BLM AIM-National Aquatic Monitoring Framework: Interim Protocol for Wadeable, Lotic Systems

Compiled by the Aquatic Core Indicator Working Group

Last updated: July, 2015

NATIONAL SYSTEM OF PUBLIC LANDS

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Table of Contents

Introduction

The Bureau of Land Management (BLM) developed the National Aquatic Monitoring Framework (NAMF) to monitor and assess the condition and trend of wadeable streams and rivers as part of the Assessment, Inventory and Monitoring Strategy (AIM)(BLM, 2015). Following the AIM principles, the NAMF standardized aquatic core indicators, sampling methodologies and survey designs to facilitate consistent condition and trend determinations of BLM lotic resources at multiple spatial scales (e.g., stream reach, BLM district, ecoregional). The NAMF was designed to facilitate quantitative monitoring and assessment of all aquatic resources at multiple spatial scales, but it will initially focus on assessing wadeable stream and river conditions at the scale of land use plans, field office, states and ecoregions, for example. However, at all scales, if any of the NAMF lotic core or contingent indicators are to be measured, the methods specified herein should be used.

This protocol was compiled for interim use while a technical reference is developed for the NAMF lotic indicators. Users should be aware that certain methods are subject to change following field studies of the precision and accuracy of the draft methods. The field parameters subject to change are clearly noted throughout the protocol.

The methods for the NAMF lotic indicators were selected by the BLM AIM Aquatic Core Indicator Working Group with the goal of maximizing compatibility with existing monitoring programs, accurately and precisely estimating condition and trend, and meeting BLM's aquatic data needs as specified by BLM policy, plans, and state and federal regulations. The specific protocols were:

- Archer, E. K., R. A. Scully, R. Henderson, B. B. Roper, and J. D. Heitke. 2012. Effectiveness monitoring for streams and riparian areas: sampling protocol for stream channel attributes. http://www.fs.fed.us/biology/fishecology/emp.
- Burton, T. A., S. J. Smith, and E. R. Cowley. 2011. Riparian area management: Multiple Indicator Monitoring (MIM) of stream channels and streamside vegetation. Technical Reference 1737-23. BLM/OC/ST-10/003+1737. Page 153. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.

- Lanigan, S. H. 2010. Field Protocol Manual: Aquatic and Riparian Effectiveness Monitoring Program (AREMP); Regional Interagency Monitoring for the Northwest Forest Plan for the 2010 Field Season. http://www.reo.gov/monitoring/reports/watershed/2010.FieldProtocol.Final.pdf.
- USEPA. 2009. National Rivers and Streams Assessment Field Operations Manual. EPA-841-B-07-009. Page 220. U.S. Environmental Protection Agency, Washington, D. C.

Precision of Indicator Estimates

The NAMF-lotic protocol can be used to assess the condition and trend of an individual stream reach (e.g., targeted monitoring of a BLM designated monitoring area [DMA]) or a population of stream reaches (e.g., random sampling of all BLM, wadeable streams in the Bruneau, ID field office). The number of replicate measurements specified per indicator per reach should therefore be adequate to derive either site-specific (i.e., targeted sample reach) or population-scale conditions estimates with acceptable levels of precision. However in some instances, such as detecting site specific trends in condition through time, additional replication might be needed. Example indicators for which this might be an issue include water quality, bank stability and greenline vegetation. Users should increase, but not decrease replicate measurements within a reach for any indicator to achieve the desired level of precision to meet monitoring objectives. Such increases should not be required for deriving population level condition estimates, where the unit of replication is the stream reach and not the individual measurements per reach.

In addition to sample sizes both within and among reaches, this protocol sought to maximize the precision of indicator estimates by specifying an index period (June 1st – September 30th see text for exceptions), utilizing repeatable field methods, advocating for annual training and using specialized field crews for data collection.

Protocol Overview

Data is collected on a segment of stream called a "reach." Reach lengths are determined based on the width of the bankfull channel. Eleven main transects and 10 intermediate transects are established within each sample reach. Measurements are taken at transects, between transects, and at the reach-wide scale. Table 1 provides an overview of which measurements are taken at specific locations within the reach. More detailed descriptions of each measurement are provided in the respective sections of this manual. All measurements are to be taken at baseflow conditions during the index period of June 1st – September 30th; exceptions can be made where climatic conditions (e.g., monsoonal rains in the desert southwest) preclude sampling during this time period.

Table 1. Core and contingent indicators/measurements and their associated measurement location for perennial, lotic systems. Asterix denotes a contingent measurement and italics a measurement for which the field protocol is under review.

All 11 Main Transects	Intermediate Transects	Between transects	Reach wide
• Invertebrates • Bankfull height • Bankfull width • *Incision height* • *Bank angle** • *Bank stability* • Substrate size • Densiometer • *Fish cover** • *Riparian vegetation* • Human influences	• Substrate size • *Bank stability* • *Riparian vegetation – quantitative estimates only**	• Large woody debris • *Thalweg profile**	• Pool delineation • Photos • Water quality • GPS coordinates

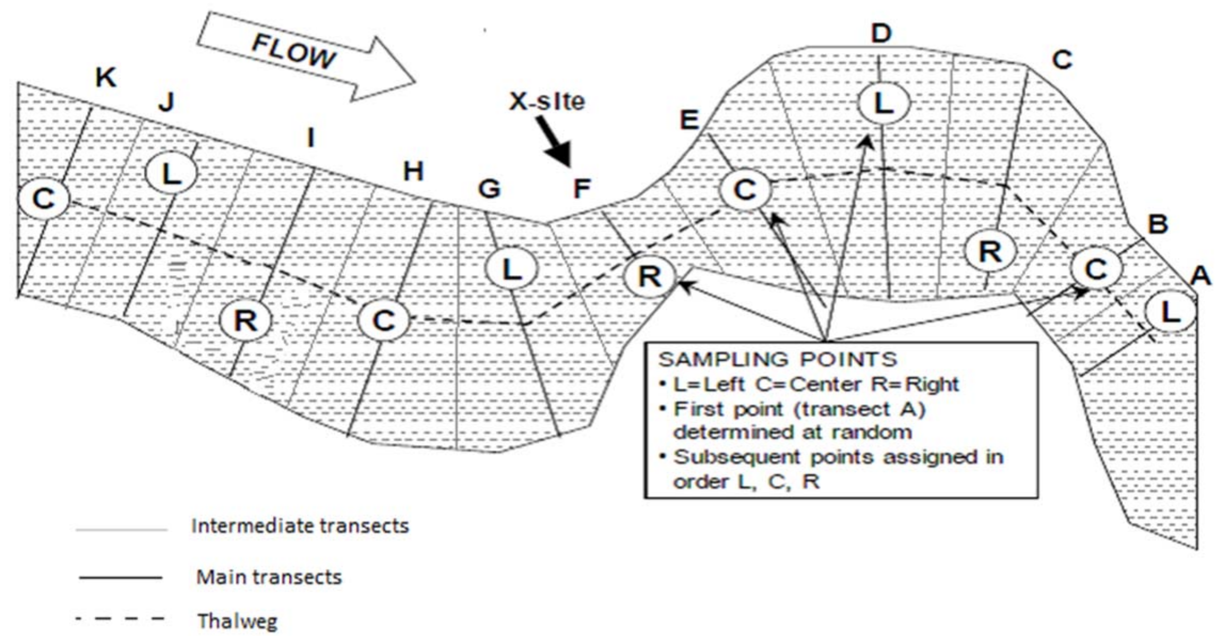


Fig. 1. Typical reach setup with 11 main transects (A – K; black lines) and 10 intermediate transects (gray lines). Reach lengths are equal to 20 x bankfull width or a minimum length of 150 m. Circled letters represent alternating benthic macroinvertebrate sampling locations.

Suggested Work Flow (specific to 2-person crew and inclusive of all core and contingent indicators)

1. Locate X-site
2. Determine reach length and if the reach can be sampled
3. Set up reach
    a. Both technicians measure and flag transects
    b. 1st technician takes coordinates at bottom of reach (BR) and top of reach (TR) (or wait till step 5b)
4. Deploy temperature probe (contingent)
5. X-site activities, visual assessments, and macroinvertebrates
    a. 1st technician samples macroinvertebrates
    b. 2nd technician does the following:
        i. Fills out verification form
        ii. Photos
        iii. Collects water quality data (YSI and grab [contingent] sample)
        iv. Start assessing riparian vegetation (if core, qualitative method used), human influences, and fish cover (contingent).
6. Pool delineation
    a. 1st technician measures depth and length of pools
    b. 2nd technician records data
7. Physical habitat
    a. Both technicians
        i. 1st technician measures the following:
            1. Bankfull width
            2. Bankfull and incision height
            3. Left bank angle, bank stability, and canopy cover
            4. Substrate and canopy cover
            5. Right bank angle, bank stability, and canopy cover

        ii. 2nd technician logs data and finishes filling out human influence, fish cover (contingent), and riparian vegetation cover and type

8. Intra-transect measurements
    a. 1st technician measures water depth
    b. 2nd technician records data and counts large woody debris
9. Intermediate transects
    a. 1st technician, measures substrate and bank stability
    b. 2nd technician, records data
10. Slope
    a. 1st technician uses auto level and records data
    b. 2nd technician uses stadia rod
11. Vegetative identification and cover (contingent)
    a. If a 3-person crew, or greater, is present and quantitative estimates of riparian vegetation are sought, start vegetative estimates immediately after the reach is set up.
12. Reach cleanup (both technicians)
13. Gear decontamination (both technicians)
14. Reach data review (Crew leader)

Important Definitions

Left and right bank- Left or right bank is determined when facing downstream.

Braided river or stream: A river or stream that has multiple mid-channel bars below bankfull that form short and small sub-channels, often with no obvious dominant channel.

Side channel: any channel separated directly from the main channel by an island (NOT a mid-channel bar).

- **Island:** stream sediments within the channel with an elevation above bankfull; islands are almost always vegetated.

- **Mid-channel bar:** stream sediments within the channel that are above current water level but below bankfull and are almost always unvegetated.

Bankfull: The lowest bank height at which the stream over tops its banks and spills out onto the active floodplain. This volume of flow occurs every 1.5 years on average and the elevation can be determined using the following indicators: (Appendix A pg. 89)

- **Examine stream banks for an active floodplai**n: Relatively flat, depositional area that is commonly vegetated and above the current water level during summer base flow unless there is a large amount of spring runoff or there has been a substantial rain event (i.e. stream running at bankfull stage).

- **Look for depositional features such as point bars:** The highest elevation of a point bar usually indicates the lowest possible elevation for bankfull stage.

- **Identify breaks 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.

- **Identify the elevation where a transition from perennial vegetation to mature, riparian woody vegetation occurs:** The lowest elevation of birch, alder, and dogwood can be useful, whereas willows are often found both below and above the bankfull elevation.

- **Examine the ceiling of undercut banks:** which is normally just *below* the bankfull elevation.

- **Stain lines:** Bankfull is at or above the highest stain line on rocks which may coincide with the lowest limit of mosses or lichens.

In the absence of clear bankfull indications, look for:

- Drift debris (sticky wickets) left by the previous seasons flooding.

- The level where deciduous leaf fall is absent on the ground (carried away by previous winter flooding).

- Unvegetated sand, gravel, or mud deposits from previous years flooding.

Where stream bed and stream bank meet

- Break in the relatively steep stream bank slope to a more gently sloping streambed.

- Associated with a rapid fining of particles from relatively coarse streambed particles to the finer stream bank particles.

- Normally (but not always) below the current water level.

- The streambed has <50% terrestrial vegetative cover.

- The stream bank is usually consolidated, the streambed is usually unconsolidated.

- In a few situations, it can be difficult to determine differences between the streambed and stream bank in reaches with cobble or bedrock substrate. Begin assessing all stream bank measurements at the scour line in these situations.

Scour line: Active channel as determined by these indicators: (Pictures – Appendix A pg. 72)

- The lowest consistent limit of sod forming or perennial vegetation.
- The ceiling of undercut banks.
- 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).
- The best place to identify scour line is in a straight, well-vegetated section of the stream channel.

Incision height: the vertical distance (height) from the observed water surface up to the level of the first major valley depositional surface at or above bankfull (Pictures – Appendix A pg. 72).

Thalweg: The flow path corresponding to the deepest part of the stream channel; almost always the area of fastest flow in any river. The thalweg will alternate back and forth across the channel from left to right bank and visa-versa.

Strahler stream order: Strahler stream order is determined from the NHD stream layer on your reach map using the following rules: (Fig. 2)

1. When two **first-order** streams (streams with no incoming tributaries) come together, they form a **second-order** stream.
2. When two second-order streams come together, they form a **third-order** stream and so on.
3. Streams of lower order joining a higher order stream do not change the order of the higher stream. Thus, if a first-order stream joins a second-order stream, it remains a second-order stream. It is not until a second-order stream combines with another second-order stream that it becomes a third-order stream.

