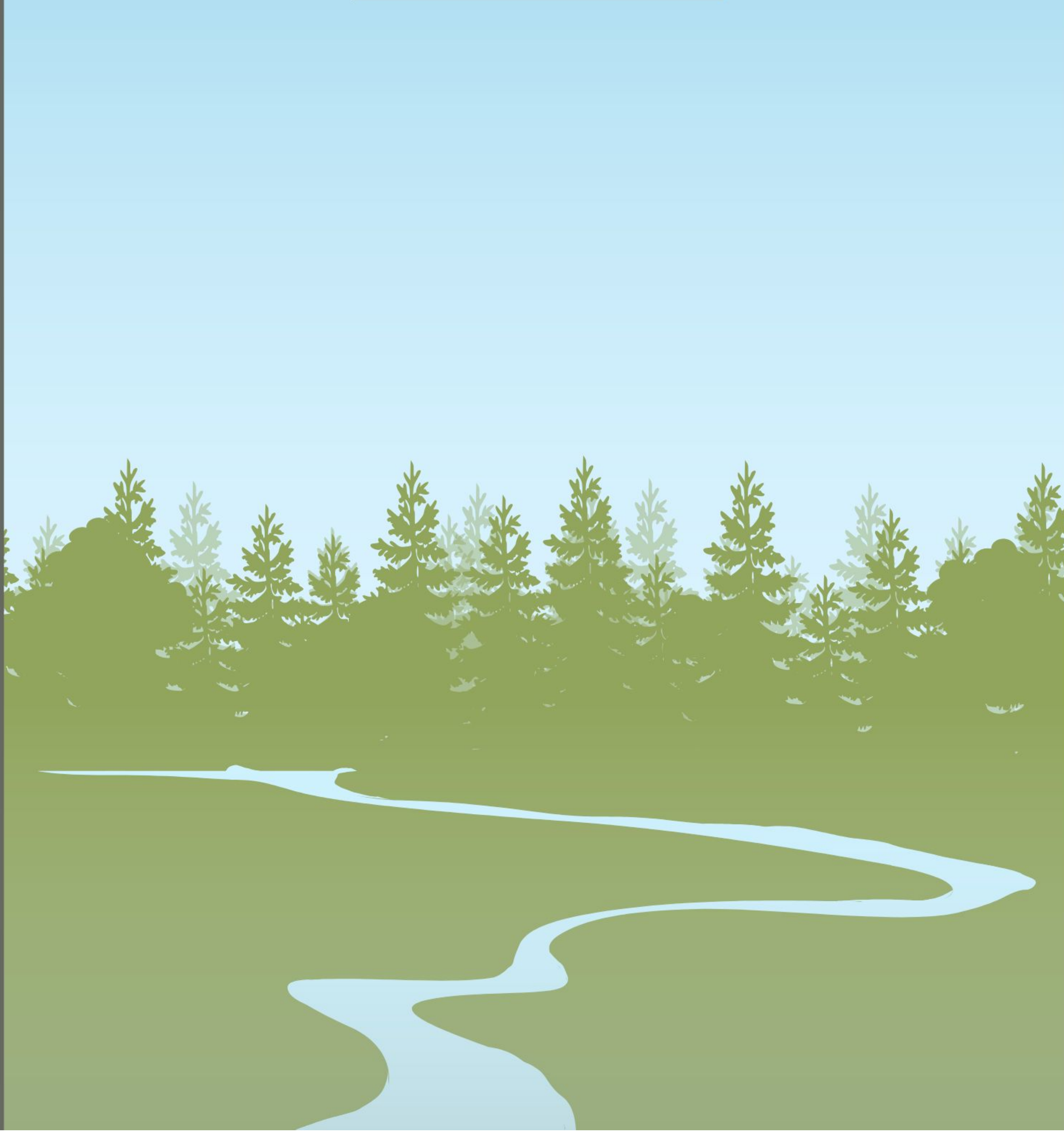
Community-Based Restoration Monitoring Protocol



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National Fish and Wildlife Foundation
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"Developing an Integrated Community-based Monitoring Approach to Track Restoration

PROJECT PARTNERS

This project would not have been possible without collaborative partners and advisors. Thank you to the many voices that contributed to this protocol.

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Alliance for the Chesapeake Bay; Dickinson College's Alliance for Aquatic Resource Monitoring; and Izaak Walton League of America.

Partners:

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AUTHORS

Primary authors:

Dickinson College's Alliance for Aquatic Resource Monitoring (Julie Vastine, Phoebe Galione); Alliance for the Chesapeake Bay (Liz Chudoba)

Secondary authors:

Stroud Water Research Center (Dave Arscott, Scott Ensign, Matthew Ehrhart, Melinda Daniels)

Contributors:

Alliance for the Chesapeake Bay and National Fish and Wildlife Foundation

Illustrator:

Phoebe Galione, Dickinson College's Alliance for Aquatic Resource Monitoring

INTRODUCTION

As jurisdictions continue to increase restoration efforts to achieve pollution reduction goals, it is essential to observe and collect data on projects to ensure their long-term success. Monitoring restoration project health and status can take many forms, from the indicators evaluated, to the diverse players collecting the data. With these questions in mind, it became clear there was a need to develop a standardized protocol to document observed changes resulting from the installed BMPS.

Project Background

In 2021, the National Fish and Wildlife Foundation (NFWF), partnered with the Chesapeake Monitoring Cooperative (CMC) and Stroud Water Research Center (Stroud) to develop a watershed-wide integrated community-based monitoring plan aimed at tracking changes in stream health conditions as a result of restoration projects implemented through NFWF's Chesapeake Bay Stewardship Fund (CBSF). Developing a consistent watershed-wide monitoring method not only meets NFWF's goals, but enhances the ability for diverse partners like local watershed groups, landowners, localities, and conservation districts to utilize the data and highlight the success of this investment.

