from people when in high traffic areas.

- If possible place the Tidbit in a location harder to access.
- Try to prevent the Tidbit from getting stolen.
- Avoid high traffic areas such as camp sites or trails on open ground.

Recording Tidbit Information:

- **Record tidbit placement in PDA** using Forms 5.1 (see the Archer PDA section of the protocol for more help).
- Information to record in PDA:
    - Tidbit ID, reach information, technician name, marker information (including marker location UTMs), photo card number and photo numbers for the Tidbit (see information about taking photos below), any additional comments about placement.
    - **A detailed description of the Tidbit location and Tidbit location UTMs**.
        - Ex: “The Tidbit is epoxied to a large rock (~60cm diameter, ~85cm tall) on RL, in large pool DS of large spanner, 9m US from Tidbit marker. ~60m DS from BR.”
- **Draw a detailed map of the Tidbit location**.
    - Depict at least 20-30m of the stream. Include the Tidbit, direction of flow, North arrow, marker, and any features that will help to

quickly relocate it (i.e. if the bank is covered by alders, don't just draw alders on the map without additional detail).

<u>If using a paper form make sure to fill out all information before leaving the stream.</u>

Before you place the Tidbit fill out the basic reach information and Tidbit ID in the PDA or on the paper form. **Double check that the Tidbit ID is recorded correctly before placing the device.**

- Tidbit ID's are located on the back; it is usually an 8 digit number.
- Make sure that the light on the Tidbit is, in fact <u>blinking</u>. If it is not return the Tidbit to your supervisor.

Place the Tidbit:

- Find a good prop-rock and place it within reach of your anchor rock or attachment point.
- Assemble all of your Tidbit placement gear within reach of your anchor rock.
- Double check that the Tidbit ID is recorded!
- Put on nitrile gloves. It is easier to do this while your hands are dry.
- Using the wire brush, thoroughly clean off the area where you will attach the tidbit.
- Mix an appropriate amount of Epoxy.
    - Wet the outside of your gloves.
    - Pull out equal amounts of white and black epoxy mix.
        - Be careful not to cross contaminate the epoxy containers this will cause the batch to set.
    - Mix and mold the epoxy with your fingers for at least 60 seconds until it is an even and consistent grey color.
    - Keep your fingers moist for easier mixing.
- Spread the epoxy evenly over the back of the tidbit, about 1 cm thick.
    - Place the back of the tidbit on the cleaned surface of the anchor point.
    - Flip the sunshield down, and lean the prop rock against it to keep it pressed to the anchor point.
    - Make sure the prop rock applies horizontal pressure on the tidbit, keeping it firmly against the anchor point, NOT downward pressure forcing the tidbit towards the streambed.
        - Try to ensure that the sensor bubbles on the front of the tidbit will not be damaged (these are needed to extract

data, so if these are destroyed, the tidbit becomes useless).

Tidbit Marker:

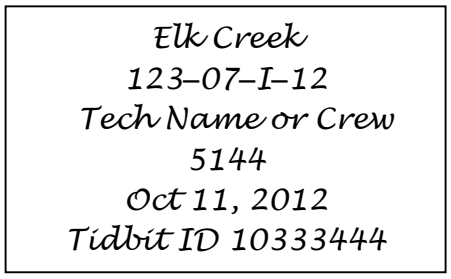
- If the tidbit is placed within 15m of the BR or TR marker, use those markers.
- If no marker is close, place a tidbit marker, except in wilderness areas where we never place markers.

Placing a marker:

- Locate an easily identifiable feature near the tidbit to attach the marker. Try to place the maker near the tidbit.
    - Use something relatively permanent like a tree.
    - Use something distinctive. For example a lone cottonwood tree near the tidbit, or a large stump with a burn mark.
- Make sure the marker has 'Tidbit' indented into it.
- Attach the marker to your chosen spot with a nail or wire.
- Record the following information in the tidbit form on the PDA or the paper form:
    - Brief description of the site marker location (ex: "US of BR 5m on RL attached to trunk of large juniper").
    - The compass bearing from the marker to the tidbit.
    - The distance from the marker to the tidbit in meters.

Photograph the Tidbit and Marker:

1. Record the Photo Card number of the Instrument Form.
2. Take a picture of an "Info Page" as the first photo in the set.
    - The Info page should contain:
        - Stream Name
        - Group-Order-Type-Year
        - Name of Technician or Crew
        - Reach ID
        - Date
        - Tidbit ID number



Note: It is important that the info page photo is taken in addition to the Reach ID / Date photo taken during sampling, so that the tidbit ID is displayed and it is obvious where the tidbit photo set begins.

3. Take at a minimum the following photos:
    - The marker (either BR, TR or the new Tidbit marker you placed). If possible show the Tidbit rock and the marker in the same photo. This makes relocating the rock easier in the future.
    - A close up of the Tidbit and rock which shows the location of the Tidbit on the rock and the rocks overall shape and size.
    - A distant shot of the Tidbit rock which would allow for someone to find that rock when returning to the area in the future.
4. Take additional miscellaneous photos as needed to accurately depict the location of the Tidbit.
5. Record the photo information in the PDA.

Tidbit (Multi-Year Water Temperature Logger) Retrieval Protocol

The tidbit is designed to collect underwater stream temperature data for 5 years. After five years, tidbits will be retrieved to download the data. It is extremely important that the bubbles on the front remain intact. Prioritize this during the tidbit retrieval process. All retrieved tidbits should be flagged, entered into the PDA, and placed in a plastic bag before leaving the stream.

Equipment:

- PDA
- Flagging
- Shovel or Trowel (if tidbit is buried)
- Chisel
- Zip Lock Bags
- Sharpie
- Site Info, Tidbit Photo, and Tidbit Instrument Sheets
- Backup Tidbit Retrieval Form

Procedure:

1. **Use GPS coordinates, photos, tidbit map, site marker, and descriptions to locate the tidbit in the stream.**
    a. Note that coordinates may be in a different datum. For tidbits placed in 2010 and 2011, the coordinates should be in NAD 27. Tidbits placed in and after 2012 will have coordinates in NAD 83. There may be exceptions to this.