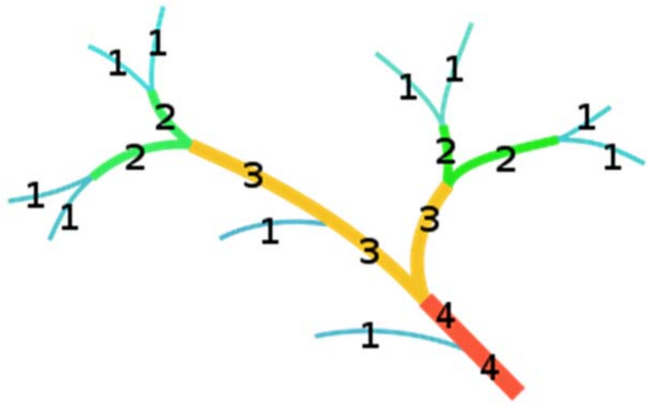


Fig. 1. Visual representation of how Strahler stream order is determined.

Initial Site Procedures

Overview: Locate the X-site and determine the sampling status of the stream reach. If the reach can be sampled, set up the reach.

Locating X-Site for Targeted Reaches

For designated monitoring areas or targeted sites, where the sample reach is selected using best professional judgement, skip to the 'Setting Up the Reach' section (pg. 22)

Locating X-Site for Probabilistic Reaches

Overview: Locate the X-site of the reach to be sampled.

Methods:

1. Crews will be given reach packets with information pertaining to the streams they are to sample. Example reach information includes:
    - Site name and code
    - Site coordinates
    - Site strata or multi-density category, if relevant
    - Closest city and HWY
    - Possible driving directions
    - Site scouting comments from field crew managers and local field offices
    - Landowner contact information
    - Georeferenced pdf maps of the surrounding area
2. Using the given information, navigate as close to the X-site as possible.
3. Crews will be equipped with maps, map software (iPad) and a GPS receiver to help facilitate navigation.
4. After all efforts have been made to reach then X-site, record whether you arrived at the X-site or not and the sources of information used to verify the X-site location. Take a GPS coordinate of the X-site or the closest location to the X-site that you were able to reach.
    a. If you arrived at the X-site, continue to the Determining the Reach Status section (pg. 16).
    b. If you did not arrive at or within view of the X-site, classify the site into the categories below and complete the Failed Site (attempts) Form (pg. 21).

Permanently inaccessible

- Every possible attempt was made to access the site, but access issues ***permanently*** prevent this site from being accessed. Examples include:
  - Cliffed out or otherwise physically unable/unsafe to reach site, and no alternate route is possible.
  - Unsafe due to marijuana grows.
  - Permission was explicitly denied by a landowner, permittee or other individual.

Temporarily inaccessible

- Access is possible via another route, additional landowner/field office contact needed or other reason for temporary inaccessibility such as:
  - Unsafe due to wildfire.
  - Need different gear (backpacking), truck, ATV, or crew.
  - Cliffed out, but access possible via a different route.

Dry visited

- Reach does not have water at > 50% of transects.

Dry-not visited

- A barrier prevented access to the X-site, but **substantial** evidence existed to suggest that the site was dry. Make sure to specify how close you were able to get to the X-site and the evidence used to determine that it was dry (e.g., talked with locals that have been to the exact site).

Determining the Reach Status

Overview: After locating the X-site, determine if the reach is sampleable. The X-site will be at the center of the reach, with half of the transect up and downstream of the X-site.

Methods:

1. Estimate the bankfull width of the stream to determine approximate reach length.
    a. If bankfull width is ≤ 7.5 m, reach length will be 150 m.
    b. If bankfull width is > 7.5 m, reach length will be 20 X bankfull width.
2. Use the distance from the X-site displayed on the GPS to walk the approximate length of the reach. Take note of the approximate location of 11 transects, assuming transects are placed at 1/10 the reach length (i.e. if the reach is 150 m long transects will be set up every 15 m).
3. While walking the reach, determine if the reach meets the following criteria:
    - You can safely access and wade >50% of transects.
    - > 50% of transects have water.
    - You can identify bankfull at > 50% of transects.
    - The current discharge level is not above the scour line or is not **unduly** influenced by a previous or current rain event.
        - Do NOT sample if:
            - High flow rainstorm events are occurring or have occurred recently (keep an eye on the weather reports and rainfall patterns).
            - The stream is flowing above scour line or water seems more turbid than typical for the physiographic region.
            - There is unusually high discharge released from dams above the reach.
            - It is unsafe to be in the water.

    If the reach meets these 4 criteria, it is sampleable; continue to step 5.

    If the reach DOES NOT meet these 5 criteria, go to step 4 to determine if the reach can be slid to meet the sampleable criteria.

4. Sliding the reach. “Sliding the reach” means that you will move your sample reach upstream or downstream of the originally intended location so that you can sample a site that was otherwise unsamapleable.
   - Reasons to slide the reach:
     - Incoming tributary that changes stream order at some point along the reach.
     - Impoundments (lakes, reservoirs, ponds, beaver ponds) with >50% of transects inundated.
     - < 50% of transects with water.
     - Physical barriers making it unsafe to access (e.g., falls, cliffs).
     - Access restrictions or change in landownership with access denied.
   - When sliding the reach, the following restrictions apply (Fig. 3):
     - For 150 m reaches: maximum deviation from X-site is 150 m (i.e., Reach may start or end a maximum of 150 m upstream or downstream of the original X-site).
     - For reaches > 150 m: maximum deviation from X-site is 250 m or such that the original X-site is retained within, whichever is larger.
     - **DO NOT** slide the reach if doing so will result in the stream changing Strahler stream order category.

     When in doubt, contact the field crew manager to discuss the pros and cons of your decision process.

   a. If sliding the reach results in a sampleable reach, record that you slid the reach on the sampling event form and continue to step 5.
   b. If the reach is still unsampleable, continue to step 6.

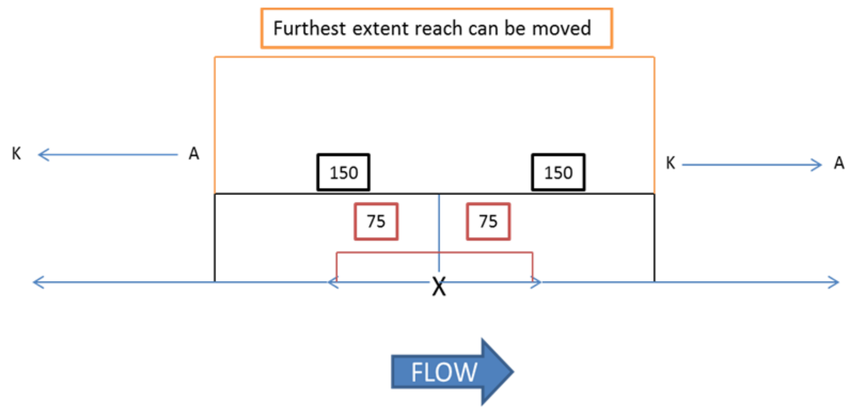


Fig. 2. Example of the maximum distance a 150 m reach can be slid. The minimum 150 m sample reaches is centered on the X-site, with 75 m up and downstream of the X-site (indicated by red). The maximum possible distance the reach should be slide up or downstream (150 m) is indicated by the black lines. In such an instance, the first (transect A) can be located a maximum of 150 m from the original X-site.

5. If the reach is deemed sampleable before or after sliding the reach, classify it into one of the categories below. Then fill out the rest of the verification form including comments about: the weather, local contacts (i.e. landowners or field offices), observations, and any other important information that might help crews get back to the reach in future years.

Wadeable

- Continuous water, sampled by wading.

Partial wadeable

- Sampled by wading (>50% of reach sampled)

Wadeable interrupted

- Not continuous water throughout reach, but >50% water throughout the entire reach.

Altered channel

- Stream/river channel present but differs from map.

a. If the reach is deemed sampleable under any of the wadeable categories, continue to the "Setting Up the Reach" section of the protocol (pg. 22).

6. If the reach does not meet the sampleable criteria and it cannot be slid, it is considered unsampleable. Classify it into one of the following categories regarding why the reach was not sampled. Fill out the rest of the verification form and continue on to the Failed Site (attempts) Form (pg. 21).

Non-target:

Non-target

- BLM no longer owns the land.

Wetland

- Standing water present, but no definable stream channel (i.e., bankfull and a thalweg could not be consistently identified). If wetland is surrounding a stream channel, define the site as "Wadeable" but restrict sampling to the stream channel. Includes "beaver lakes".

Dry-visited

- Reach does not have water at > 50% of transects.

Impounded

- Stream is submerged under a lake or pond due to manmade or natural (e.g., beaver dam) impoundments. If the impounded stream is still wadeable, record it as "Altered" and sample.

Map error

- No evidence that a water body or stream channel was ever present at the X-site.

Non-sampleable temporary:

Not wadeable

- Reach is not wadeable at the present time, but could be wadeable in the future at lower flow condition. **Only use this category if >50% of transects CANNOT be waded.**

Temporarily inaccessible

- Not wadeable due to rain.
- Unsure how to sample- (e.g. braided systems or large beaver impact but could be sampled with further instruction).
- People recreating prevented sampling.

- Started to attempt to access or sample but simply didn't have time.

<u>Other temporary</u>

- Only use if the situation does not fit any of the above categories and provide detailed comments on failed site (attempts) form if used.

Non-sampleable permanent:

<u>Permanently inaccessible</u>

- Vegetation too dense to get to at least 50% of transects.
- Not-wadeable and not boatable at least 50% of transects.
- Permanently denied access by land owners.
- Hike is too dangerous due to cliffs, large scree fields, and steep hill slopes.
- Marijuana growth in the vicinity of the stream.

Failed Site Form

Overview: Fill out the relevant information on the failed site form to provide more details on all attempts made to sample the site and what could be done to sample the site if one was to revisit it.

Methods:

1. If you have not already done so, record the GPS waypoints of the X-site OR **the closest location to the X-site that you were able to get to**.
2. Take photos of all barriers that prevented reaching the site or pictures of multiple transects including:
   - Gate or private land access issues
   - Vegetation: Indicate vegetation type (e.g., rosebush). Use a person or a depth rod in the photos for scale.
   - Cliffs
   - Rapids
   - Poor road conditions
   - If the site was dry, take a photo of the X-site with comments specifying if moisture was present, if there was any riparian vegetation, and if there was a discernable channel.
3. Note all barriers that prevented you from accessing or sampling the reach.
4. Provide **DETAILED** route information about how you attempted to access the site and provide alternate routes to the site for future crews if applicable.
5. If landownership was an issue, provide information regarding who and when landowners, field offices, and field managers were contacted.
6. Field managers should be notified of all failed sites every 2-3 days during check-in. If there is ANY doubt as to whether the site is sampleable, field managers should be notified before leaving a 1-2 hour driving radius of the site if possible and cell phone reception allows.

Setting up the Reach

Overview: After determining the reach is sampleable, use the average of 5 banfull widths to establish the reach length. Set up the 11 main transects, and take GPS coordinates of bottom of reach (BR) and top of reach (TR).

Method citation: combination of U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009) and USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012).

Methods:

1. Measure (surveyor's rod, tape, or laser range finder) the bankfull width at minimum 5 places of "typical" width. Measurements should be taken within 5 bankfull channel widths upstream and downstream from the X-site.
2. Record the 5 measurements and compute reach length using the following rules:
    - Reach length should be 20 times the average of the 5 bankfull width measurements.
    - If the average bankfull width is ≤ 7.5 m, use 150 m for the minimum reach length.
    - If the average bankfull width is > 100 m, use 4 km for the maximum reach length.
3. Starting at the X-site (or if the reach is slid, start at the middle of the reach known as transect "F") (Fig. 4).
    a. Measure upstream, along the thalweg, the length of 1/10 the total reach length.
    b. Place 2 pin flags, 1 on each bank, **perpendicular** to the wetted channel.
    c. Repeat 4 more times upstream of transect F for a total of 5 transects upstream of the X-site (transects G – K).
    d. While at the TR, stand mid-channel and record a waypoint.
        - If the reach is slid, record this on the sampling event form and record the **new X-site,** BR, and TR coordinates (after the reach as been set up).
    e. Return to the X-site and repeat steps a-d this time moving downstream (transects E – A)
    f. Transects will be labeled A-K, transect "A" = BR and transect "K" = TR.

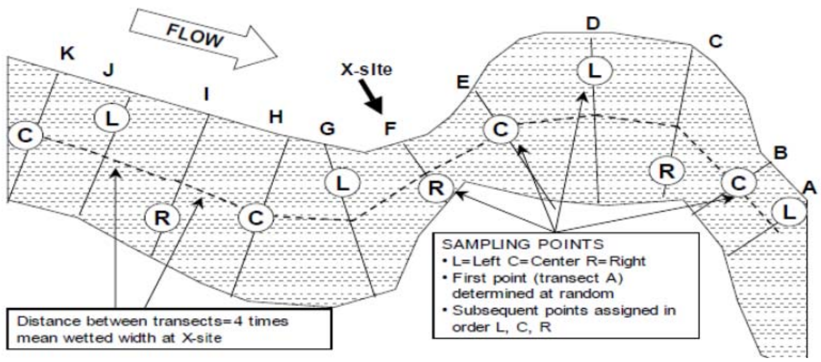


Fig. 3. A reach that has been fully set up with the locations of the 11 main transects.

Special situations: Appendix B pg. 78
Interrupted flow: See page 78
Side channel: See page 80

Photos

Overview: Take photos of the BR, X-site, TR, monumenting location, and a reach overview, in addition to pictures of interesting features throughout the reach.