This protocol uses four components to assess restoration site status: visual-physical assessment, physical water quality indicators, biological water quality indicators (benthic macroinvertebrates), and photos. Integrating this data will help the NFWF and CMC teams determine the status of restoration projects and assess whether site follow up or additional maintenance is required.

The monitoring team for this project includes three CMC partner organizations (CMC Team) the Alliance for the Chesapeake Bay (Alliance), Dickinson College's Alliance for Aquatic Resource Monitoring (ALLARM), and the Izaak Walton League of America (IWLA) who work with organizations funded through the CBSF to select sites and conduct the monitoring activities across the Chesapeake Bay watershed. Stroud Water Research Center provides scientific oversight of the program and data analysis.

ALLIANCE for the Chesapeake Bay

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

STROUD WATER RESEARCH CENTER

Alliance for Aquatic Resource Monitoring ALLARM est. 1986

Dickinson

IZAAK WALTON LEAGUE OF AMERICA 1922 - 2022

Project Overview

The outcome of this project is to engage volunteer monitors in collecting data to help assess the status of National Fish and Wildlife Foundation stream restoration sites (up to 2 years before implementation and up to 5 years after implementation). Specifically, this protocol aims to collect data in relationship to ten best BMPs that fall within four major categories:

1. Riparian buffers
2. Stream restoration (bank stabilization and floodplain reconnection)
3. Cattle fencing
4. Dirt and gravel roads (erosion and sediment control)

Monitoring restoration status and impact can take many forms ranging from the indicators evaluated to the diverse players collecting the data. It is important to acknowledge that measuring ecological lift can be difficult due to the lag times and complex variables across restoration sites.

This monitoring protocol has three goals:

1. Use biological, chemical, physical, and visual indicators to assess restoration project status and water quality impacts over time.
2. Educate and engage community members and community-based monitoring partners about Bay restoration activities and impacts.
3. Contribute to long-term water quality data collection and stream health understanding.

Data collected at the restoration location will be compiled into a site report to be shared with the landowner, project partners, and NFWF. Data will be used to inform maintenance needs to determine whether the BMPs continue to have the intended geomorphological and biological impact over time. Additionally, data will be used to develop standardized restoration case studies that NFWF can use to track projects.

SITE SELECTION AND SET UP

Annually, the NFWF team will select a subset of approved grant applications with planned stream restoration, forest buffer, cattle exclusion, or dirt and gravel road improvement projects that may be suitable for monitoring. From that subset list of approved grant applications, the CMC team will work with on-the-ground Project Partners (NFWF Grantee or applicable Project Manager) to obtain and review site plans, fill out the background information, and conduct initial site visits to determine which projects/sites within each NFWF Grant are viable for monitoring (if more than one project is planned). The monitoring team will fill out the Project Documentation Form to identify which projects/sites within each grant are included in this monitoring protocol.

The Project Documentation Form will be submitted to NFWF prior to the start of monitoring activities and will indicate that a project is covered by the Quality Assurance Project Plan (QAPP) Community-based Restoration Monitoring to Track Progress of Restoration Projects implemented through the NFWF Chesapeake Bay Stewardship Fund (approved 11/13/23). Only projects that follow this protocol exactly will be covered by the approved Project QAPP. If any additional monitoring is planned on site, a separate NFWF QAPP will be required and may include elements from this project.

Site selection criteria

In order to be considered for monitoring activities, sites **must**:

1. Have a planned forest buffer, stream restoration, cattle fencing project, or gravel road improvements.
2. Be located on a 1-3 order perennial stream (1^{st} order streams are preferable).
3. Have at least 100 meters of stream receiving treatment from the proposed project (except dirt/gravel roads).
4. Be safe, accessible, and wadable along the entire assessment reach (100m).
5. Have a landowner(s) willing to allow access to the site for at least 6 years.

Additional considerations to prioritize projects, if more than one project is being implemented within a grant:

1. Priority should be given to sites where additional structural or non-structural BMPs are being installed. All BMP's do not have to have NFWF funding to be included in the prioritization.
2. Priority should be given to sites with smaller upstream watersheds and watersheds that share multiple sites.
3. Dams, bridges, and other build infrastructure (e.g. exposed sewer pipelines) in the area should be considered and not included within the stream reach.

Background Information

The CMC team will gather background information for each project site selected. This can be done using the watershed delineation feature of Geographic Information Systems (GIS), Model My Watershed, EPA Freshwater Explorer, or How's My Waterway. The CMC team will fill out the first page of the Site Background Template with all relevant background information (see Site Background Instructions).

Figure 1. Stuart Park Site Reach. Image credit: Trout Unlimited

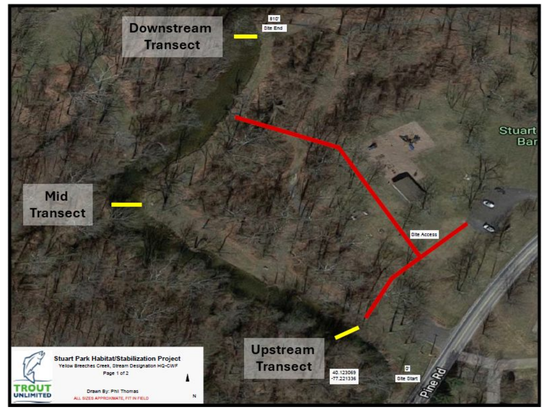


Figure 2. Establishing the three transects. Image credit: Trout Unlimited, with ALLARM modifications

Site Visit and Assessment Setup

The CMC team will conduct an initial site visit with the Project Partner to determine if the site is viable for monitoring and identify the monitoring assessment reach within the proposed project area. The monitoring team will fill out the second page of the Site Background Template to document the decisions made in the field.