- You may have to change the settings in your GPS accordingly.

b. *It is important to spend quality time searching for tidbits*. Do not leave the stream unless you are certain you have found the correct location and the tidbit is missing.

2. Retrieve the Tidbit

a. Tidbits might be buried by sediment. If necessary, use a shovel to carefully move the sediment around to locate the tidbit. Tidbits that have become dislodged occasionally remain in the sediment beneath the rock.
b. Use the chisel to carefully remove the tidbit from the rock.
    i. It is crucial that we do not break the tidbit during this process. Be mindful of the bubble sensors on the front of the tidbit.
c. Flag tidbit with: stream name, group-order-type-year it was placed, name of technician or crew, reach ID (as it is written on the instrument info sheet), date retrieved, type of placement (bomb, PVC housing, direct epoxy), and Tidbit ID number (only if the number is visible on the tidbit, do not copy a number from the Instrument Form or another source).
d. Place tidbit in a plastic bag along with pvc casing, sunshield, bomb, etc.
e. Remove all PIBO tidbit traces from the stream, including: the marker, cable, housing, and flagging.
    i. If the tidbit is missing: only remove all traces if you are completely you are in the correct spot and the tidbit is missing.

3. Make a Tidbit Retrieval Entry in the PDA

a. A PDA entry is made for every tidbit, including tidbits that are missing.
b. Select Tidbit Retrieval in Forms 5.1 (If PDA is broken/unavailable, use the Tidbit Retrieval Backup Form).

i. Enter technician name, tidbit ID (8 or 3 digits on the back or side of tidbit), stream name, reach ID (as it is written on the instrument info sheet), and G-O-T.
    1. Only record Tidbit ID if it is visible on the tidbit. If the tidbit ID has been scratched or is covered by epoxy, enter G-O-T in replace of the tidbit ID. Do not record the Tidbit ID number from the Instrument Form or another source.
ii. Enter the tidbit condition and stream reach flow (see explanation in Hobo Retrieval section), enter if the tidbit was glued to a rock or not, and if it was in a bomb, etc. (below is a visual aid).
iii. You will be prompted to collect the GPS location of the tidbit. Make sure to do this while you are at the spot where the tidbit was placed (or where you think it was placed, if you can't find it).
iv. Enter if the tidbit was firmly attached or not and if you flagged it.
v. PDA Comments:
    1. If tidbit was determined to be missing, comment on your level of confidence that you are in the correct location.
    2. LOW: <50%, MEDIUM: 50%-90%, and HIGH: >90%. Collect UTMS at the location you think it should be.

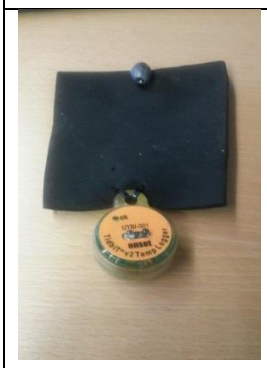
Sunshield	PVC	Metal Bomb	Plastic Bomb
			

Figure E2: **Different tidbit placement methods that you will need to record.**

Cow Camera Placement

The Cow Cam/Plant Cam sometimes is placed at several DMA sites that will have both EM and IM performed during the field season. The main objective is to place the camera as perpendicular to the reach as possible with a view of as much of the reach as possible. The camera will take a photo every 15 minutes from 5am to 11pm.

Objective:

- Set Cow Cam controls
- Place Cow Cam
- Record info about Cow Cam and location on the Instrument Form.

Enter the Camera Settings:

- Add 4 AA Lithium Titanium batteries to the camera. Do not use any other type of battery.
- Check that the camera has a 16GB memory card labeled with the Camera Number. Each camera has its own memory card -which has space for 12,000 photos- and they should never be separated.

Open the front panel of the camera to access the settings.

- Turn the yellow arrow dial (bottom left corner of cow cam) to SETUP.
- Press the Power/Status button (top left corner). It takes a moment to turn on.
- **It is important to note while going through the settings, when the display is flashing it is NOT set and will default to previous settings. To keep the setting you choose push select after any change is made. Be sure that after every selection the display is not flashing.**
- The first window is **TIME LAPSE INTERVAL**. Press the SELECT button and the time will start flashing. Use the +/- buttons to select **15 MIN**. Press the SELECT button again and the time will stop flashing. Press the RIGHT ARROW(>) button to move to the next setting.
- Use the +/- buttons to choose **PHOTO**. Press SELECT then RIGHT ARROW (>).
- Use the +/- buttons to choose **HIGH** photo quality. Press SELECT. Press RIGHT ARROW(>).

- Use the +/- buttons to choose **1-SHOT**. Press SELECT then RIGHT ARROW(>).
- Use the +/- buttons to choose **5 A.M. DAILY WAKEUP**. Press SELECT then RIGHT ARROW (>).
- Use the +/- buttons to choose **11 P.M. DAILY SLEEP**. Press SELECT then RIGHT ARROW(>).
- Use the +/- buttons to choose **YES** for **IMPRINT INFO**. Press SELECT then RIGHT ARROW(>).
- For **DATE/TIME** press the SELECT button and the month will flash. Use the +/- buttons to choose the month, press SELECT to select that month. Repeat until the **current date and time are set**. Press RIGHT ARROW(>).
- Set the **CAMERA NAME**. Press SELECT. Use the +/- buttons to choose the group order and type. Name the camera by the GROUP-ORDER-TYPE of the stream. For example **123-04-K**.
- Set the focus dial around the lens to 3+ feet.
- Turn yellow arrow dial to AUTO – You are done setup the camera

Establish the best location for the camera at the site:
The best location for the camera is where it can record as much of the reach as possible looking perpendicular to the stream