Method citation: modified from USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012)

Methods:

1. Use a depth rod as a stand for the camera to get a consistent height on all photos.
2. Do not to zoom in for any photo.
3. A depth rod should be visible in as many photos as possible. Make note what bank the depth rods is on (i.e. right bank or left bank.
4. Make sure that both left and right banks are present in all pictures.
5. For all photos record the following information:
    - Camera and photo number
    - Photo type (i.e., BR, X-site, TR, monument, overview, other)
    - Letter of the closest transect
    - Direction facing (upstream, cross-section, downstream)
    - Comment or monument feature
6. Take the following photos:
    a. 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, but will not always be practical.

    b. The bottom (BR), X-site, and top of the reach (TR):
        - Considering vegetation and sunlight, take a photograph looking either upstream, cross-section, or downstream standing at a distance of ~5 meters from the channel (if you cannot see both banks, move further back).

    c. Miscellaneous photos:
        - Take a minimum of 2 miscellaneous stream photos, more is always better. Your goal is to

take photos of the stream channel (include both banks) that are either:

a. Representative of the reach (special situations such as side channels or interrupted flow).
b. Characteristic of problematic features for protocol implementation.

d. Monumenting photos:
   - The purpose of these photos is to help future crews re-locate the sample reach.
   - Strive to combine photos showing a prominent feature(s) of the area (e.g., large tree, boulder or human structure) with a narrative of the reach description.

General photo do's and don'ts:

- Do not take photos displaying unprofessional behavior.
- 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.

Special situations: Appendix B pg. 78
Beaver impacted reaches: See Page 82

Water Quality

Overview: Sampled at the X-site or Transect "F" (reaches that have been slid not to contain the original X-site) before any mid-channel measurements are taken.

Method citation: modified from U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009).

Methods (pH, specific conductance, temperature, turbidity):

1. Review the calibration log (located in the YSI pelican case) to ensure the sonde was calibrated for both pH and specific conductance within the last 7 days.
2. Record the most current calibration date.
3. If the sonde has not been calibrated in the last 7 days, the YSI sonde will need to be recalibrated following the manufactures directions. Example directions for NAMC supported YSI are in Appendix C, pg. 82.
4. Standing mid-channel and in flowing water, if present, lower the probe to a depth of 0.5 m below the water surface. If water depth is < 1 m, take measurements at mid-depth.
   - Avoid contacting the stream bottom with the YSI, as the instrument is delicate.
5. Record the pH, specific conductance (µS), and temperature (C°).
   - For specific conductance make sure the YSI is set to measure specific conductance (i.e., temperature corrected conductivity).

Grab sample for total nitrogen and phosphorus (contingent indicator)

1. Obtain a pair of surgical gloves and place them on both hands
2. Obtain a 50 ml centrifuge vial (new or acid washed) and rinse it with stream water three times. Be careful not to overly disturb the stream bottom; increasing suspended solids.
3. Using the 50 ml vial, collect water sample at the X-site or transect "F". Fill the vial 75% full, this will leave head space in the vial for freezing.
4. Fill out water quality label with the full site code and the date. Make sure to spell out the month and keep two digits for the day.

5. Place on outside of vial. Tape over vial with clear packing tape and put in a plastic bag to prevent water from degrading the label.
6. Immediately after collecting and labeling, place the sample on ice. **<u>If in the field for longer than 24 hours, the sample will need to be frozen using dry ice</u>**.

In-situ turbidity measurement (contingent)

1. Protocol is for use with La Motte turbidometer.
2. Inspect the calibration log to ensure the meter has been calibrated within the last 7 days. If not, calibrate the meter following the manufactures instructions.
3. Obtain a sample vial from the La Motte turbidometer and rinse it five times with stream water.
4. From the thalweg, collect a depth integrated (i.e., lower the sample vial at a rate resulting in the vial filling before reaching the stream bottom) sample from the water column. Be very careful not to disturb stream bottom sediments prior to or while collecting the water sample.
5. Pour off water from the vial such that the meniscus is level with the white line.
6. Thoroughly wipe the sample vial, while holding onto the cap only, with kim wipes to remove any finger prints or debris.
7. Place the sample vial in the meter with the vertical white line aligning with the black arrow.
8. Close the meter and obtain a measurement using the provided meter instructions.
9. Remove and invert the vial, while only handling the cap, and obtain a second and third reading. Record all thee readings.
10. If anyone of the three readings is double that of a previous reading, it is recommended that you take additional readings of the same water sample until three homogeneous readings are obtained.
11. Please provide comments if unusual values or stream condition are observed.
12. **DO NOT store the meter in the sun. When the meter is exposed to heat it will frequently produce erratic readings**.

Thermistor deployment for temperature monitoring (contingent)

Method citation: Compilation of USFS/BLM PIBO and AREMP (Lanigan 2010, Archer et al. 2012)

Methods:

- Thermistors can be easily deployed and installed to obtain a more temporally integrated picture of the thermal regime of a stream reach (contingent method).
- A minimum deployment time of June 1st through September 15th is recommended to capture the thermal maxima, which can limit the population viability of cold-stenothermic taxa. However, there is also value in deploying a thermistor while sampling the site to obtain the maximum daily temperature during the day of sampling.
- Regardless of the temporal period to be sampled, the following field guidance is provided for deploying thermistors:
  - Launch the thermistor to record at hourly intervals.
  - If the option exists, set the thermistor to not write over data when the memory is filled.
- Considerations for probe placement:
  - Attach the temperature logger to a secure location such as a tree trunk or a root wad. Think about high and low flows when placing the thermistor in the stream.
  - Be Smart; you don't want the temperature logger in too strong current or in a shallow area that may not have water at a later date.
  - Pick one of the deepest locations in the channel where you can access, focusing on the thalweg.
  - If possible, DO NOT swage cable to rocks in the stream as higher flows can dislodge the rock and probe will be lost. Use longer cable to reach bank.
  - 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.
  - Place the thermistor in a location that will be camouflaged from people when in high traffic areas. Use grass, dirt, or moss to cover the wire if you are placing it in a high traffic area.
  - Avoid areas just downstream of tributaries and obvious groundwater seeps, as water temperatures in these areas

will not be representative of the stream reach. 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.
    - For additional information on deploying thermistors: http://www.onsetcomp.com/files/download.pdf

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

Recording thermistor information

- Record the thermistor number carefully and check to make sure it is correct, and check again!
- Record the date and time the thermistor was placed in water.
- Record the location of the thermistor relative to the bottom of the reach.
    - Is the thermistor on river right or river left?
    - Use landmarks (e.g., wire attached to roots of enormous Ponderosa Pine, logger hidden underneath undercut bank).
- Record GPS coordinates for the logger's location

Special situations: Appendix B pg. 78
Interrupted flow: See page 78
Beaver impacted reaches: See Page 82

Benthic Macroinvertebrates (BMI)

Overview: Sampled at each of the 11 main transects after water quality sampling has been completed or in targeted riffle habitats – see below for details.

Method citation: targeted riffle (USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012)); reach-wide sampling (USEPA 2009)

Method overview

Two methods are provided for the sampling of benthic macroinvertebrates: 1. Targeted-riffle and 2. Reach-wide. The targeted riffle approach is designed for sample reaches containing fast-water or riffle habitats. In contrast, the reach-wide protocol is designed for low gradient reaches void of fast-water or riffle habitats; however, agencies like the USEPA are now using the reach-wide method for all sampling. The two methods have been shown to result in comparable data and thus the data from the two approaches should be considered interchangeable (Gerth and Herlihy 2006, Rehn et al. 2007).

Targeted-riffle Methods:

1. Identify riffles located within the sample reach
2. If ≥ four riffles are present, collect invertebrates from the first four riffle or fast-water habitats.
    a. Collect invertebrates at two locations within each fast-water habitat for a total of eight samples
3. If only two – three riffles are present, collect invertebrates from all fast-water habitats.
    a. Collect invertebrates at three - four locations within each fast-water habitat for a total of eight samples
4. Determine the location of each Surber sample location within fast-water habitats by generating two pairs of random numbers (1 – 9)
    a. The first number in each pair (multiplied by 10) represents the percent upstream along the habitat unit's length.
    b. The second number in each pair represents the percent of the stream's width from river left (RL) looking downstream.

   c. Repeat this process to locate the second sampling location.
   d. Take samples where the length and width distances intersect (estimate by eye).
   e. 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.
5. See general collection and preservation methods below.

Reach-wide Methods:

1. Using the last number in the time of a digital face watch, randomly select the starting location at transect A.
   - 1-3="Left" – 15% from the left wetted edge
   - 4-6="Center" – 50% from the left wetted edge
   - 7-9= "Right" – 15% from the right wetted edge
2. Place the Surber sampler or kick net 1 m below the first transect at the randomly selected position so the mouth of the net is facing into to the flow.
   - If the stream is only one net wide at a transect, place the net across the entire stream width and consider the sampling point to be "Center".
   - If a sampling point is located in water that is too deep or unsafe to wade, select an alternate sampling point on the transect at random.
3. Continue moving upstream repeating steps 2-3 at all 11 transects alternating among left, center and right sampling locations.
4. See general collection and preservation methods below.

General methods and sample preservation:

1. Carefully scrub all stones focusing on cracks and crevices of large stones that are stuck to the bottom.
2. After removing all large stones, disturb small substrates (e.g., sand, gravel) to a depth of about 5 cm, if possible by raking and stirring with hands or scrub brush.
3. After the area contained by the sample frame has been thoroughly cleaned, lift the net straight up off the stream bed ensuring that all materials are retained within the net.
4. If the dolphin bucket is full midway through the reach, empty contents into wash tub, bucket, or tray and continue.

5. Rinse the net thoroughly into a wash tub, bucket, or tray with the squirt bottle, making sure to get all organic matter and any bugs clinging to the net. Move contents into the 500 µm sieve.
6. Spoon or spatula the sample into sample jars and preserve with 95% ethanol.
7. Fill out a BMI label for the inside and outside of the all jars. Include the stream name, site code, date, and number of jars (e.g., 1/5, 2/5 and so on). Make sure to use the full site code and the date (e.g., XE-SS-4120, May 06 2014). Tape over outside label with packing tape to protect against spilt ethanol.
8. Record the number of jars, number of transects, area sampled, and sampler used.

If at any point in the sampling or washing process the sample is compromised, (dolphin bucket falls off, sample is spilt while cleaning etc.) the sample will need to be discarded and retaken.

Special situations Appendix B pg. 78
Interrupted flow: See page 78
Side channel: See page 80
Beaver impacted reaches: See page 82

Other:

- Use a kick net to sample transects that are too deep to sample using the Surber sampler
- Sampling with a kick net:
  a. Hold mouth of net firmly on stream bottom into the flow of the stream.
  b. Stand upstream of net and use your feet to disturb the sediment in an area roughly 30 X 30 cm.
  c. After the area has been thoroughly disturbed with your foot, remove the net from the water, while pulling the net upstream to send any invertebrates and debris to the bottom of the net.
  d. Repeat above steps at all transects requiring a kick net.
  e. After all transects have been sampled composite all samples into the sieve and proceed as a normal sample.
  f. Only record the kick net as the method used if it was used at >50% of transects; however, make sure note how many

transects the kick net was used for in the comments section even if it was only used for one transect.

Citations:

Archer, E. K., A. R. Van Wagenen, R. Andrew, M. Coles-Ritchie, P. Ebertowski, A. D. Becker, K. B. Uhler, P. G. Eskandari, L. Babich, and R. Leary. 2012. PIBO-EMP PACFISH INFISH Biological Opinion Effectiveness Monitoring Program for Streams and Riparian Areas: 2012 Sampling Protocol for Vegetation Parameters:60.

Burton, T. A., S. J. Smith, and E. R. Cowley. 2010. Riparian area management: Multiple Indicator Monitoring (MIM) of stream channels and streamside vegetation. Technical Reference 1737-23. BLM/OC/ST-10/003+1737. Page 153. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.

Gerth, W. J., and A. T. Herlihy. 2006. Effect of sampling different habitat types in regional macroinvertebrate bioassessment surveys. Journal of the North American Benthological Society 25:501–512.

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

Lanigan, S. H. 2010. Field Protocol Manual: Aquatic and Riparian Effectiveness Monitoring Program; Regional Interagency Monitoring for the Northwest Forest Plan for the 2010 Field Season. http://www.reo.gov/monitoring/reports/watershed/2010.FieldProtocol.Final.pdf.

Rehn, A. C., P. R. Ode, and C. P. Hawkins. 2007. Comparisons of targeted-riffle and reach-wide benthic macroinvertebrate samples:

implications for data sharing in stream-condition assessments. Journal of the North American Benthological Society 26:332–348.

USEPA. 2009. National Rivers and Streams Assessment Field Operations Manual. EPA-841-B-07-009. Page 220. U.S. Environmental Protection Agency, Washington, D. C.

Pool Delineation

Overview: Define habitat units throughout the reach.

Method citation: USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012) and AREMP (Lanigan 2010) protocols

Full channel or partial channel pools

- **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.