1. Determine if the site is safe, accessible, and wadable along the entire assessment reach. Consideration for parking, stream access, electric fencing, and any access restrictions should be well documented.
2. Determine the length of the assessment reach based on stream order.
   Order 1 = 30m Order 2 = 60m Order 3 = 90m
3. Determine the location of the assessment reach within the proposed project area. If the project area is larger than 100m, the reach should be located at the most downstream area of the project. Additional considerations:
   a. The entire assessment reach should end or start at least 10m upstream or 20m downstream of a bridge so that no part of the reach is touching or being crossed by a bridge.
   b. The reach should be at least 10m downstream of a dam so that no part of the reach is touching or being crossed by a dam. Dams must be less than 2ft wide. If a site contains larger dams, it may not be suitable for this protocol. Ideally, a dam will not be near the monitoring site, as the dam effects will override any restoration impact other than riparian vegetation.
   c. If the project involves a dirt and gravel road BMP, the entire monitoring reach must be downstream of the BMP.

4. Identify three transect locations along the 30, 60, or 90-meter reach evenly distributed across the reach at the start, middle, and end points. Keep in mind safety and representative characteristics of the stream, and adjust the exact location of the transect accordingly.
    a. Transect considerations:
        i. The three transects should represent different characteristics present throughout the stream reach (e.g. riffles, runs, shallow areas, and deep areas).
        ii. Water should be wadable across the entire transect (e.g. you can touch the bottom with your hand to pick up rocks). Avoid deep pools.
        iii. The banks must be accessible on both sides of the transect. Avoid areas with large over-hanging vegetation (e.g. shrubs, trees, vines) that reduce access if there is a clear area close by.
        iv. Consider clearly defined natural markers (e.g. trees, fence posts, etc) to make the transect easy to identify.
    b. Place permanent reference markers at each transect location (pink flags or flagging tape labeled with the transect identifier).
        i. If there are trees/shrubs on site place pink flagging tape on the tree/shrub at the transect location.
        ii. If there is no vegetation prior to restoration, place pink flags in the ground on the bank. After the restoration practice is installed, mark the tree tubes with flagging tape.
    c. Record latitude/longitude coordinates for each transect in decimal degrees (you can use the GPS on your phone), on which bank the merker is located and any visual reference markers for each transect on the Site Background sheet.

Figure 3. Setting up a transect. Photo credit: ALLARM

5. Identify the standard photo locations (25%, 50%, and 75% of the reach length).
    a. Place yellow flagging tape reference markers using the same techniques as the transects at the 25% and 75% reach length locations.
    b. Record specific instructions on the Site Background form for where the photos are taken (ie. 7.5 m upstream of the first transect marker on the left bank). Refer to the previous standardized photos found printed in the site binder.
    c. The 25% and 75% points are taken from the stream bank, so select the bank that is easiest to access and produces the most unobstructed photos.
6. Measure bankfull width in meters at each transect. Determine riparian zone transect length in meters based on bankfull width at each transect (round to the nearest meter).
7. Determine macroinvertebrate collection approach (muddy or rocky bottom). Use the Muddy Bottom vs. Rocky Bottom Decision Tree. *There are a limited number of sites where macroinvertebrates will be collected and analyzed by a laboratory to the family level. All other sites will use either the EPA Volunteer Monitoring or Virginia Save Our Streams order level protocol.*

Landowner Expectations

This monitoring requires site access for a minimum of six years, and in some cases, monitoring may occur for seven years (two years prior to the restoration and five years after). It is important to set up communication expectations so that the landowner knows when the monitoring team (including volunteers) will be visiting the site. The Project Partner will be responsible for working with each landowner to ensure they understand the expectations and timelines for monitoring. Project Partners will give each landowner the Community-Based Restoration Landowner Packet to ensure they understand the requirements.

The landowner must sign a Landowner Expectation Agreement prior to the start of monitoring activities. It is also recommended that the names of the people who will be on site, if known, be shared with the landowner.

Once monitoring is established on site, the monitoring team can take over communications with the landowner to coordinate and schedule monitoring visits. The Project Partner is responsible for sending a reminder to the landowner within one week of the monitoring date to ensure they turn off electric fences, unlock gates, and relocated farm animals away from the section of stream being monitored.

Assessment Teams

It is recommended that an assessment team consists of 4-6 people and may contain a combination of CMC staff, NFWF grantee staff, and volunteers. CMC staff provide quality assurance and monitoring oversight of all data collected. Any additional monitors who participate (grantee staff or volunteers) must complete the following steps to become certified:

1. Attend the program orientation (virtual or in-person).
2. Attend a protocol training workshop (virtual or in-person). Volunteers will be provided with all of the necessary equipment at the training workshop.
3. Attend a monitoring day for field training.

For sites located on a farm, CMC staff will provide a brief Farm 101 training to educate monitors on the best practices for being on site. This is to make sure everyone is respectful of the site and ensures the safety of all participants.

Figure 4. Stuart Park assessment crew. Photo credit: ALLARM

Annually, monitors will attend a refresher course to review program materials and any site-specific requirements to make sure they are up to date. CMC staff will work with the NFWF grantee organization and local partners to recruit and train monitors as needed.

MONITORING COMPONENTS AND FREQUENCY

The visual-physical assessment, physical water quality indicators, and photos are always assessed together in the spring (March – May) and/or fall (September – October) following the monitoring frequency in **Table 1**. At least one survey is conducted prior to restoration and can occur in the same season as installation. However, ideally two surveys are conducted in the spring and fall prior to restoration. Post-restoration surveys start the season after implementation and occur every spring and fall for 2 years. After two years, surveys are conducted once a year in either the spring or fall.