- Find an appropriate tree
    - Approximately half way between the BR and TR
    - A distance away from the stream where the camera can see all of the reach
    - Medium diameter where the camera can be attached to the trunk or branches
    - Potentially discreet area where the camera will not be easily seen by passersby
- At a site with no appropriate trees:
    - Find a good location using criteria above
    - Drive a T-post into the ground at least 18in
- **Make sure the location is camouflaged from people:**
    - Try to prevent the Camera from getting stolen

- Avoid high traffic areas such as camp sites or trails on open ground
- Place the Camera in a hard to see or difficult to access location
- If using a T-post take extra care to place in a concealed or hard to get to location

Placement:

- Secure the camera to the tree or T-post
  - Use the webbing or elastic straps
  - Make sure the control panel is accessible without moving the camera
  - If using a ball joint attachment, electrical tape the hinge and camera to prevent it from tilting forward
- Aim the camera so that as much of the reach as possible is visible

Record Cow/Plant Cam information in Archer PDA:

- Fill out the required areas of the form in the PDA **BEFORE YOU LEAVE THE SITE**.
- Collect UTMs with the location of the Cow Camera.
- Make sure the Camera ID# is entered correctly.
- Write a detailed description of the Cow Cam's location.
- On the instrument map form draw a detailed map of the Cow Cam's location so we can efficiently relocate them during retrieval.
  - Depict some of the stream. Include the Cow Cam, direction of flow, North arrow, marker, and any features that will help to quickly relocate it, location of the BR is recommended.

APPENDIX F: Aquatic Invasive Protocol

Invasive species pose a threat to biological diversity. PIBO's spatial scale offers an opportunity to detect the spread of aquatic invasive species in the Columbia and Missouri river basin. That being said PIBO crews also pose a potential threat as a vector by which aquatic invasive could be transported. According to the literature most likely mechanism for spreading invasive species is contaminated equipment. Following is our collection protocols for aquatic invasive species see Appendix G for our gear decontamination protocol.

Collection and recoding of aquatic invasive species:
If you find one any of the following aquatic invasive species in your bug sample or during any other sampling task such as collecting pebbles, cross sections, etc. collect an additional specimen. **Do not mix your invasive samples with your macroinvertebrates samples**.

Store the specimen according to the PIBO protocol for macroinvertebrate samples, include on the labels -"invasive sample" see Figure F1, on Form 1 make a comment, mark the number of invasive samples collected in the logger. The number of bug jars on Form 1 and in the logger will not change. At the end of hitch record on the macroinvertebrate summary sheet the number of aquatic invasive samples collected at each reach. At the bunkhouse place the specimen in a box designated by your supervisor for aquatic invasive specimens. **Do not mix your invasive samples with your macroinvertebrates samples.**

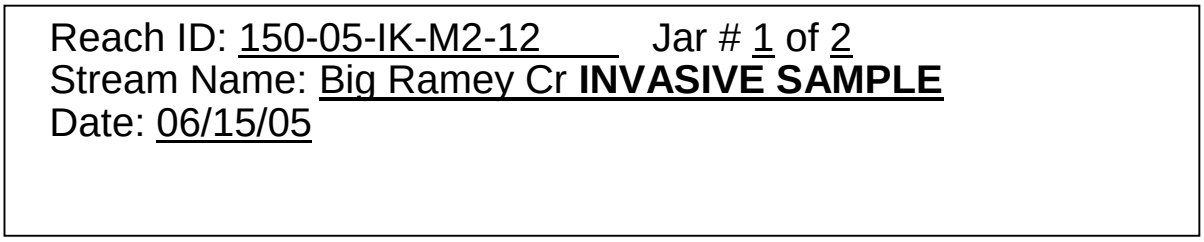


Figure F1: Example of aquatic invasive label.

Below is a list of invasive species of concern that are likely to be found in streams and riparian areas sampled by PIBO.

Type	Common name	Genus species
Aquatic Animals	New Zealand mudsnails	*Potamopyrgus antipodarum*
	Rusty Crayfish	*Orconectes rusticus*
	Red Swamp Crayfish	*Procambarus clarkii*
	Ringed Crayfish	*Orconectes neglectus*
	Northern Crayfish	*Orconectes virilis*
Aquatic Plants	Yellow Flag Iris	*Iris pseudacorus*
	Brazilian Elodea	*Egeria densa*
	Didymo	*Didymosphenia geminata*
Terrestrial Plants	Japanese Knotweed	*Fallopia japonica*
	Giant Knotweed	*Polygonum sachalinese*
	Giant Hogweed	*Heracleum mantegazzianum*
	Garlic Mustard	*Alliaria petiolata*
	Himalayan blackberry	*Rubus discolor*
	English Ivy	*Hedera helix*
	Salt Cedar	*Tamarisk ramosissima*
	Orange hawkweed	*Hieracium aurantiacum*
	Yellow archangel	*Lamiastrum galebdolon*

The following pages include pictures and descriptions of each of these species. Pages 156 and 157 include a Quick Reference Guide for identifying freshwater mussels in the field. Freshwater mussels are not invasive species. In fact, they are one of the most endangered groups in North America.

If you find one of these invasive species or freshwater mussels:

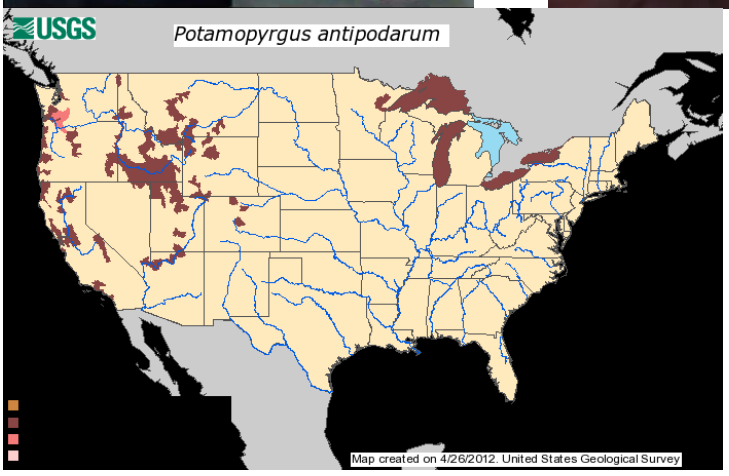
- **Take a sample of it (unless it is a mussel, *do not* *collect mussels)***
- **If you find a freshwater mussel take a photo of it.**
- **Make a comment on Form 1 and in the data logger.**
- **Take note of what stream(s) you found it in so you can inform your supervisor once you return to the bunkhouse. Give your supervisor the sample and tell them which photo #s refer to the photos of the invasive.**
    - **Supervisors will report this information back to the Logan office.**