Methods:

1. Starting at transect A walk upstream looking for a break in slope that could be a pool tail.
    - The pool tail is the shallowest point in the pool that would still have water flowing out if the flow were reduced to a trickle.
2. Measure the depth of the pool tail to the nearest 1 cm. **(All depths/heights are recorded in cm and all widths are recorded in m).**
3. Find and measure the max depth of the pool to the nearest 1 cm.
    - Check the max depth making sure that it is ≥1.5 times the pool tail depth for a qualifying pool.
4. Measure the length of the pool from the pool tail to the pool head rounding to the nearest 0.01 m.
    a. Make sure the pool is longer than it is wide.
    b. If width > length: is it a plunge pool (i.e., A pool formed when the thalweg drops vertically off an obstruction such as a boulder or log. To qualify as a plunge pool the max depth of the pool must be within 20% of the total width from the obstruction).
    c. If any portion of the pool is outside of the sampling reach, measure the whole pool and make a comment.
5. Check all pool criteria confirming that it is a qualifying pool.
    - Max pool depth is ≥ 1.5 times the pool tail depth

- Depressions in the streambed that are concave in profile, laterally and longitudinally.
- Bound by a ‘head’ crest (upstream break in streambed slope) and a ‘tail’ crest (downstream break in streambed slope).
- Span at least 50% of the wetted channel width at **any** location within the pool.
    - So a pool that spans 50% of the wetted channel width at one point, but spans <50% elsewhere is a qualifying pool.
- Only consider main channel pools where the thalweg runs through the pool, and not backwater pools.
- Must be longer than it is wide
    - Plunge pools are the only pool that can be wider than they are long.

6. If the pool doesn’t meet the criteria, then consider it a riffle/run.

If there are two consecutive potential pools: To lump or to split?

1. Measure the pool tail of the upstream pool.
2. If it is ≥ 10 cm deeper than the downstream pool tail depth, lump them into 1 pool.
3. If it is ≤ 10 cm deeper than the downstream pool tail, split the 2 pools in to separate pools.

Special situations: Appendix B pg. 78
Side channels: See page 80
Interrupted flow: See page 78
Beaver impacted reaches: See page 82

Physical Habitat (PHAB)

Overview: Measurements will be made at the 11 main transects, along the longitudinal profile, and at 10 intermediate transects (Fig. 1). Both technicians will participate in PHAB measurements. Transect measurements are to be started on the left bank (when looking down stream) moving to the right bank.

Example workflow:

1. Begin PHAB at transect A.
2. First measure:
    a. Bankfull width
    b. Bankfull height
    c. Incision height (if possible on the left bank to make work flow easer)
3. Starting on the left bank measure:
    a. Bank stability
    b. Bank angle (contingent indicator)
4. Moving across the stream towards the right bank start:
    a. Substrate
5. Continue with substrate measurements until finished on the right bank.
6. At the right bank measure:
    a. Bank angle
    b. Bank stability
7. Canopy density can be measured with bank and substrate measurements; alternatively crews could do a separate pass per transect for all canopy density measurements.
8. When all transect measurements are completed, work upstream conducting the longitudinal profile (contingent indicator) and tallying LWD between transects.
9. At thalweg stations 5, 7, or 14 (dependent on reach length) intermediate transects will be set up, measurements include:
    a. Bank stability and substrate (start on the left bank and finish on the right bank).
10. Continue upstream to the next transect, finishing the longitudinal profile.
11. Repeat until all transects have been completed.

Bankfull Height and Width

Overview: Measured at all main (11) transects using the lowest most consistent indicator of bankfull.

Method citation: bankfull height (USEPA 2009); bankfull width is a compilation of (Harrelson et al. 1994, USEPA 2009)

Method – bankfull height:

1. Identify bankfull width using the indicators described on p. 10 of the definitions section.
2. Place one depth rod with the metal end touching the bankfull mark.
3. Lower the depth rod so that it is parallel to the water surface and level.
4. Place the second depth rod vertical on the water's surface.
5. Measure the height where the horizontal rod crosses the vertical rod to the **nearest 1 cm**. The measurement is taken from the bottom of the horizontal depth rod. **(All depths/heights are recorded in cm and all widths are recorded in m.)**

Method – bankfull width:

1. Identify bankfull width using the indicators described on p. 10 of the definitions section.
2. Using the tape measure, depth rod, or laser range finder, measure from bankfull on left bank to bankfull on right bank.
3. Record measurement in meters rounded to the **nearest 0.01 m.**

Special situations: Appendix B pg. 78
Interrupted flow: See page 78

Incision Height

Overview: Measured at all main (11) transects using the first terrace at or above bankfull.

Method citation: U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Identifying incision height:
Examine both left and right banks to identify the vertical distance (height) from the observed water surface up to the level of the first major valley depositional surface at or above bankfull (Fig. 5 & 6). This is the incision height, as measured from the water surface. (More photos in Appendix A pg. 72)

- Incision height can either be an active floodplain, inset floodplain, or a terrace.
- If the height of this surface differs between banks, use the lower of the two surfaces.
- The top of a "cutbank" against the steep hillside at the edge of the valley is not necessarily an indication of recent incision.
- If the channel is not greatly incised, bankfull height and incision height can be the same (i.e., the first depositional surface is the active floodplain) (Fig. 5). For example:
    - Spring fed systems with no visible terraces.
    - A "V" shaped valley or gorge with no visible terraces (Fig. 6).
- Bankfull height CANNOT be greater than incision height.
- If the channel is incised greatly, the bankfull height will be less than the incision height. (Fig. 6)

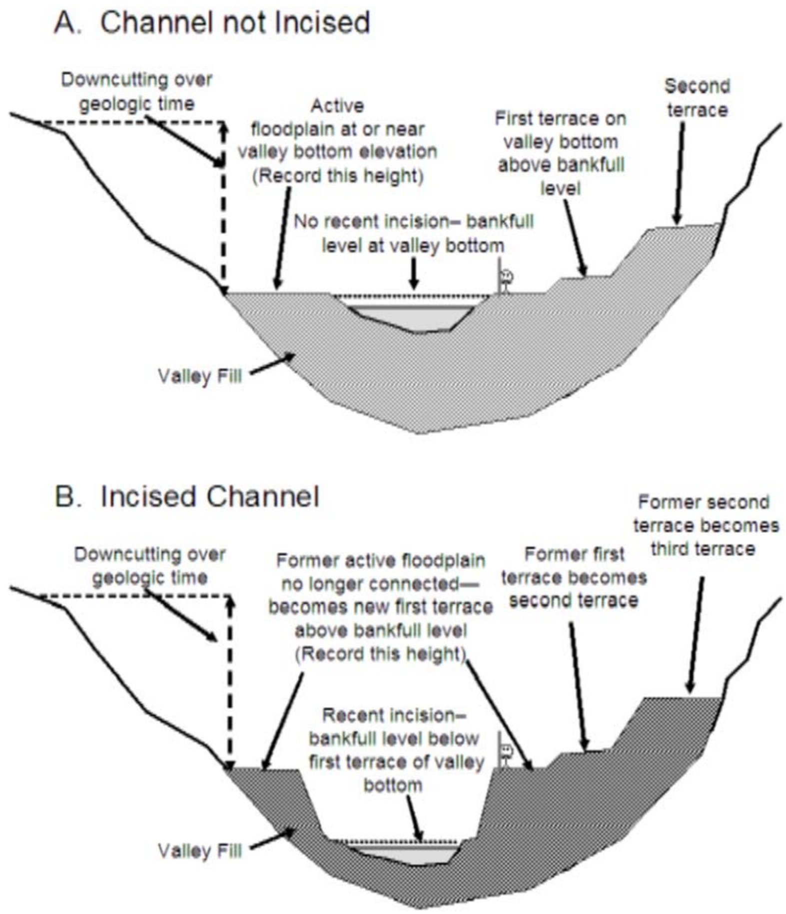


Fig. 4. (A) Channel with low incision where the active floodplain is similar to the bankfull height. (B) incised channel where the elevation of the floodplain is above bankfull height.

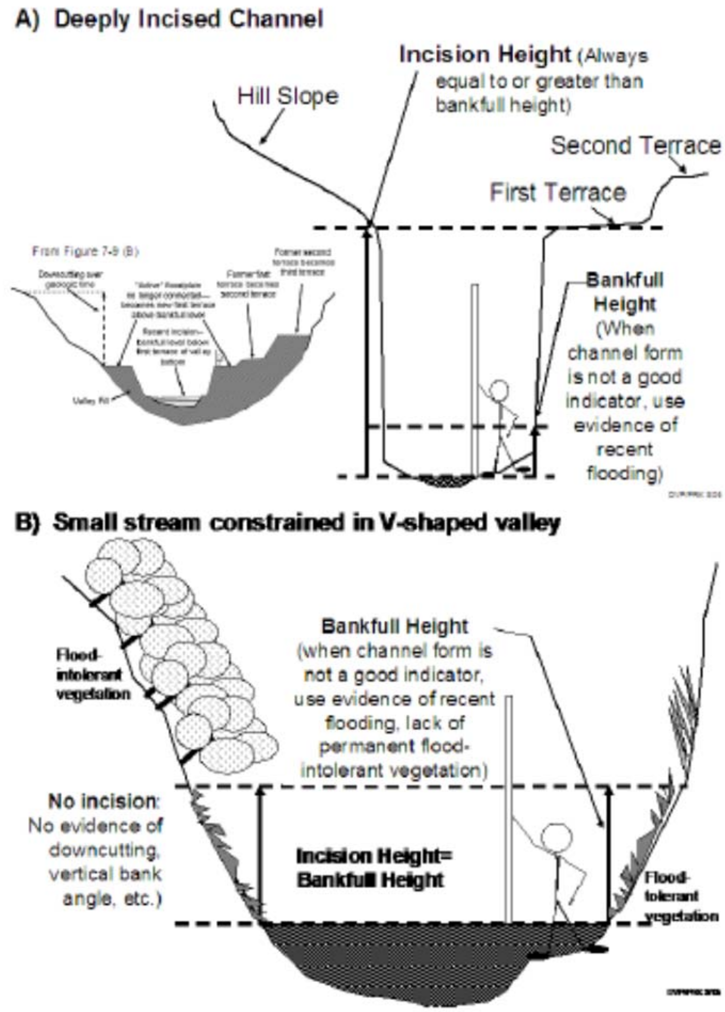


Fig. 6. Determining bankfull and incision heights for (A) deeply incised channels, and (B) streams in deep V shaped valleys.

Methods:

1. Place a depth rod (rod A) with the metal end touching the terrace.
2. While keeping the metal end in place, lower the depth rod towards the water surface until the rod is level.
3. Place the second depth rod (rod B) vertical on the water's surface.
4. Measure the height **to the nearest 1 cm** where the horizontal rod crosses the vertical rod, taking the measurement from the bottom of the horizontal depth rod.
5. If the terrace is too far from the water and requires multiple measurements:
    a. "Leap frog" the rods by taking rod "B" and lower it towards the ground until level (being careful not to move it from its previous position).
    b. Take rod "A" and hold it horizontal next to the vertical rod and measure the height.
    c. Repeat this until the surface of the water is reached then sum all the measurements to get incision height.

Special situations: Appendix B pg. 78
Interrupted flow: See page 78
Side channel: See page 80

Bank Angle (contingent indicator)

Overview: Measure the bank angles at all main (11) transects for the left and right banks.

Method citation: USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012)

Methods:

1. Use the point where the bed meets bank as the lower limit for measurements.
    - Depositional bank: if deposition of streambed material extends above the scour line, the lower limit of measurements is where deposition meets the streambank.
    - Slump blocks, logs or rocks: if the connection point (i.e., where the top of the slump block, logs, or rocks meets the bank) is below the scour line, the lower limit of your measurement is there.
2. Use the first flat depositional feature at or above bankfull as the upper limit.
    - If this feature is not present, the upper limit is 0.5 m above the local bankfull elevation (Fig. 7).

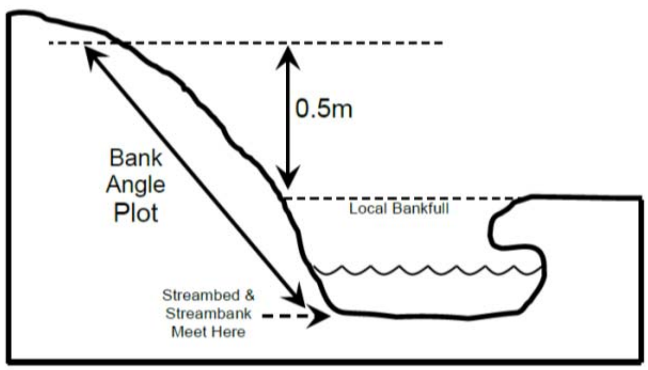


Fig. 7. Upper limit of bank angle measurements if no flat deposition feature is present.

3. Record whether the bank is obtuse or acute (fig. 8)

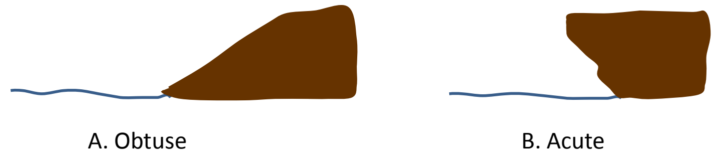


Fig. 8. An obtuse bank (A) and an acute bank (B).