Benthic macroinvertebrate samples are collected in the spring following the monitoring frequency in **Table 1**. At least one sample is collected prior to restoration and can occur in the same season as spring installations. Post-restoration samples are collected after installation and then every other year thereafter. *Note: For practices installed in the spring, the first post-restoration benthic sample is collected 1 year later*.

Table 1: Monitoring frequency overview

Monitoring Type	Pre-Restoration (up to 2 years prior)	Post-Restoration (Year 1 and 2 after install)	Post-Restoration (Years 3-5 after install)
• Visual-physical assessment • Physical water quality indicators • Photos	Minimum 1 survey before installation (spring or fall) Can occur the same season the installation occurs	Twice annually (spring and fall), starting the season after implementation	Once annually (spring or fall, depending on when the installation occurs)
Benthic macroinvertebrates	Minimum 1 sample before installation (spring). Can occur the same season the installation occurs	Once (spring) in Year 1 after installation	Every other year (spring) in Years 3 and 5 after installation

Site Arrival and Set Up

Before arriving to the monitoring site, review all of the site paperwork to familiarize yourself with the project logistics, such as where to park and how to access the sampling reach.

When you arrive on site, do not walk directly across the transect lines during setup. Then:

1. Locate the transect reference markers (pink flags) and confirm the latitude / longitude coordinates of each transect location. ***Note:*** *If a marker is missing, use the coordinates to find the transect location and replace the marker.*
2. Assess stream crossings and entry points along the reach.
3. Check the photo location reference markers (yellow flags). Replace any missing markers.
4. Assess the benthic sample collection locations along the reach (spring only).
5. Plan your monitoring approach. Monitors can split into teams, if needed.

Example Monitoring Approach - may vary spending on site and monitoring team.

1. Begin at the downstream transect.
   a. Measure air temperature first, then water temperature, and then turbidity. ***Note:*** *Measure turbidity before the sediment is disturbed by macroinvertebrate collection and cross-section observations.*
   b. Collect the benthic macroinvertebrate sample below the first transect (spring only). If you have enough monitors, split into two teams.
   c. Collect all other the measurements following the order on the datasheet.
2. Move to the photo reference marker between the downstream and midstream transects. Take two stream reach photos (downstream and upstream).
3. Move to the midstream transect.
   a. Collect the measurements following the order on the datasheet.
   b. Take midstream reach photo.
4. Move to the photo reference marker between the midstream and upstream transects. Take the two stream reach photos (downstream and upstream).
5. Move to the upstream transect. Measure the water temperature. Collect the measurements following the order on the datasheet.

Figure 5. Monitoring at a flagged transect. Photo credit: ALLARM

In-Stream Measurements

AIR AND WATER TEMPERATURE

Temperature is an important water quality indicator as it affects both the biological and physical characteristics of an ecosystem. When the sun heats shallow freshwater streams, warmer water temperature stimulates growth, reproduction, and decomposition of plants and animals in the stream. Warmer water hold less oxygen, which is needed to sustain aquatic animals.

Air and water temperature are measured using a Hanna Digital Thermometer and recorded in degrees Celsius (°C).

Air Temperature is measured at the downstream transect (before water temperature):

1. Find a place near the downstream transect out of direct sunlight.
2. Hold the thermometer by the white plastic cover and wait for the temperature reading to stabilize.
3. Record the temperature in Celsius to the nearest 0.1 °C on your datasheet.

Water Temperature is measured at the downstream and upstream transects:

1. Enter the stream above or below the transect and move to the middle of the stream.
2. Place the tip of the thermometer beneath the surface of the water. Do not submerge the display! See Figure 6. Allow the water temperature reading to stabilize.
3. Record the temperature in Celsius to the nearest 0.1 °C on your datasheet.
4. Measure the replicate:
   a. Remove the thermometer from the stream and wait 30 seconds.
   b. Place the thermometer back into the water. Allow the reading to stabilize.
   c. Record the replicate value.
   d. The two replicate values must be within ± 0.5 °C of each other. If the values are outside the range, measure additional replicates until values are within the range (see example below).

Figure 6. Water temperature reading. Photo credit: Alliance

Example Temperature Measurements	Replicate #1	Replicate #2	Replicate #3
	13.1 °C	~~13.8 °C~~	13.2 °C

WATER CLARITY

Water clarity, or transparency, is a measure of how much light passes through water – a function of light that is scattered by particles and absorbed by dissolved substances. These particles reduce the depth that sunlight can penetrate a stream and affect the growth of aquatic plants. Very high concentrations of fine sediment can also be detrimental to fish and macroinvertebrates.

Water clarity is measured using a turbidity tube and recorded in centimeters (cm).

Water clarity is measured at the downstream transect (before benthic sample collection):

Rinse the Equipment

1. Move to the center of the waterway just below the downstream transect.
2. Rise the transparency tube 3 times with water: face upstream, hold the tube horizontally in the middle of the stream at mid-depth, and allow the tube to fill and rinse all sides.
3. Empty the rinse water downstream.

Measure Water Clarity

1. Close the small drain tube by squeezing the crimp, if you are using one with a drain tube.
2. Hold the tube horizontally in the middle of the stream at mid-depth, and allow the tube to fill with water.
3. When the tube is full, lift it out of the water, and carefully exit the stream.
4. Stand with your back to the sun so the tube is shaded. Remove sunglasses, if wearing.
5. Look straight down through the opening of the tube. If the secchi disk is visible (you see two white and two black triangles), record the water level as > 60 cm on your datasheet.
6. If you cannot see the secchi disk, open the drain clamp to drain the sample slowly or if your turbidity tube has a buttoned bottom instead, press the tube down on the ground to open bottom to let the water out. When the secchi disk faintly appears, immediately close the clamp or stop pressing down on the turbidity tube.
7. Read the scale on the side of the tube and record the water level on your datasheet.