New Zealand mudsnail
Potamopyrgus antipodarum (POAN)

General: The shell is elongated and it has a dextral coiling. The shell has 7 or 8 whorls. Between whorls are deep grooves. Shell colors vary from gray and dark brown to light brown.

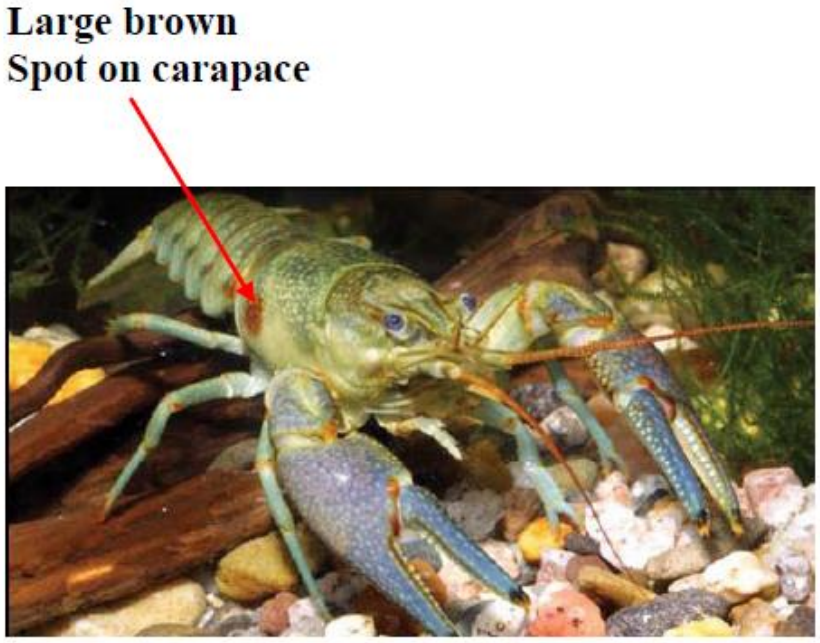
Habitat: The snail tolerates siltation, thrives in disturbed watersheds, and benefits from high nutrient flows allowing for filamentous green algae growth.

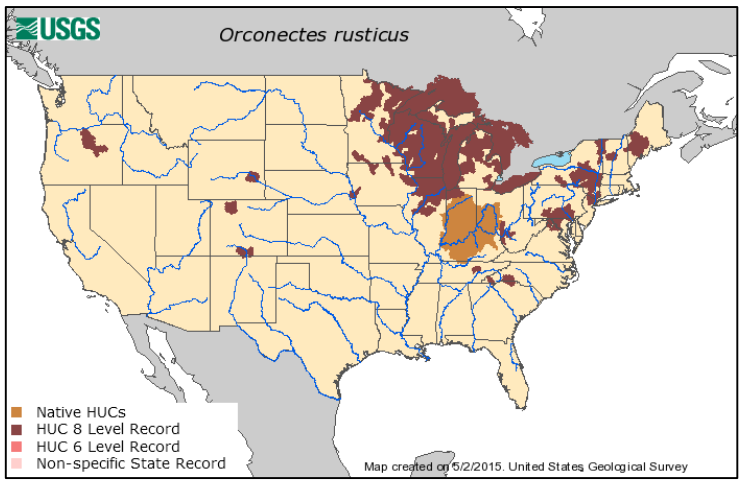
Impacts: New Zealand mudsnails are tiny invasive snails that threaten the food webs of trout streams and other waters.



Rusty crayfish
Orconectes rusticus (ORRU)

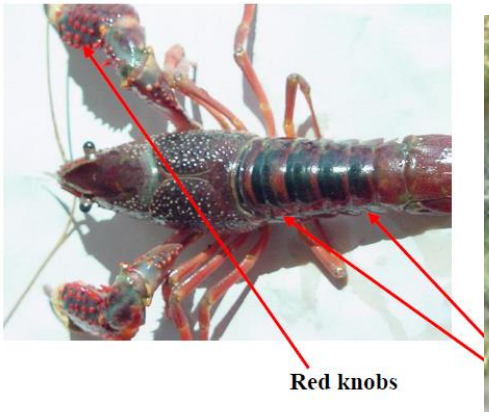
General: Large, rust colored spots on either side of the carapace. They have large, grayish-green to reddish-brown claws with black bands at the tips. The claw leaves an oval gap when closed.

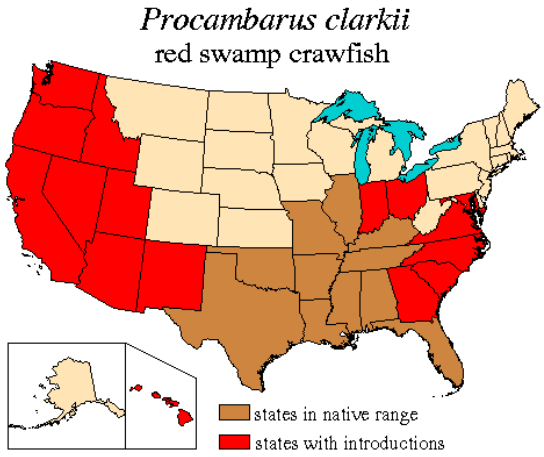




Red swamp crayfish
Procambarus clarkia (PRCL)

General: Generally large, adults (5.5-12 cm), and dark red in color. Black stripe on abdomen. Claws and carapace have spiky, reddish knobs and pincers are long and narrow.