4. Lay depth rod perfectly in-line with transect flags, perpendicular to the channel.
5. Place a compass on top of the depth rod (not on the sides) and record the angle displayed on the compass to the nearest degree.
    - Compass come with a built in clinometer and must be set at 90° or 270° for accurate readings.

Follow guidelines below for measuring angles on various types of banks.

Types of Banks:

Simple Banks: 1 angle >10 cm in height:

- Measure the angle from the base of the bank (where the streambed and bank meet) up to the first flat, floodplain-like surface located at or above the bankfull elevation.
- If a bankfull indicator / feature is not present, the upper limit of bank angle plot is 0.5 m above bankfull elevation.

Complex Banks: 2 angles (both ≥10 cm 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 tallest section of bank
    - o Lower portion of the bank if it is taller than the upper portion (Fig. 9 Left).
    - o Upper portion of the bank if it is taller than the lower portion (Fig. 9 Right).

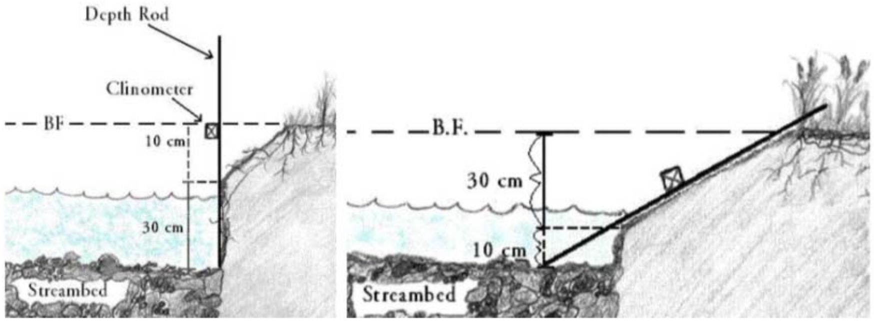


Fig. 9. (Left) The lower, vertical, portion of the bank is taller than the upper and is there for measured. (Right) The upper, slanted, portion of the bank is taller therefore it is measured.

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

- Measure the average angle by laying the depth rod along the outer corner of the steps (Fig. 10).
- Strive to represent the bank angle as accurately as possible with one rod placement.

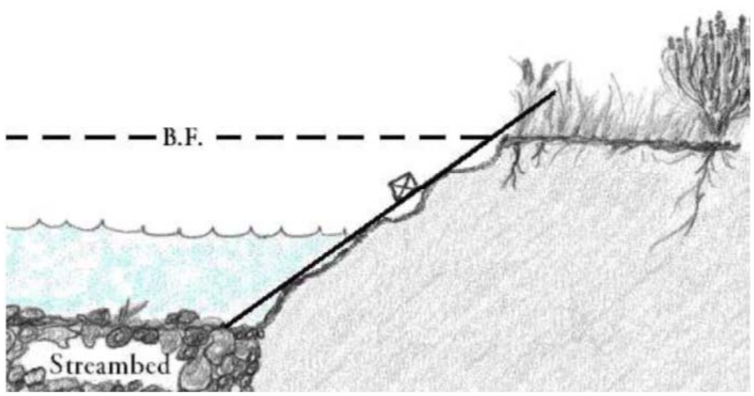


Fig. 10. Measure the angle of banks with 3 or more angles by laying the rod along outer edges.

Undercut Bank

- 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:
    - o <5 cm non-qualifying undercut
    - o ≥5 cm qualifying undercut
    - o NA ceiling above bankfull *(this is a non-qualifying undercut)*
- Undercut banks are measured from the deepest point of the undercut up to the ceiling of the overhang (Fig. 11).
    - o Occasionally the back of the undercut will be a consistent depth, thereby lacking a deepest point (Fig. 12). Place the depth rod at the highest elevation, resulting in the smallest angle (angle B).
    - o Enter the angle as "1°" if the deepest part of the undercut is elevationally above the ceiling (Fig. 13).

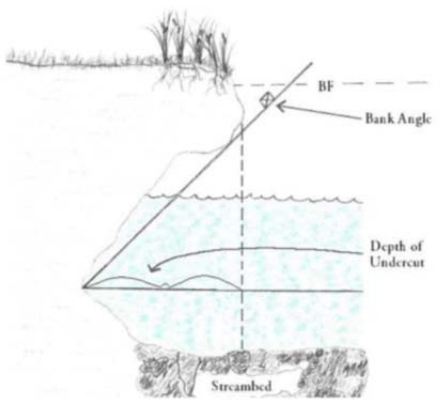


Fig. 11. Measure undercut bank angle from the deepest point to the ceiling of the undercut; determine if the undercut has a qualifying depth (≥5 cm) by lowering you depth rod until it is horizontal.

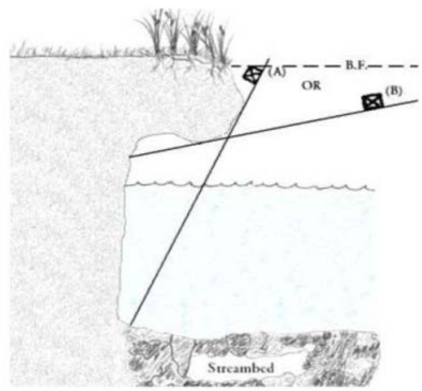
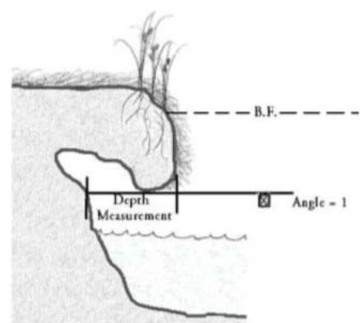


Fig. 12. Undercut banks with a constant depth are measured with the base of the depth rod at the highest elevation (angle B, not angle A).

Fig.13. When the deepest point is elevationally above the ceiling of the undercut, determine if the undercut is 'qualifying' by holding the depth rod horizontal and directly underneath the ceiling. Record the angle as 1°



Depositional banks:

- Depositional features are not considered part of the bank. Start you bank angle measurement at the point where deposition ends.
- On un-vegetated depositional features such as point bars, start the measurement at the point where the top of the depositional feature and streambank meet (Fig. 14).
- If deposition ends at or above the first flat, floodplain-like feature (Fig. 15), record as a non-measureable angle (Flag code “K”).
- Use the point where the depositional feature becomes >50% vegetated (perennial species) to define were the deposition ends and bank begins.

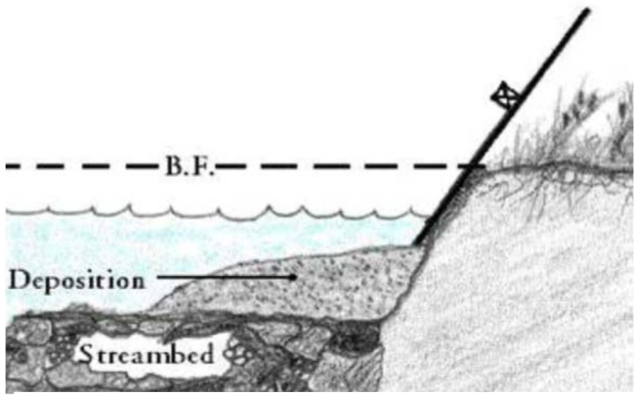


Fig. 14. Begin measuring the angle from the point where the deposition and bank meet.

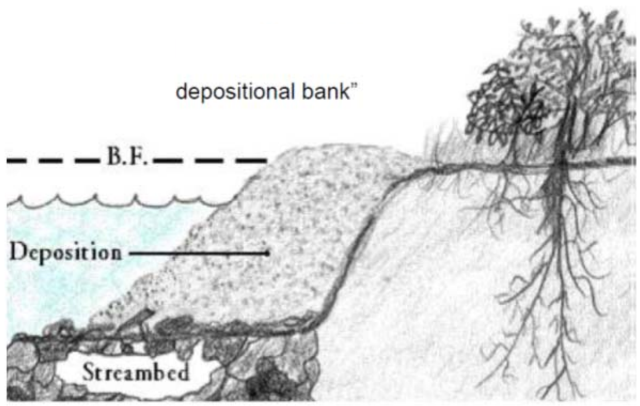


Fig. 15. Do not measure an angle when the deposit covers the first flat, floodplain like feature.

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 (Fig. 16 right).
- If the connection point is above the scour line, the lower limit of your measurement is where bed meets bank (Fig. 16 left).
- Do not consider slump blocks that are not attached to streambank.

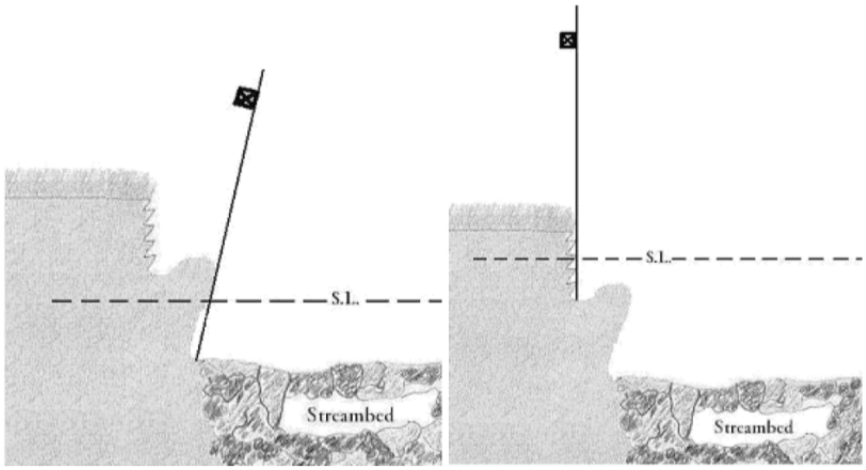


Fig. 16. Location of bank angle measurements with a slump block still attached and relative to the scour line.

Logs and Rocks:

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

Special situations: Appendix B pg. 78

Side channels: See pg. 80

Bank Stability and Cover

Overview: Measured at a minimum of all main (11) and intermediate (10) transects on the left and right banks.

Method citation: BLM Multiple Indicator Monitoring (Burton et al. 2010)

Methods:

1. Define the plot area needed to estimate bank stability.
    a. Plot height extends perpendicular to the stream between the scour line and the first flat or depositional feature at or above bankfull.
    b. Plot width extends parallel to the stream 25 cm upstream and downstream of the transect flag (50 cm wide total).
2. Assess bank type, cover, and stability:

Bank Type

- **Depositional (D)**: This applies to all streambanks associated with sand, silt, clay, or gravel deposited by the stream. These are recognizable as “bars” in the channel margins adjacent to the greenline, typically lenticular-shaped mounds of deposition on the bed of the stream channel adjacent to or on the streambank.
- **Erosional (E)**: This applies to all banks that are not “Depositional”, (i.e. cut banks, undercut banks, straight runs with no visible depositional features and outside edge of bends).

Bank cover

- **Covered (C)**: This applies to banks with at least 50% cover within the plot of the following types or combination thereof:
    a. Perennial vegetation (including roots)
    b. Cobbles 15 cm or larger
    c. Anchored large woody debris (LWD) with a diameter >10 cm
    d. Moss **does not** count as cover
- **Uncovered (U)**: This applies to all banks that do not meet the “Covered” criteria.

Bank stability

Record the single most prominent feature of the following 5 types. To qualify, a feature must be obvious and span at least one-fourth (13 cm) of a plot width or greater. Additionally, keep in mind that these features (absent, fracture, slump, slough, and eroding) are on a continuum of stability where absent is the most stable and eroding is the least.

- **Fracture (F):** This applies to the top of the bank where a visible crack is observed (Fig. 17). The fracture has not separated into two separate components or blocks of a bank.
- **Slump (S)**: This applies to a stream bank that has obviously slipped down resulting in a separate block of soil/sod separated from the bank (Fig. 17-18). Slumps may be created by excessive animal trampling.
- **Slough (SL)**: This applies to banks where soil or sod material has been shed or cast off and has fallen from and accumulated near the base of the bank and typically occurs on banks that are steep and bare (Fig. 19-20).
- **Eroding (E)**: This applies to banks that are bare and steep (within 10 degrees of vertical), usually located on the outside curves of meander bends in the stream (Fig. 21-22). Undercut banks are not considered “eroding” banks even if they are scoured or eroded below the elevation of the base of sod or the roots of vegetation, and because such erosion occurs mostly below the scour line (outside the plot frame). Such undercut banks are stable as long as there is no slough, slump, fracture, and/or erosion above the scour line or ceiling of the undercut bank.
- **Absent (A):** This applies in all other situations, if no feature meets the minimum criteria.