Measure the Replicate

1. Swirl the transparency tube to resuspend any settled sediment and then pour the water out of the tube. Repeat the above section “Measure Water Clarity” for replicate #2.
2. The values of the two replicates must be within ± 10 cm of each other. If the values are outside of the range, measure additional replicates until two values are within the range.

Clean Up

Empty the water from the transparency tube. Rinse the tube to remove any sediment.

Example Water Clarity Measurements	Replicate #1	Replicate #2	Replicate #3
	55 cm	43 cm	54 cm

Channel Geometry Measurements

Collectively, changes in **bank height**, **bankfull width**, and **bank angle** can reflect the adjustment of the stream to changes in hydrology, sediment load, and vegetation on the stream banks. Restoration practices that reduce intense storm runoff and reduce sediment load may, over the course of many years, lead to a shallow, wider, and less rapidly migrating stream channel. It is difficult to interpret stream dynamics, watershed impacts, or the influence of restoration from any one of these three metrics by itself.

Measure **bank height**, **bankfull width**, **bank angle**, and **wetted width** at the left and right back of the stream at each transect.

These measurements can be taken within 4 meters (2 meters of each side of transect) at the most representative spot along the bank.

Materials Needed:

- Protractor
- Measuring tape
- Level
- (3) Gage sticks (carry upright to avoid accidentally hitting other people)

Figure 7. Gage sticks, protractor, and measuring tape. Photo credit: Alliance

Monitoring Tips:

- Begin at the downstream transect and work your way upstream.
- When wading across the stream, do not disturb the potential cross-section points where you will observe the substrate.
- All channel geometry measurements (i.e. bank height, bank angle, etc.) can be measured together at a transect before moving to the next one.

BANK HEIGHT

Bank height is the point along the stream bank where a rising stream would expand beyond its channel into the floodplain. Bank height may be different at each side of the stream.

1. Stand the gage stick on the stream bed at the base of the bank so that it stands completely vertical. Be careful to not let the gage stick sink into the streambed.
    a. If the bank is sloped (Example 1, Figure 8): use the second gage stick and level to create a flat expansion from the top of the bank until it meets the first gage stick.
    b. If the bank is vertical (Example 2, Figure 8) or undercut (Example 3, Figure 8): read the measurement on the gage stick where it touches the top of the bank.
    c. If the bank is taller than the gage stick, use the measuring tape instead.
2. Record the measurement in meters on your datasheet.

Example 1: Sloped Bank **Example 2:** Vertical Bank **Example 3:** Undercut Bank

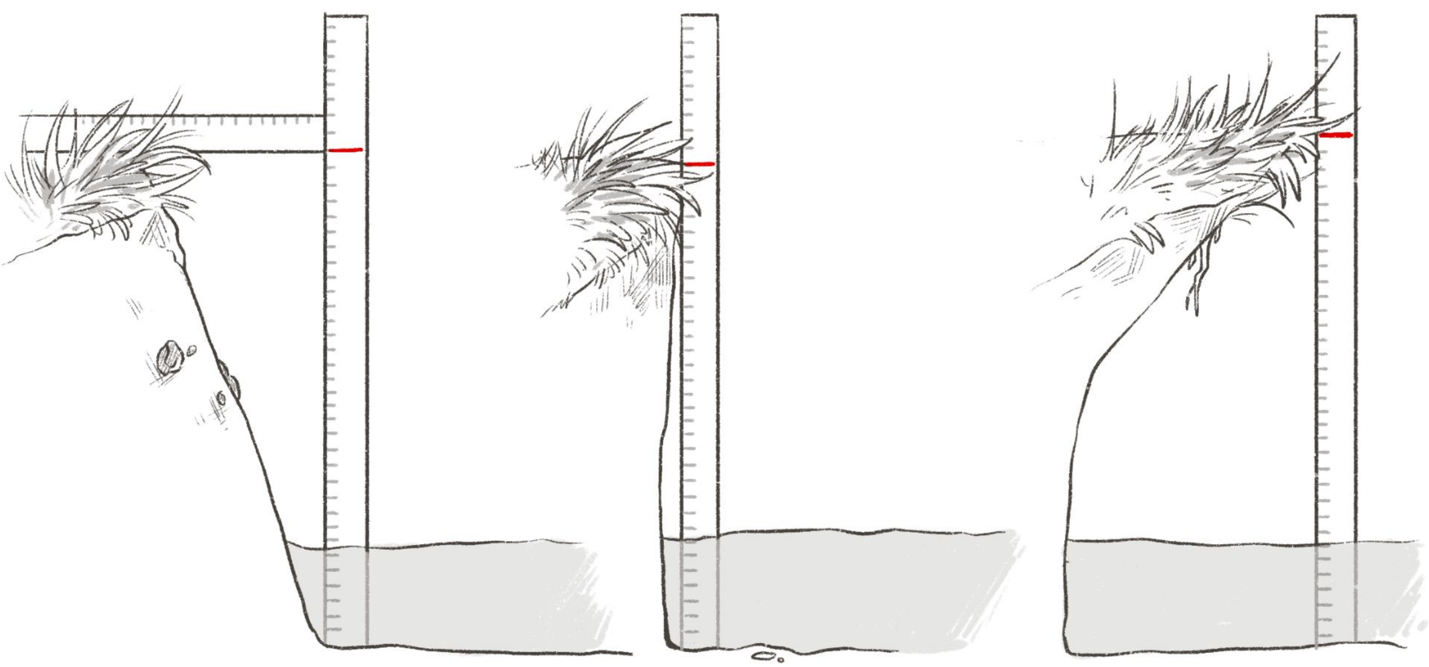


Figure 8. Measuring the bank height using a gage stick. Image credit: ALLARM

BANK ANGLE

Bank angle is the angle of the bank relative to the stream.