Ringed crayfish
Orconectes neglectus (ORNE)

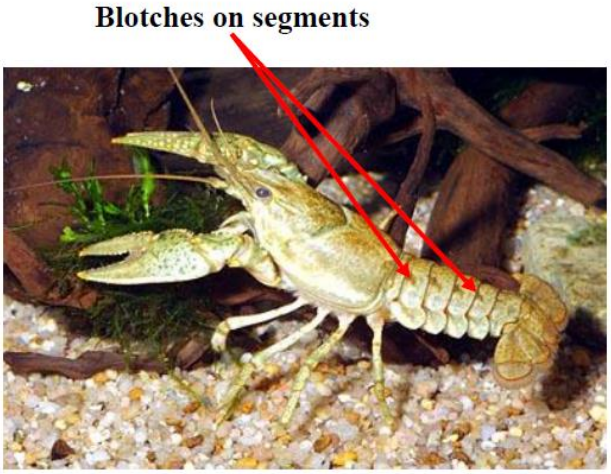
General: Medium sized (4-9 cm) and is olive-green to reddish-tan in color with two dark strips cross the width of the central carapace. A pair of dark stripes runs lengthwise along the edge of the abdomen. Claws are large and broad with black or brown rings around orange tipped pincers.

Range: Introduced populations have been found specifically in the John Day River and Umpqua River in Oregon.

Northern crayfish
Orconectes virilis (ORVI)

General: Its coloration is typically muddy green to reddish-brown for all individuals, regardless of age, size and gender. The pincers are green to greenish-blue with orange tips and may be studded with white knobs in adults. Lengthwise blotches occur in pairs on the abdomen.

Note: Do not confuse with Signal crayfish which can be identified by the smooth texture of their claws lacking noticeable bumps. The native crayfish's claws are also more robust (wider) than their invading cousins.



Yellow flag iris
Iris pseudacorus (IRPS)

General: Showy perennial; 3-4 feet (~1 m) tall; erect stalks, multiple flowers produced on each; Large clumps formed from lateral rhizome growth, attaining 20 feet (6 m) width.
Leaves: Grow from plant base; long [3-4 ft. (0.9- 1.2 m)], flattened and sword-like with raised midrib.
Flowers: Three drooping, yellow sepals with purple-brown markings and 3 smaller, unmarked, upright yellow petals; 3 in. (7.6 cm) wide; Blooms spring to early sum-mer.
Fruit: Brown capsules; 2 in. (5 cm) long; 3-angled and up to 4 inches length; disk-like seeds.
Habitat: Wet areas; still and moving water.
Impacts: Displaces native plants, reducing carrying-capacity for other species.
Notes: Withstands wide variety of conditions.

Brazilian Elodea
Egeria densa (EGDE)

General: Submersed freshwater perennial herb forming dense mono-specific stands. Bright green, erect, cylindrical stems, simple or branched. Grows to water surface forming dense mats. Reproduces by fragmentation; roots slender, white or pale, unbranched, without tubers.

Leaves: Bright green, minutely serrated; 1-3 cm long, up to 5 mm broad. Lowest leaves opposite or whorls of 3; middles and upper leaves whorls of 4 to 8. Short internodes give very "leafy appearance.

Flowers: Small (18-25 mm), white, three petals, float on or rise above water surface on thread-like appendages.

Habitat: Still and flowing waters; lakes, riparian zones, water courses, wetlands.

Impacts: Restricts water movement, traps sediment, and causes fluctuations in water quality. Out-competes native vegetation, affecting habitat and biodiversity.

Didymo
Didymosphenia geminata (DIGE)

General: Single-celled, microscopic, freshwater diatom; produces mucilaginous stalk by which live cells attach to rocks and vegetation. During blooms, stalks form mats that cover streambed. Also known as “rock snot” because of mucous-like appearance. Ranges in color from brownish yellow to white, appearing slimy or like wet toilet paper stranges. Feels fibrous, like wet cotton/wool.

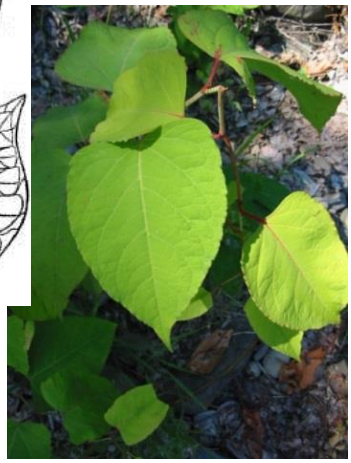
Habitat: Mainly warm, pristine waters with abundant sunlight, low nutrients, and high oxygen levels/swift currents. Formations rare in lakes.

Impacts: Cover and alter habitat, displacing plant, fish, and invertebrate communities. Spreads via attachment of boats, wading gear, or fishing equipment.

Notes: Colonies tend to die back in low water conditions/ at end of summer as daylight hours diminish. Mats of dead algae can resemble dried tissue paper.