Special situations: Appendix B pg. 78
Side channels: See page 80

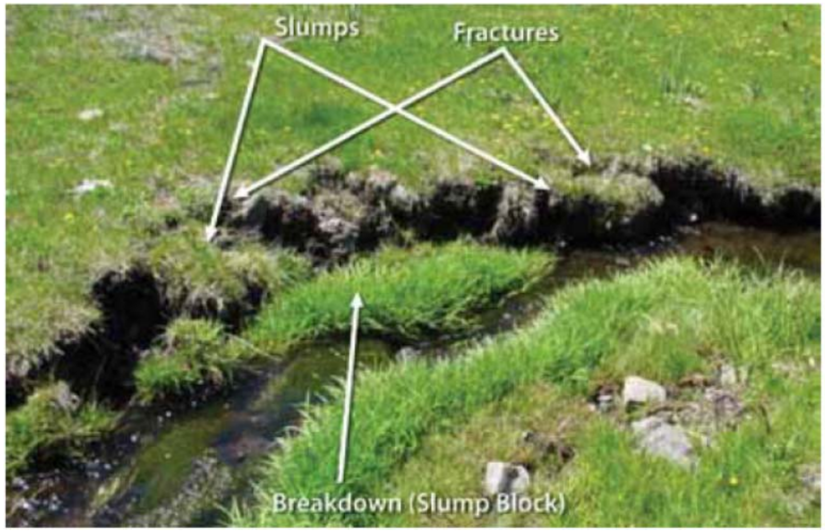


Fig. 17. Slump blocks that are detached from the streambank and isolated to the channel are not considered part of the streambank. Slumps must be obviously sliding down but still attached as part of the streambank. Fractures must be obvious at the top of the bank or on the bench (Burton et al. 2010).

Fig. 18. The left streambank is a point bar that is depositional (D) and covered (C). Slump blocks on the right bank are mostly covered with vegetation, still attached to the streambank, above the scour line and therefore are recorded as erosional (E), covered (C), and slump (S). Photo - PIBO, U.S. Forest Service (Burton et al. 2010).

Fig. 19. Three different conditions are shown at this location. The left side is an outside bend that is erosional (E), with no vegetation, rock, or wood cover (U), and slough (SL) directly entering the stream. The upper middle section is an erosional (E) streambank, uncovered (U) with slump (S). The lower right streambank is a point bar that is depositional (D) and covered (C) (Burton et al. 2010).

Fig. 20. The streambank is erosional (E) and not covered with vegetation, rock, or wood. It has a bank angle of more than 10 degrees (22 percent) from vertical with no bench to capture the sediment, and thus the sediment enters directly into the stream as slough; therefore, it is recorded as uncovered (U) and slough (SL) (Burton et al. 2010).

Fig. 21. The streambank has an obvious scour line. The bank evaluated is above the scour line to the first bench and is recorded as erosional (E), uncovered (U), and eroding (E) or slough (SL) (Burton et al. 2010).

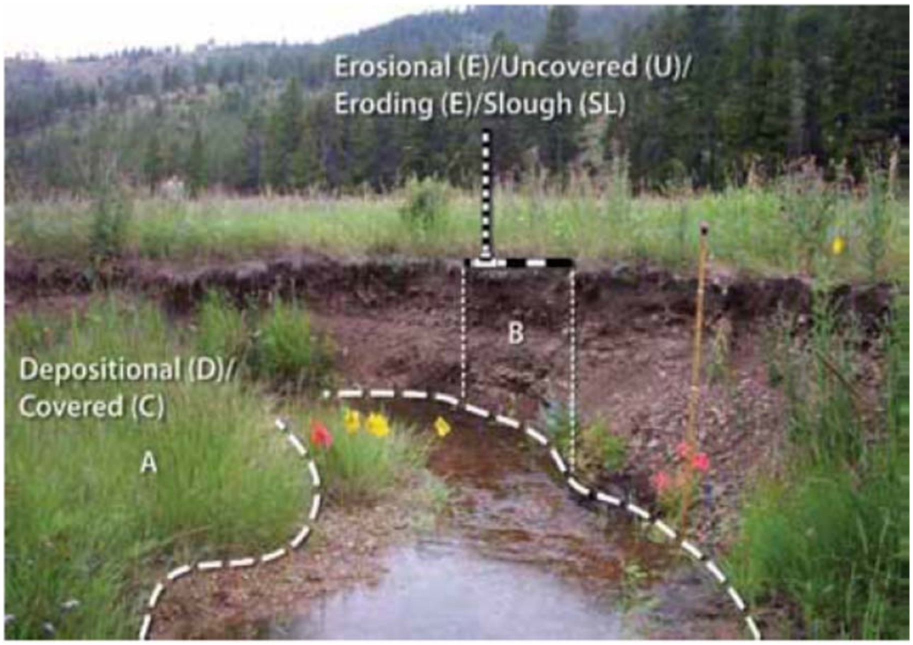


Fig. 22. The dotted line represents the scour line. "A" is a point bar, thus it is depositional (D) and covered (C). "B" shows the length of streambank evaluated. The streambank evaluated is erosional (E), uncovered (U), and eroding (E) or slough (SL) (Burton et al. 2010).

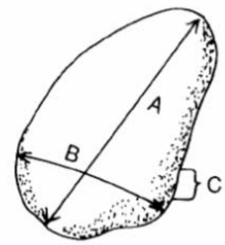
Substrate

Overview: Substrate is measured at 10 points across the active channel: 5%, 15%, 25%, 35%, 45%, 55%, 65%, 75%, 85%, and 95% of the distance from scour line to scour line (aka the active channel). Substrate is measured at all main (11) and intermediate (10) transects.

Method citation: BLM Multiple Indicator Monitoring (Burton et al. 2010).

Methods:

1. Identify the active channel by determining where the scour line is located on both the left and right banks; the active channel is below this line; no substrate particles should be sampled above the scour line.
2. Starting at the scour line for the left bank, place the depth rod on the substrate roughly 5% of the width of the active channel, while holding the depth rod vertically and without looking directly at the substrate.
3. Pick up the first substrate particle the depth rod touches.
    - Avoid looking down when grabbing substrate particles to minimize bias against small or large particles.
    - If particles are too large to pick up or "cemented" into the streambed measure as best you can using the depth rod.
    - If the substrate if covered by macrophytes, algae etc., sample the inorganic substrate below the growth.
    - Depositional features (e.g., point bars) located below the scour line are considered part of the active channel and should be sampled.
4. Measure the intermediate axis (B axis) of the particle and record in mm. (Fig. 23).
    - If not measurable (i.e., fines, bedrock, hardpan, organic matter), select one of the below categories:
        - < 2 mm
        - Bedrock
        - Hardpan
        - For organic matter, record as other and provide comment.



A = LONGEST AXIS (LENGTH)

B = INTERMEDIATE AXIS (WIDTH)

C = SHORTEST AXIS (THICKNESS)

Fig. 23. Example of a particle's B or intermediate axis.

5. Denote whether the particle was picked form the wetted channel (including mid-channel bars) or if it was picked from outside the wetted channel.
6. Repeat process for remaining locations; 15%, 25%, 35%, 45%, 55%, 65%, 75%, 85% and finishing 95% of the way across the active channel (i.e., scour line to scour line).
    - If you reach the last substrate measurement and have less than 5 particles from the wetted channel, take supplementary pebble measurements from additional transect points (e.g., 20%, 50% and 80% if three additional particles are needed per transect) until a total of 5 particles from the wetted channel have been measured per transect.

Special situations: Appendix B pg. 78
Side channel: See Page 80

Canopy Cover

Overview: Measured at all main (11) transects on the left bank, mid-channel, and right banks.

Method citation: U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Methods:

1. Start by facing the left bank, standing at the scourline.
2. Hold the densiometer 0.3 m above the surface of the stream. Level the densiometer and hold in front of you so your face is just below the apex of the taped "V" (Fig. 24).
3. Count the number of grid intersection points within the "V" (0-17) that are covered by a tree, a leaf, or a high branch.
4. Move to the stream at mid-channel and face upstream. Repeat steps 2-3.
5. Rotate a quarter turn and repeat steps 2-3 three times.
    - Will end up with four total measurements: center up, center right, center down, and center left.
6. Move to the right bank and while facing the right bank. Repeat steps 2-3.

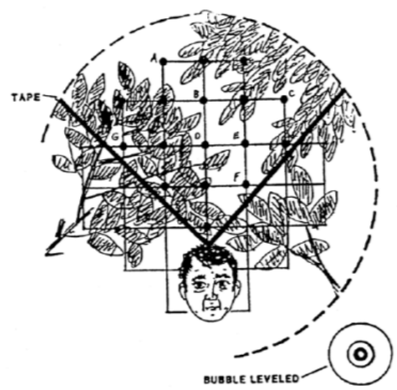


Fig. 24. Modified densitometer, count intersections in the V covered by vegetation.

Special situations: Appendix B pg. 78
Side channels: See page 80

Longitudinal Profile (contingent indicator)

Overview: Measure water depth along the entire sample reach of the main channel.

Method citation: U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Methods:

1. Using the following rules, verify the increment distance between measurements:
    - For widths ≤ 1 m, establish stations every 0.5 m (30 per intra-transect distance).
    - For widths > 1 and ≤ 2.5 m, establish stations every 1 m (15 per intra-transect distance).
    - For widths > 2.5 and ≤ 3.5 m, establish stations every 1.5 m (10 per intra-transect distance).
    - For widths > 3.5 m, establish stations at increments equal to 0.01 times the reach length (10 per intra-transect distance) (e.g., a reach of 400 m would have stations every 4 m)
2. Start at transect A, working your way upstream.
3. At each thalweg profile station, use a depth rod to locate the deepest point within the flow path (the thalweg), which may not always be found at mid-channel.
4. Measure the thalweg depth **to the nearest 1 cm** from the substrate surface to the water surface. Read the depth on the **side** of the rod to avoid inaccuracies due to the wave formed by the rod in moving water.
5. Use the depth rod, stadia rod, or tape measure to approximately space each thalweg station.
6. Proceed upstream to the next thalweg station, repeating steps 3-5 until reaching the intermediate transect (station 5 for reaches ≥2.5 m, station 7 for reaches <2.5 m and > 1 m, station 14 for reaches ≤ 1 m).
7. At the intermediate transects, classify the size of the bed substrate particles (see cross sections measurements pg. 53), and determine bank stability for both right and left bank (See bank stability pg. 46).

8. Proceed upstream to the next thalweg station, repeating steps 3-7 until all Thalweg and transect measurements are completed.

Special situations: Appendix B pg. 78

If the thalweg is too deep to measure directly:

1. Stand in shallower water and extend the stadia's rod at an angle to reach the thalweg.
2. Determine the angle by resting the clinometer on the upper surface of the rod and reading the angle on the external scale of the clinometer.
3. Record the water level on the rod and the rod angle in the comments section of the field data form.

Interrupted flow: See page 78
Side channels: See page 80

Large Woody Debris

Overview: Measured along the entire sample reach of the main channel.

Method citation: supplemented version of the U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Methods:

1. Scan a stream segment between two cross-section transects.
2. Talley all pieces of LWD that have a large end diameter of > 10 cm, a length >1.5 m, and are at least partially within or bridging the bankfull channel. Once the diameter is less than 10 cm, visually cut the log and do not use this portion for length estimates.
3. Keep tallies separate for each size class (based on the diameter of the <u>large end</u> **AND** the length) and for each location (pieces all/ part in bankfull channel or pieces bridge above bankfull channel). (Fig. 25)
   a. diameter of the large end:
      i. 0.1 m to <0.3 m
      ii. 0.3 m to <0.6 m
      iii. 0.6 m to <0.8 m
      iv. >0.8 m
   b. length of the piece (where diameter > 10 cm):
      i. 1.5 m to <3.0 m
      ii. 3 m to <5 m
      iii. 5 m to <15 m
      iv. >15 m

   Note: If the piece is not cylindrical, visually estimate what the diameter would be for a piece of wood with circular cross-section that would have the same volume.
4. Repeat steps 1-4 for the next stream segment between transects ensuring that no pieces are double counted.

Special situations: Appendix B pg. 78
Side channel: See page 80

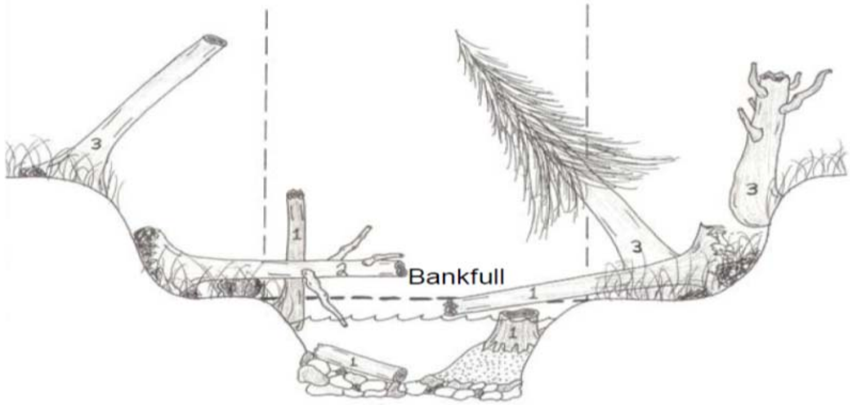


Fig. 25. Pieces of wood labeled with a 1 are within the bankfull channel, pieces labeled with a 2 are spanning the bankfull channel and pieces labeled 3 are not counted.

Visual Fish Cover Estimates (contingent indicator)

Overview: Visually estimated at all main (11) transects within the wetted channel.