Monitoring Tips:

- If the bank is undercut, the bank angle will be **<** 90°.
- If the bank is set back, the bank angle will be **>** 90°.
- Looking at bank height, measure the bank angle that represents the majority of the bank.
- You may split into two teams to measure both banks at the same time.

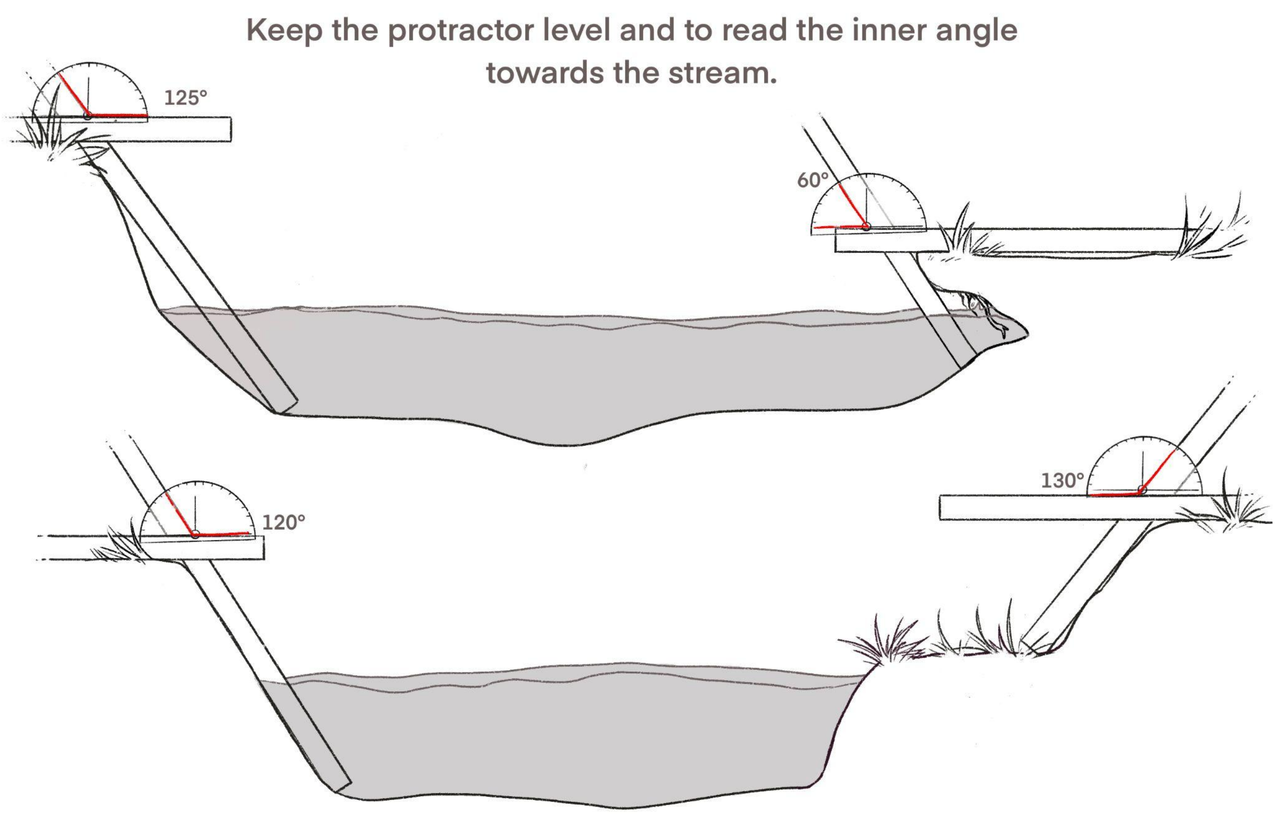


Figure 9. Using a gage stick and protractor to determine bank angle. Image credit: ALLARM

1. Place the gage stick so that it rests on the entire bank, touching as much of the bank as possible. Long grasses and plants may need to be pushed to the side.
   a. For severely undercut banks: Place the bottom of the gage stick at the base of the undercut (avoid placing it on the rising back wall) and rest the top of the gage stick against the edge of the overhanging bank. Measure the angle (Figure 9).
2. Place the second gage stick with the level attached horizontal on the ground at the top of the bank.
3. Face downstream and align the protractor where the two gage sticks meet. Keep the center point (vertex) on the streamside edge of the gage stick.
4. Read the angle on the streamside of the protractor and record it on your datasheet.

BANKFULL WIDTH

Bankfull width is the distance between the two banks from the point at which the channel, if full of water, would spill out over one or both banks. There are many field indicators of bankfull, including: change in bank slope (top of the stream bank), vegetation changes, and scour features.