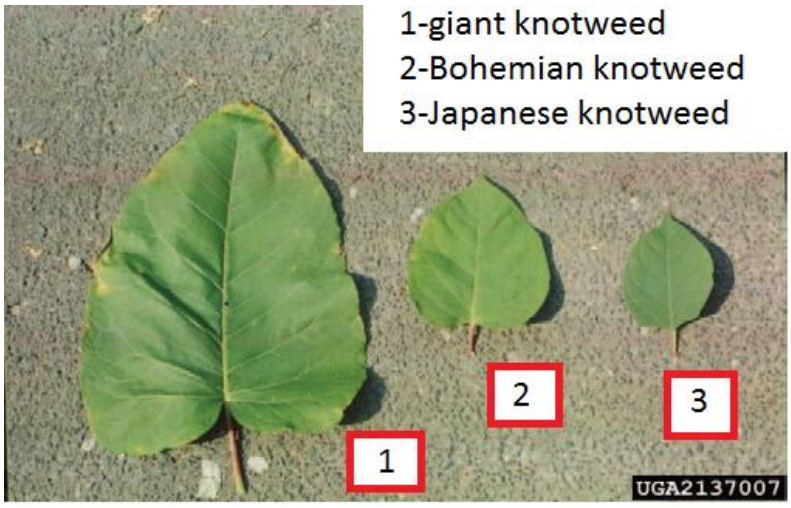
Japanese knotweed
Fallopia japonica (FAJA)

General: Perennial; 1 to 3 m tall; Stout reddish brown hairless stems; nodes slightly swollen; red/purple shoots appear early in spring; mature canes hollow with purple speckles.
Leaves: 1-3 cm stalks, alternate, broadly ovate, rounded, flat or heart-shaped at base and taper to pointed end; 10-15 cm L x 5-12 cm W.
Flowers: Flowers July to October; greenish-white to cream in large plume-like clusters at ends of stems.
Habitat: Open areas, roadsides, waste areas, streams and ditch banks. Versatile plant, but prefers light.
Notes: Fresh rhizomes snap like carrots and usually possess dark orange central core with orange/yellow outer ring. Rhizomes may be knotty/leathery brown, extending up to 3 m deep and 6 m away from plant.
Note: The hybrid between giant and Japanese knotweeds is also an invasive.



Giant knotweed
Polygonum sachalinense (POSA)

General: Perennial; Grows 3 m tall. Similar to Japanese knotweed. Stems stout, bamboo-like, smooth, hollow, light green to red-dish-brown, sparingly branched.
Leaves: Deeply heart-shaped base, blunt leaf tip, 15 to 40 cm long. Hairs on leaf underside long, thin, wavy.
Flowers: Small, creamy white to greenish-white inflorescence; grow in short, branched clusters from leaf and near ends of stems. Blooms July to October.
Leaves: Cordate or heart shaped; often > 1ft. long.
Fruit: 3-sided, black and shiny.
Habitat: Wet areas; riparian zones, water courses, wetlands, disturbed areas.



Giant hogweed
Heracleum mantegazzianum (HEMA)

General: Perennial; large, tall (up to 15-20 ft. (4.6-6.1 m) with stout, dark reddish-purple stem and spotted, hollow leaf stalks that produce sturdy bristles.

Leaves and Stems: Large stalk/stems, 5-10 cm diameter, hollow, usually marked with reddish-purple blotches and pustules/ bumps with single erect hair in center. The leaves are deeply lobed/incised, compound, sharply pointed, and up to 5 ft. (1.5 m) wide.

Flowers: Large umbrella-like inflorescence up to 2 1/2 ft (0.8m) diameter. Blooms late spring to early summer.

Habitat: Giant hogweed can invade a variety of habitats but prefers moist, disturbed soils such as riverbanks, ditches and railroad right-of-ways.

Caution: health hazard; causes skin sensitivity to UV radiation and leads to blistering and severe burns.

Garlic mustard
Alliaria petiolata (ALPE)

General: Herbaceous, biennial; produces garlic odor when crushed.
Leaves: First year plants are basal rosettes with green, heart to kidney-shaped leaves (5-10 cm wide) staying green through winter. Leaves on flowering plants (2nd year) are alternate, sharply-toothed, triangular, approximately 2.5 cm long and 5-7 cm wide.
Flowers: Numerous white flowers growing in cluster at end of sterns; flowers >5 inch wide with four white petals in "cross" pattern. Flower stalks usually single and unbranched. Blooms early spring (May to June).
Fruit: Long (2-6 cm) slender green capsule produced summer to early fall.
Habitat: Forest understory/ edges, roads, streamsides, trails and agricultural

Himalayan blackberry
Rubus discolor (RUDI)

General: Perennial shrub with ribbed, reddish stems forming dense, impenetrable thickets. Branches covered with sharp, slightly curved thorns; grows upward to 15 ft.
Leaves: Palmately compound, alternate, usually with five large, oval leaflets toothed with thorns along under-side of mid-rib. Dark green upper sides and grayish-green underside. In 2nd year, several side shoots produced having smaller leaves with 3 leaflets.
Flowers: Pinkish/white, five-petaled flowers with numerous stamens (0.8-1 in. (2-2.5 cm) in diameter); bloom late spring to early summer. No flowers on 1st year growth.
Fruit: Shiny purple to black aggregate of druplets, 1-3 cm diameter.
Impacts: Aggressively displaces native species; dominates riparian areas.
Notes: Trailing blackberry is smaller, straighter, low-growing, with thinner thorns and leaves with three leaflets of similar color on both sides.

English ivy
Hedera helix (HEHE)

General: Perennial; woody evergreen vine with long, trailing stems, growing to 100 ft. (30 m) in length.

Leaves: Alternate, waxy, with palmate veins. Leaf shape variable, but commonly occurs as a 3-5 lobed leaf with heart-shaped base. Juvenile leaves lobed; mature leaves larger and pointed (possibly not lobed).

Flowers: Umbrella-like terminal clusters of greenish or white flowers. Flowers in the fall given sufficient light.

Fruit: Round, black with fleshy outer covering enclosing one to a few hard, stone-like seeds; matures in spring.

Habitat: Still and flowing waters; lakes, riparian zones, water courses, wetlands.

Impacts: Aggressive; outcompetes and shades all levels of vegetation in forested and open areas. Kills native vegetation and decreases biodiversity.

Salt cedar
Tamarisk ramosissima (TARA)

General: Spreading shrubs or small trees, 5-20 ft. tall, with numerous reddish, slender, arching branchlets.

Leaves: Pale gray-green, small, alternate, scale-like leaves. Fine-textured, juniper like foliage.

Flowers: Pale pink to white, small, perfect, and regular, arranged n spike-like racemes. The distinct petals or sepals occurs in fours and fives.