Method citation: U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Methods:

1. For each main transect, visualize a plot that extends 5 m upstream and 5 m downstream of the transect and across the entire wetted width. (Fig. 26)
2. Estimate the following features and types of fish cover in the plot:
    a. ***Filamentous algae*****:** long streaming algae that often occur in slow moving waters.
    b. ***Aquatic macrophyte*****:** water loving plants, including mosses, in the stream that could provide cover for fish or macroinvertebrates. If the stream channel contains live wetland grasses, include these as aquatic macrophytes.
    c. ***Large woody debris:*** larger pieces of wood that can influence cover and stream morphology (i.e., those pieces that would be included in the large woody debris tally [> 1.5 m in length and 10 cm in diameter at the large end]).
    d. ***Brush and small woody debris:*** smaller wood pieces that primarily affect cover but not morphology.
    e. ***In-channel live trees or roots:*** living trees that are within the channel – estimate the aerial cover provided by the parts of these trees or roots that are inundated.
    f. ***Overhanging vegetation*****:** includes tree branches, brush, twigs, or other small debris that is not in the water but is close to the stream (within 1 m of the surface) and provides potential cover.
    g. ***Undercut banks:*** any bank that has an undercut > 5 cm deep.
    h. ***Boulders:*** basketball to car-sized particles.
    i. ***Artificial structures*****:** designed for fish habitat enhancement, as well as in-channel structures that have been discarded (e.g., concrete, asphalt, cars, or tires) or

deliberately placed for diversion, impoundment, channel stabilization, or other purposes.

3. For each cover type, estimate the **aerial** cover. Record the appropriate cover class in fish cover:
   - 0=absent: zero cover,
   - 1=sparse: <10%,
   - 2=moderate: 10-40%,
   - 3=heavy: >40-75%, or
   - 4=very heavy: >75%).
4. Each kind of cover may equal 100%.

Special situations: Appendix B pg. 78
Interrupted flow: See page 78
Side channels: See page 80

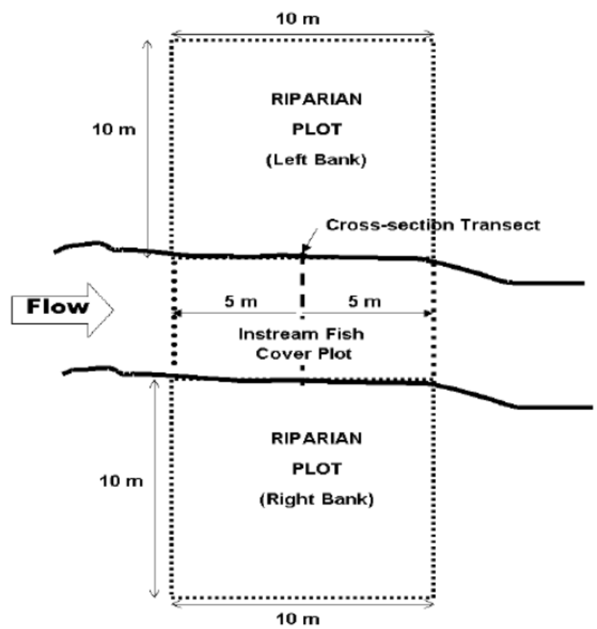


Fig. 26. 10 m X 10 m riparian plot for conducting visual riparian vegetative estimates, human impact assessments, and for conducting instream fish cover estimates.

Slope (field covariate)

Overview: Measure the change in elevation over the entire length of the sampled reach.

Method citation: USFS/BLM PACFISH/INFISH Biological Opinion Monitoring Program (Archer et al. 2012)

Methods:

Setting up the tripod and auto level

1. Determine a location to set up the auto level so that BR and TR will be visible from the same spot.
    - This is rarely possible at highly vegetated or steep reaches, so attempt to set up in a location where as much of the reach as possible is visible.
    - The most challenging part of slope is finding the best place to set up the level. Tips:
        - Sometimes vegetation removal is required but waving the rod around through vegetation can help see the rod through the level.
        - Sighting across land can be easier than trying to move up the stream.
        - It is ok to have a negative slope for a section as long as the total reach slope is positive.
2. Extend the tripod legs and firmly set into the ground. Adjust so the legs are in a regular triangle and are set so there is no wobble.
3. Place the auto level on the base plate and tighten the center screw.
4. Begin adjusting the legs of the tripod until the bubble is approximately in the center of the level.
5. Adjust the foot or fine screws until the bubble is exactly in the center of the circle.
6. Gently swivel the instrument to make sure it is level in all planes.

Taking measurements

1. Position the stadia rod at the BR, holding the bottom of the rod at the water's surface as vertical as possible with the numbers facing the auto level.
2. Sight the stadia rod through the auto level and record the reading **to the nearest 1 cm** (Fig. 27).

a. Stadia rods are 5 m in length and alternate between black and red 1 m sections.
b. Each 1 m section is broken up into 10 cm increments designated by a large number on the right side and a line that stretches all the way across the stadia rod.
c. Each 10 cm section is divided in half with "E" symbols that are 5 cm in length.
d. The top or bottom of each block or line in the "E" is 1 cm.
e. For the image below (Fig. 27) the final measurement would be recorded as 142 cm.

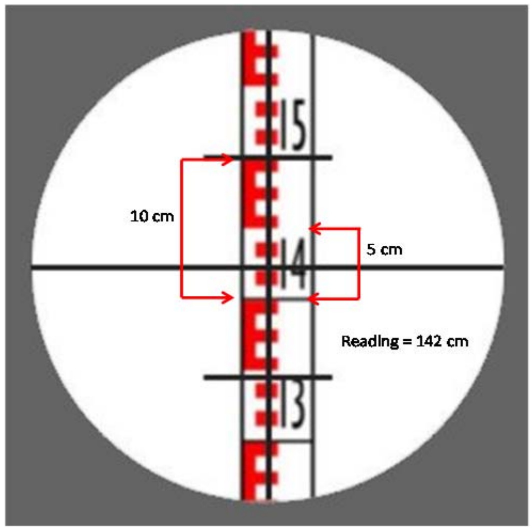


Fig. 27. Stadia rods are broken up into 10 cm sections, denoted by the large number on the right. Each 10 cm section has a large "E" that is 5 cm long. Each meter section is broken up by alternation red and black section colors.

3. Move the stadia to TR (or the farthest location that can still be seen through the level) and gently swivel the instrument (being careful to make sure the bubble stays inside the center of the level) to face the next reading.
4. Hold the stadia rod as before, vertically, with the bottom at the water level and the numbers facing the auto level.
5. Sight the stadia rod and record the reading **to the nearest 1 cm.**

6. If the TR is not visible from the first location that the level is set up at, hold the stadia rod at the last measured transect in the **exact** position as the reading before (this serves as a reference point connecting the next line of shots).
7. Move the auto level to a new position where the stadia rod can be seen as well as a new portion of the reach. Set up as before making sure the equipment is level.
8. Back sight to the stadia rod, and start the new line of measurements from that point.
9. Continue and repeat until the stadia rod is sighted at TR.
10. Repeat steps 1-9 via a second pass to get a second total change in slope.
11. Calculate the % difference between the two readings. If it is greater than 10%, conduct a third pass.
    a. $Elevation\ of\ pass\ 1\ X\ .1 = 10\%\ of\ elevation$
    b. Add and subtract the 10% from the original elevation to get the acceptable range

Special situations: Appendix B pg. 78
Side channel: See page 80
Interrupted flow: See page 78

Riparian Vegetation Estimates

Visual Riparian Estimates

Overview: Visually estimated at 11 main transects; left and right banks.

Method citation: supplemented version of the U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009).

Methods:

1. On the bank of each transect, visualize a 10 m x 10 m plot to estimate riparian vegetation cover.
    - Plot height starts at the scour line and extends 10 m back into the riparian zone.
    - Plot width extends 5 m upstream and downstream of the transect (Fig. 26).
        - On steeply sloping channel margins, estimate the distance into the riparian zone as if it were projected down from an aerial view.
2. Within this 10 m X 10 m area, conceptually divide the riparian vegetation into 3 layers:
    - Canopy layer (>5 m high)
    - Understory (0.5 to 5 m high)
    - Ground cover layer (<0.5 m high)
3. Categorize the dominant woody vegetation type for the canopy and understory layers as:
    - Deciduous – riparian (where riparian is defined as plants with a facultative-wetland or obligate wetland indicator status: http://rsgisias.crrel.usace.army.mil/NWPL/)
    - Deciduous – non-riparian
    - Coniferous (e.g., juniper, cedar, pine, fir)
    - Broadleaf evergreen (e.g., sagebrush, rhododendron, Manzanita)
    - Mixed- more than 10% of the areal coverage is made up of alternate type
4. Divide each layer into the below sub-categories
    - Canopy
        - Large trees (0.3 m [1 ft.] diameter at breast height [dbh])
        - Small trees (<0.3 m dbh)

    - Invasive/noxious woody trees and small trees*
- Understory
    - Woody shrubs and saplings
    - Non-woody vegetation
    - Sedges, rushes/bulrushes
    - Invasive/noxious herbs, grasses and forbs*
- Ground cover
    - Woody shrubs and saplings
    - Non-woody vegetation
    - Sedges, rushes/bulrushes
    - Invasive/noxious herbs, grasses and forbs*
    - Bare ground or duff

*Invasive/noxious species are minimally defined by the USEPA's list for the Western EMAP studies and include: common burdock, giant reed, cheatgrass, musk and canadian thistle, teasel, Russian-olive, leafy spurge, english ivy, reed canarygrass, Himalayan blackberry and salt cedar); however, this list should be customized and supplemented for the field office in which data is being collected.

5. Estimate the % aerial cover that each subcategory would make up of the total cover within the respective canopy, understory, or ground cover layer. Estimate the aerial cover as the amount of shadow that would be cast by a particular sub-category if the sun were directly over the plot area. Include standing dead trees as cover. Record the appropriate cover class:
    - 0=absent: zero cover
    - 1=sparse: <10%
    - 2=moderate: 10-40%
    - 3=heavy: 40-75%
    - 4=very heavy: >75%
6. The maximum cover in each layer is 100% so the sum of the aerial cover for the combined three layers could add up to 300%.
    - Ground cover is the only layer that must equal 100% coverage.
7. Repeat steps 1-6 for the opposite bank.

Special situations: Appendix B pg. 78
Side channel: See page 80

Quantitative Riparian Estimates (contingent indicator)

Overview: Estimate the relative vegetation composition along the greenline for species having 10% or more foliar cover at a minimum of 42 plots (left and right banks of all main [11] and intermediate [10] transects in addition to 19 supplemental transects).

Method citation: BLM Multiple Indicator Monitoring (Burton et al. 2011)

Methods: See Burton et al. 2011

Visual Estimates of Human Influence

Overview: Visually estimated at all main (11) transects on the left and right banks.

Method citation: supplemented version of the U.S. EPA National Rivers and Streams Assessment Protocol (USEPA 2009)

Methods:

1. At each transect visualize a 10 m x 10 m plot to estimate human influence (Fig. 27).
    a. Plot height starts at the scourline and extends 10 m back into the riparian zone.
        - On steeply sloping channel margins, estimate the distance into the riparian zone as if it were projected down from an aerial view.

    b. Plot width extends 5 m upstream and downstream of the transect.
2. Examine the channel, bank, and riparian plot area adjacent to the defined stream segment for the following human influences:
    - Walls, dikes, revetments, riprap, and dams
    - Buildings
    - Pavement/cleared lots (e.g., paved, graveled, dirt parking lot, foundation)
    - Roads or railroads
    - Inlet or outlet pipes
    - Landfills or trash (e.g., cans, bottles, trash heaps)
    - Parks or maintained lawns
    - Row crops
    - Pastures, rangeland, hay fields, or evidence of livestock
    - Logging
    - Mining (including gravel mining)
    - Hydrologic alterations (irrigation diversions, impoundments)
    - Grazing by livestock or wild horses & burros
    - Grazing exclosure
    - Recreation

3. For each type of influence, determine if it is present and what its proximity is to the stream and riparian plot area. Consider human disturbance items as present if you can see them from the cross-section transect. The same human influence may be marked present at more than one transect but **do not include them if you have to sight through another transect or its 10 m x 10 m riparian plot.**
4. For each type of influence, record the appropriate proximity class in the human influence tab. Proximity classes are:
   - ***B* (*Bank*) -** Present within the defined 10 m stream segment and located in the stream or on the stream bank.
   - ***C* (*Close*) -** Present within the 10 m x 10 m riparian plot area, but away from the bank.
   - ***P* (*Present*) -** Present, but outside the riparian plot area.
   - ***0* (*Absent*) -** Not present within or adjacent to the 10 m stream segment or the riparian plot area at the transect.
5. Repeat steps 1-4 for the opposite bank.

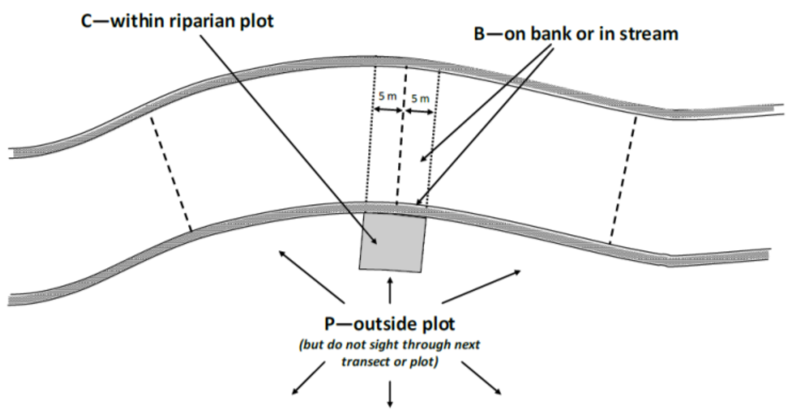


Fig. 27. Plot used for visual assessment of human influence at each of the 11 main transects.