1. Check your bank height measurements to determine which bank (left or right) is shorter.
2. Place the tape measure on top of the shorter bank at the same location where bank height was measured.
3. Stretch the tape across the stream to the other bank, making sure the tape is level and above the water. The tape may touch the second bank well below bank height, however it should be at the same location where bank height was measured. Consider the following scenarios:
    a. Left and right banks are even (Figure 11): Measure the distance from the top of the left bank to the top of the right bank.
    b. One bank is lower than the other bank (Figures 10 and 12): Measure the distance from the height of the lower bank to the same spot on the higher bank.
    c. There is a step on one or both banks (Figure 13): Measure the distance from the top of the true bank, not at the step.
    d. The stream is within a ravine or has no floodplain (Figure 14): Look for field indicators, such as flood debris, an absence of soil, or vegetation changes to determine bankfull. The bankfull may be just below the line where:
        i. flood debris ends
        ii. plant communities change from one kind to another
        iii. the soil was eroded and the bank scoured away
4. Record the bankfull width distance in meters on your datasheet.

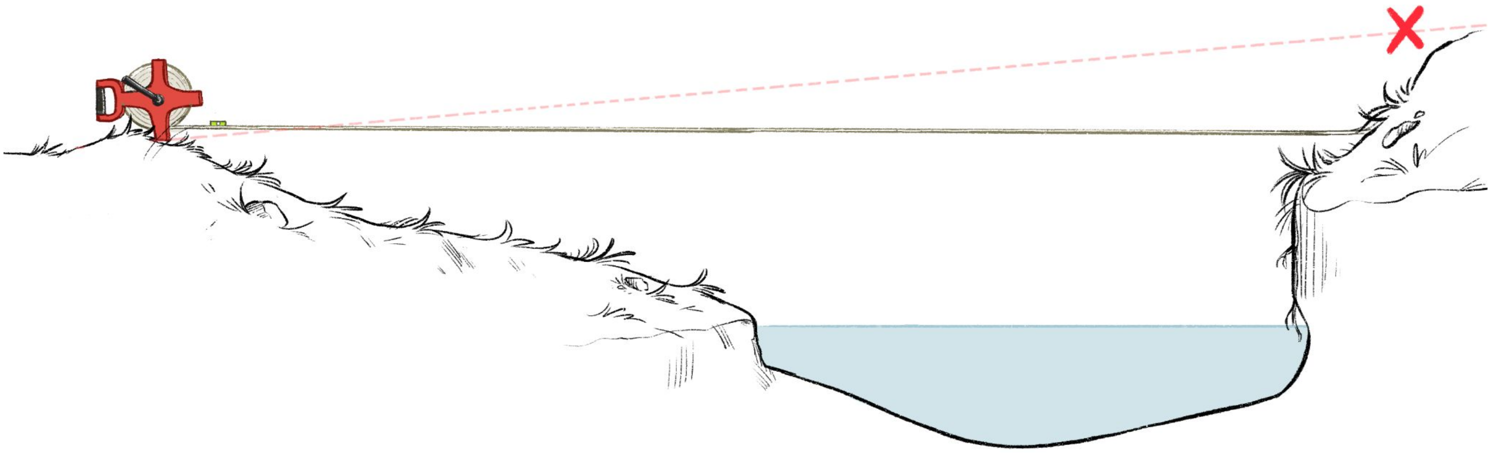


Figure 10. Measure bankfull width across the channel from the bank that is lowest, keeping the tape measure level. Look for where water would spill over into the floodplain and place the measure tape at that point. Image credit: ALLARM

EXAMPLE BANKFULL WIDTHS UNDER DIFFERENCE BANK CONDITIONS

You may find that the stream you are assessing does not match any of these scenarios. Remember that bankfull height is always measured in reference to the start bank and that the "bank" may be a distance away from where the water is actively flowing.

Monitoring Tips:

- It may be helpful to reference the bankfull widths and cross-section diagrams from previous monitoring events.
- Keep the measuring tape above the water at all times. The current will pull the tape away if it is in the water, making it difficult to measure the bankfull width.
- Wade across the stream downstream from where you will be measuring depth, substrate, and periphyton so you do not disturb the substrate in the sampling area.

Level Banks

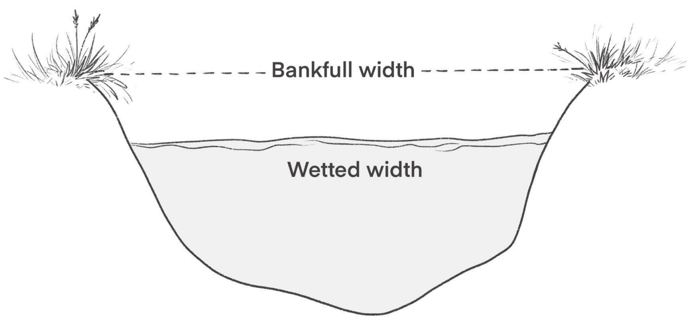


Figure 11. Measuring bankfull from the top of the stream bank on each side. Image credit: ALLARM

Uneven Banks

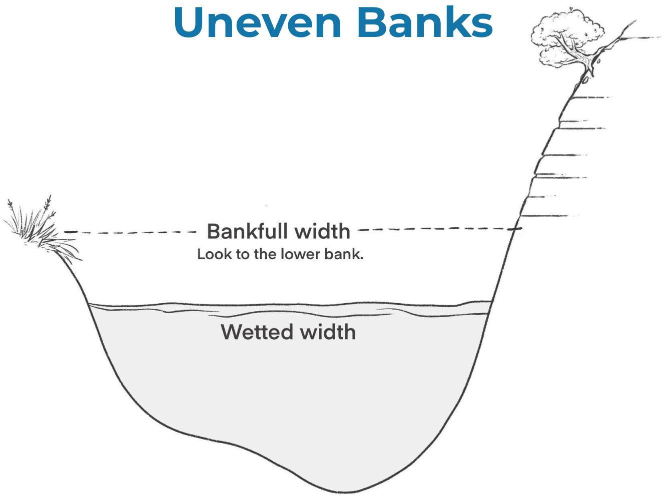


Figure 12. Using the lower bank as the reference for bankfull. Image credit: ALLARM