Habitat: Riparian zones, replacing willows, cottonwoods, etc.

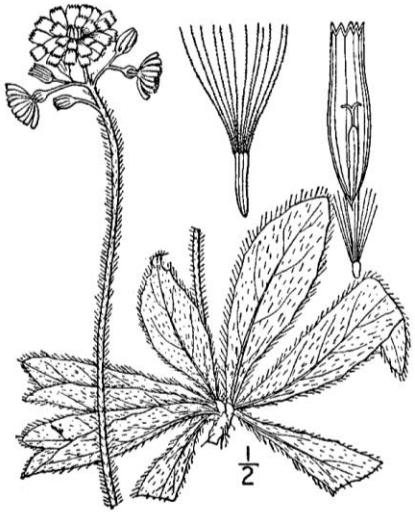
Orange hawkweed
Hieracium aurantiacum (HIAU)

General: A fibrous rooted perennial herb in the Aster family that grows 10-36 in. tall and branching at the top to produce flower heads.

Leaves: Simple, basal with 1 or 2 leaves measuring about 4.5 inches in length. Both leaves and stems are covered with hairs.

Flowers: Conspicuous orange-red ray flowers with 5 to 35 flower heads.

Habitat: Moist meadows, pasture, roadsides, forested areas, riparian zones, etc.



Yellow archangel
Lamiastrum galebdolon (LAGA)

General: Evergreen to semi-evergreen, fast growing perennial groundcover that can be trailing or upright of growing over other plants.

Leaves: Oppositely arranged, oval shapped, toothed, and hairy with typically variegated silvery-gray markings. In cold temperatures, leaves develop purple coloring on the undersides and in the center of the leaf above.

Flowers: Small and yellow, two lipped – the upper lip is hooded and the lower lip with orange to brown markings, flowers are in whorls in leaf axils on short stalks.

Habitat: Often escapes residential plantings to nearby forested areas, greenbelts, and riparian areas.

QUICK REFERENCE GUIDE TO WESTERN FRESHWATER MUSSELS

How to identify live and shell specimens

Genus: *Anodonta* "Floaters"

- Shells are thin and smooth, with no teeth
- Very difficult to identify to species level
- Prefer varying habitats, including low to mid-gradient streams and stable backwater areas
- Occurs mainly at low to mid elevations
- Larvae may be on fish (fins) between early June and late July
- Host fish include dace, redside shiner, sculpin, stickleback, and some salmonids

Anodonta sp. papillae. Singular papillae, "finger-like"; short excurrent opening

Margaritifera falcata "Western Pearlshell"

- Shells can be thick, with lateral and pseudocardinal teeth
- Prefers faster, cooler water in varying gradient streams
- Occurs at high, mid, and low elevations
- Larvae may be on fish (gills) between April and late May
- Host fish utilized locally include rainbow trout

Margaritifera falcata papillae. Fleshy stalks near shell, with "tree-like" papillae ends

Gonidea angulata "Western Ridged"

- Shells usually have distinctive ridge from umbo to posterior valve opening, with small or absent pseudocardinal teeth
- Have a strong foot that anchors the mussel firmly, they are hard to dislodge usually
- Prefer runs and riffles in low to mid gradient streams
- Occurs at low to mid elevations
- Larvae may be on fish (gills) between June and mid July
- Host fish utilized are mainly sculpin

Gonidea angulata papillae. Bifid papillae, non-uniform

Anodonta sp. shell variations

Margaritifera falcata shell

Gonidea angulata shell

Quick Tips

- Freshwater mussels are one of the most endangered groups of animals in North America; in most western states mussels are protected and permits are required for handling, disturbing, or relocating mussels (check with state agencies).
- Freshwater mussels (Bivalvia: Unionoida) are distinct from their marine counterparts because they require a host fish to complete their lifecycle and fertilization occurs internally.
- Mussels are sensitive to disturbance and handling. When possible photograph the mussel(s) without handling, and document longitude and latitude of find.
- If you handle a mussel, be sure to put it back in the same location as you found it. Do not stick the mussel into the substrate; instead, lay it flat on the sediment surface.
- Mussels are very difficult to identify to species level using shells alone; when possible try to use papillae for identification.

Quick Reference Mussel Guide created by Alexa Maine, CTUIR Mussel Biologist, (541) 429-7553, alexamaine@ctuir.org

The Xerces Society for Invertebrate Conservation

APPENDIX H: Equipment List

Stream Gear	Camping Gear
Flags	Coleman 2-burner Stove w/ Hose
Bug Net	Propane Tank
Pool Tail Fines Grid	Camp Chairs
Pool Tail Fines Viewer	Crew Tent
Clipboard w/complete set of forms	Filled Water Jugs (at least two 7 gal.)
Field Vests	Cooler with Ice
Compasses w/clinometer	Cook Kit (w/dishes and utensils)
Survey Level	Dish Soap & Sponge
Level Tripod	Food Bins
Hand Level	**Crew Gear**
Stadia Rod	Depth Rods
30-m Tape Measure	Waders
Replacement 30-m Tape	Wading Boots
Clear Plastic Rulers	Daypacks
2 Gallon Bucket for Bugs	Backpacking Packs (if needed)
Sieve for Bugs	Water Filter
Forceps and a Plastic Spoon	MSR Backpacking Stove
Bug Jars w/Lids	Para cord
Bug Labels	First Aid Kit (truck)
String (for repairing fines grid)	Backpacking First Aid Kit
Electrical Tape	Shovel
Alcohol Nalgene Bottle	Saw
Reach Markers and Nails	Fire Extinguisher