Special situations: Appendix B pg. 78
Side channel: See page 80

Gear Decontamination

Overview: Decontaminate equipment after every reach sampled, before you leave the reach.

Methods:

1. Use a scrub brush (attached to Surber net) to remove all visible mud / organic material from boots and waders before decontamination.
2. Use the large Rubbermaid Roughtote provided to make a solution of Sparquat that is at least 4.7%. To do this, fill the Roughtote with 6 gallons of water (1 full water jerry) and add 36oz. of Sparquat (or 6oz. of Sparquat for every gallon of water).
3. Soak any gear items that have been in contact with the water for at least 10 minutes. For example waders, boots and bug nets.
4. When decontamination is complete, put the used Sparquat solution back into the labeled 7 gal Aquatainer.
    a. If possible rinse the waders, boots, and other gear with water (not from the stream).
5. Before every decontamination session, determine if the Sparquat solution may be reused. To check for potency, use the "Quat Check 1000" test strips that have been provided. When the test strip reads below 600 ppm, you need to make a new solution.
6. Discard the Sparquat solution when it is no longer effective, it will need to be discarded down a drain that flows to a treatment facility.

Appendix A. Bankfull, Incision and Scour Line Photos

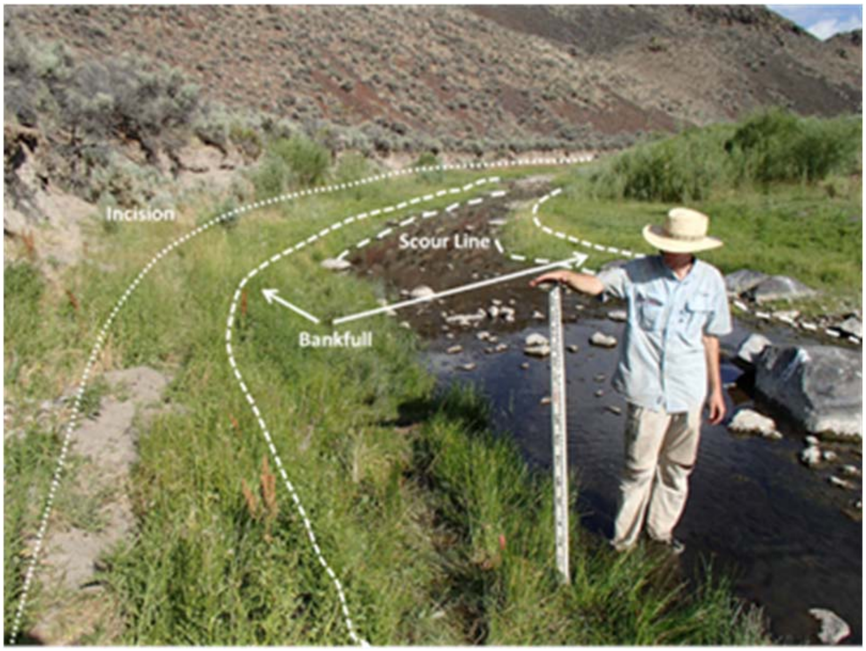


Fig. A1. Bankfull, incision, and scour line geomorphic features for a typical high desert system. Bankfull is noted by the break in slope at the lowest terrace.

Fig. A2. Incision height, bankfull, and scourline indicators for a small, high desert stream system. Bankfull height is indicated by the stainlines on rocks. Incision height is the first flat depositional feature above bankfull, where there is a drastic change in the vegetation type and a change in slope of the stream bank.

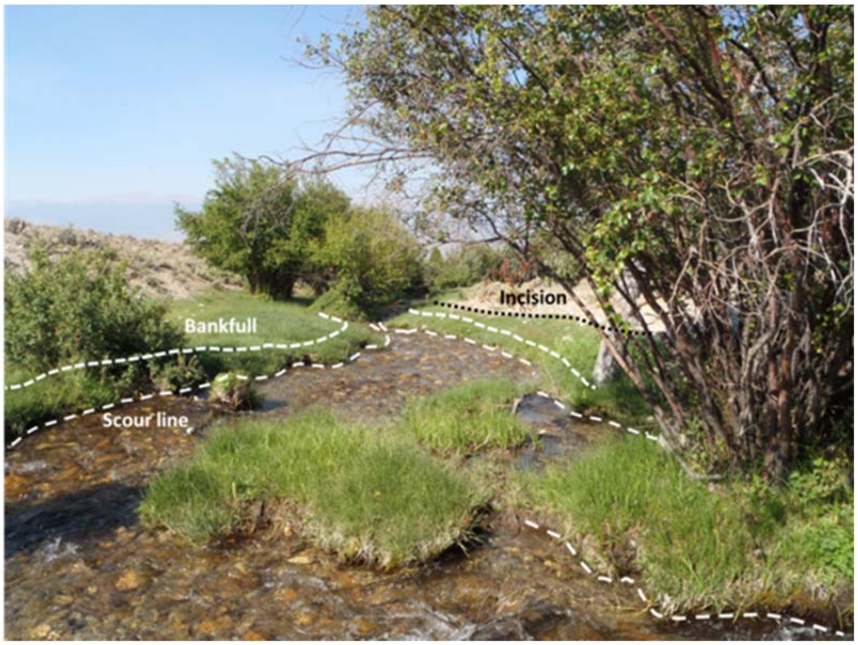


Fig. A3. Incision height, bankfull, and scourline geomorphic surfaces for spring-fed systems. Incision height is marked by the change from green vegetation to bare dirt.

Fig. A4. Incision height, bankfull, and scour line geomorphic indicators for a southwest in desert system. Incision height is demarcated by the lower limit of flood intolerant vegetation (e.g. Sagebrush).

Appendix B. Special Situations

Interrupted Flow

Overview: For streams with interrupted flow, follow the guidelines below for what to measure on a qualifying stream.

Is the reach dry? A Dry reach is defined by >50% of transects are completely dry. If possible, try sliding the reach to gather more water (see sliding the reach pg. 24).

If reach is still dry even after sliding the reach:

- Do not sample the reach, but make appropriate notes on the failed site (attempts) form:
  - Is a channel present?
  - Is there any riparian vegetation in or near the stream channel?
  - Are any other important features present in the reach (e.g. diversions, puddles, moist ground)?

Is the flow of the reach Interrupted? An interrupted reach is defined by > 50% of transects have at least puddles of water. If so, use the following guidance for setting up the reach and sampling:

- **Reach set up**- If the X-site or any of the five locations used for measurements of "typical" width are dry, use the width of the unvegetated portion of the stream bed in determining reach length.
- **Water quality-** Collect at the closest location to the X-site that has water > 10 cm deep and > 1 m^2. If no location exists, do the best you can to take the measurements and record appropriate comments about the quality of the sample.
- **Macroinvertebrates-** Do not collect at dry transects, but if enough water is present to take a bug sample, collect it. Record any appropriate comments about the quality of the sample. Always record the altered sample area if for any reason an

invertebrate sample was not taken at a transect. (e.g., two transects were dry, bugs were taken at nine transects).

- **Pool delineation**- Measure only pools that have flow, even a trickle. Do not measure stagnant pools.
- **Bankfull and incision height**- At dry transects measure the height from the edge of the unvegetated (active channel) portion of the stream bed.
- **Thalweg**- Record depths as 0 when dry.
- **Fish cover**- If the transect is dry, all fish cover is 0%.
- **Slope**- If multiple transects are dry, use the edge of the active channel (bankfull) for placement of the stadia rod instead of the water's surface.

Side Channel

Overview: Guidance for sampling a reach with a side channel present.

What is a side channel?

- **Side channel**: any channel separated directly from the main channel by an island (NOT a mid-channel bar).
    - **Island:** stream sediments within the channel with an elevation above bankfull; islands are almost always vegetated.
    - **Mid-channel bar:** stream sediments within the channel that are above current water level but below bankfull and are almost always unvegetated.
- **Minor side channel:** if the wetted channel is split by an island containing less than or equal to 15% of the total flow.
- **Major side channel:** if the wetted channel is split by an island with the side channel containing 16-49% of the total flow.

When and where to measure PHAB attributes when a side channel is present:

1. No measurements are needed on minor side channels.
2. Take the following measurements on **major side channels only:**
    - Bank width and height
    - Incision height
        - Do not use the island for the incision height measurements; use the outside bank of the main channel.
    - Bank angle and undercut distance
    - Substrate size
    - Bank stability
    - Fish cover estimates
    - Riparian and human influence estimates
        - There is a chance that side channel plots could contain water from the main channel. If there is water present, record as barren/bare dirt or duff.

- Pool delineation
    - When islands are present, only consider pools in the main channel; **don't** measure pools in side channels.
    - If a side channel is present, the pool must span at least 50% of the **main** channel's wetted width; disregard side channels width when making this determination.

Methods for setting up transects on qualifying side channels:

1. Visualize the main channel transect continuing over the island to the near bank of the side channel.
2. From the point that the transect would intersect the bank of the side channel, orient the transect so that it is perpendicular to the stream flow (Fig B1).

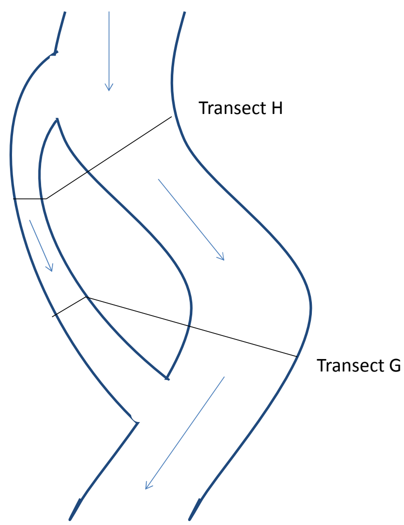


Fig. B1.. Transects are set up on side channels such that they are projected linearly across the island and turn perpendicular to the flow of the side channel.

Dry Side channel: If the side channel is dry, take no measurements and do not recognize it in the thalweg profile since it does not meet the flow requirement.

Beaver Impacted Reaches

Overview: Guidance on sampling a reach that is impacted by beaver dams.

Methods:

1. Reach set up
   a. If >50% of the transects are inundated by beaver ponds, try to slide the reach to avoid the beaver pond.
   b. If large beaver ponds exist, place transects that fall in beaver ponds perpendicular to the thalweg of the beaver pond or the pool's center if no thalweg can be located. (Fig. B2).

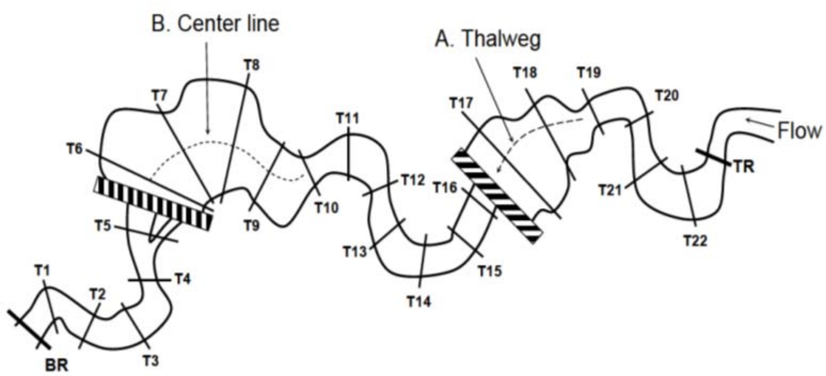


Fig. B2. (A) set up transects on a beaver impacted stream following the flow of the thalweg if visible. (B) Set up transects perpendicular to the center line of the beaver pool if the thalweg is not visible.

   c. Note which transects are impacted by beavers using the comments fields.
   d. If multiple side channels exist, follow side channel protocol above only if bed meets bank and bankfull indicators can be identified.
2. Photos
   a. Take photos of the following features such that you can see as much of the feature as possible.
      - Top of beaver pools, upstream and downstream

- The beaver dam, upstream and downstream
- Overview of each beaver pool
- Take all other photos outlined in the photo section of the protocol (pg. 33)

3. Temp probe
   a. Place at BR instead of X-site.
4. Water chemistry
   a. Measure at BR, not the X-site.
   b. If there is a beaver dam / pool at BR, measure below the dam / pool even if it is downstream from the reach.
5. Macroinvertebrates
   a. Sample beaver dams that are safe to wade and do not have deep "bottom less" fine sediments.
   b. Kick nets will frequently be used in beaver ponds as they can be very deep and have low flow.
6. Pool delineation
   a. Measure pools using the crest of the beaver dam for the pool tail. Record all pool tail depth measurements as 0 m.
   b. To define the upstream boundary of the beaver pool, look for:
      - Flowing water
      - Normal wetted width
      - Elevationally above beaver dam height
      - Normal substrate
   c. Beaver dams do not have to be actively maintained to qualify as beaver pools.
7. PHAB and overall reach assessments
   a. Note which transects are impacted by beavers and how extensive the beaver impact is but collect all other measurements as normal to the best of your ability.