APPENDIX I: Crew Checklist

Beginning of Hitch:	**End of Hitch:**
Electronics Kit	**To Do**
Charged Cell Phone	Complete Photo Summary Sheet
Charged Satellite Phone	Complete Macro Summary Sheet
Charged Data Logger	Complete Veg Summary Sheet
Charged PDA	Enter all Data into Logger (i.e. photos)
Charged InReach	Enter all Data into PDA
Camera w/SD Card	Ensure all forms are Complete
GPS	Clean and Organize Truck and Gear
Extra AA Batteries (for GPS)	Perform Truck Inspection (report damage)
Calibrated Conductivity/Temp Meter	Complete Truck Mileage Sheet
Instruments (HOBO, Tidbit Kits, etc.)	Turn in all Forms, Summary Sheets and Folders
Site Info	Sign Time and Travel Sheets
Hitch Summary Sheet	Turn in Complete Electronics Kit
All Folders from Hitch Summary	Turn in Labelled Bug Jars
Forest Maps with Sites	Replenish Gear Supply (Make a list)
Gazetteers	
Instrument Forms	
Spare Forms	
Gear	
Crew Gear	
Complete Stream Kit	
Complete Veg Kit	
Sparquat Kit	
Filled Sparquat Nalgene	
Bug Alcohol	

APPENDIX J: Crew inReach Locator Beacon Instructions

Use the check button to select/advance; the X button to go back/escape; Arrow button is for navigation.
If the upper left light is blinking red something is wrong; most likely the InReach can't get a satellite.

To Use:
Power up the unit:

- Press and hold the check mark button.
- Once the screen turns on select the Power On options by navigating with the center button and then clicking the check mark.
- Wait for the small light at the top left corner to blink green and you are now up and running.

inReach Settings: Be sure your inReach settings are as follows

- Message check interval is 20min (remember to check for messages throughout the day)
- Tracking
    - Moving interval 30 min
    - Stationary interval 4 hours
    - Stationary radius 100 m

Messages for You:
Check messages at the **start, middle, and end** of your work day.

- Check for messages by looking for a red box with the number of messages over the messages icon.
- To read messages navigate to the Messages icon.
- Select each message read and respond as needed.

Messages to the Hotline:

- Each inReach should have "Hotline" programmed into contacts with the SMS number 435-760-5693
    - If not, add a Hotline SMS contact with the number 435-760-5693
- Messages to the Hotline should be sent SMS unless otherwise directed. The Hotline is always the contact point, do not communicate with a crew or scout directly without expressed permission from the Hotline.
- **At the beginning and end of every hitch, send a message with your crew name to the hotline so we know what crew has what unit Ex: "I1 leaving bunkhouse"**

Check-In Instructions

- **Friday Check In**: Any form of communication (phone call or inReach text) is ok.
  inReach Check In Instructions:
  - Go to Messages and select new
  - In the To field go to Select and scroll up to the Hotline SMS entry.
  - Go to the message box and select to get the keyboard. As you begin to select letters the unit will try to autofill words use the right arrow box to accept or just keep typing.
  - Type in "Checking in, all OK".
  - Select OK when done and Send to mail to the Hotline.
- **Sunday Check In**: **Always** call the hotline.

Need Help

If you need non-urgent help you can also send texts with the inReach to the Hotline. Please be as specific as you can about the nature of the question/issue. Once you have typed in your message you have one more step to send it quickly otherwise it may take up to 20 minutes to send and another to 20 minutes to receive a response. Go to the Check icon and select check now to immediately send and receive all messages.

Emergency:

If you have a medical/rescue emergency press the SOS button. A screen will appear confirming that you are in a real emergency, select Emergency and hit the check button. A generic emergency text will appear you may edit this or send it as is. The device will then count down from 20 seconds (giving you an opportunity to cancel) and then send your location will be sent to the emergency system. Once activated it cannot be turned off. Immediately contact the Hotline and explain the details of your emergency.

*Remember this, as all federal property, is for work purposes. Be sure to have your inReach fully charged at the start of each hitch. If you are going on a long backpack or other trip that will keep you away from a charger make sure to fully charge the green lipstick charger that is in your kit. When charging the inReach from the lipstick charger you will get ~80% charge so plan accordingly (e.g. fly in's need multiple lipstick chargers).

APPENDIX K: PIBO RULES & GUIDING PRINCIPLES

Follow PIBO's 5 guiding principles:

1. Safety
2. Quality Data
3. Be a good representation of the Forest Service
4. Efficiency
5. Enjoy your job and the opportunities it provides

Hours:

- The work day is 10 hours long and can range from 0600 hours - 2000 hours daily (6:00 am – 8:00 pm)
- You cannot work outside of those hours without supervisor approval
- You cannot work more than 11.5 hours in 1 day, without supervisor approval
- You cannot work more than 80 hours per pay period without prior supervisor approval. *If you anticipate that your hitch will exceed 80 hours, call the hotline immediately to discuss logistics.*
- You must take minimum of 30 minutes for a lunch break
- If you skip a 15 min break, you cannot quit work 15 min early
- Setting up and breaking camp are not work hours. Buying groceries or eating lunch at a restaurant, is not working, don't record the hours.
- Falsification of time & travel sheets is grounds for termination.

Driving:

- You absolutely cannot drive past 2000 (8:00 pm)! Rare exceptions may be granted with prior supervisor approval. *Plan ahead so you're not scrambling to find a camp site at 7:45*
- You cannot be on the phone while driving. Violation of the FS policy is grounds for termination
- An individual cannot drive more than 10 hours per day
- No more than 2 hours driving without a rest stop
- Do not depart from your approved work travel-route without supervisor approval *For example, you cannot drive 1/2 hour to get food*
- No alcohol is permitted in the government trucks
- No smoking in government trucks

General

- You cannot stop to eat a meal at an establishment with "Bar" "Tavern" "Pub" "Brewery" "Saloon" etc. in the name of the establishment without prior supervisor approval
- Maintain PIBO EM policy that safety is the top priority
- Check in on Friday, Sunday, and any other designated days
- Makes effort to work cohesively with crew members and supervisors
- Help maintain strong relationships with bunkhouse providers
- Follow Equal Opportunity and Civil Rights policies
- Everyone must wear hiking or wading boots whenever working on the stream