Step Banks

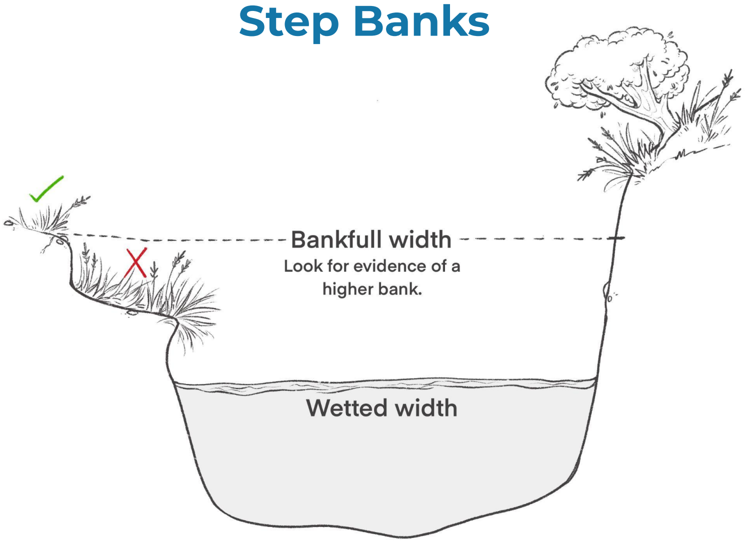


Figure 13. Measuring bankfull at the top of the bank steps/bench. Image credit: ALLARM

"Ravine" Banks

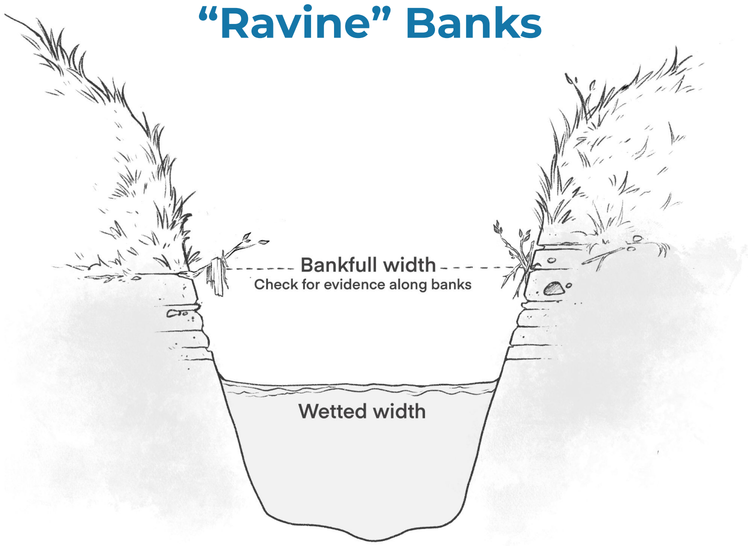


Figure 14. Use depositional and vegetation indicators (i.e. absence of soil, flood debris, etc.) to determine bankfull. Occasionally seen in first-order streams. Image credit: ALLARM

WETTED WIDTH

Wetted width is the distance from the water's edge on the left bank to the water's edge on the right bank.

Wetted width is measured using a tape measure and recorded in meters.

1. Place the tape measure at the water's edge.
2. Stretch the tape across the stream to the water's edge at other bank, making sure the tape is level and above the water.
3. Read the distance in meters on your datasheet.

Cross-Section Measurements

CROSS-SECTION POINTS

You will measure water depth, substrate, and periphyton at three points along the transect. Use the wetted width distance to determine the 25%, 50%, and 75% measurement points from the left bank (the left bank is on the left when facing downstream).

Figure 15. Marking the cross-section points. Photo credit: ALLARM

Example (Figure 15): If the wetted width is 3.6 meters:

- 25% measurement point = 0.9 m from the left bank
- 50% measurement point = 1.8 m from the left bank (mid-channel)
- 75% measurement point = 2.7 m from the left bank

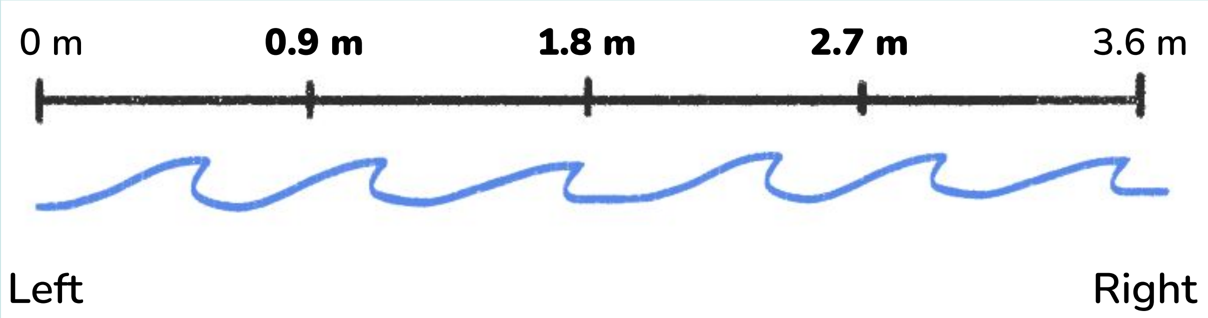


Figure 16. Example of wetted width measurement locations. Image credit: ALLARM

WATER DEPTH

Water depth is the distance from the stream bed to the water surface. Water depth is measured using a gage stick and recorded in centimeters.

1. Place the gage stick on the streambed and turn the calibrated side of the stick **downstream**.
2. Read and record the water depth in centimeters on your datasheet.

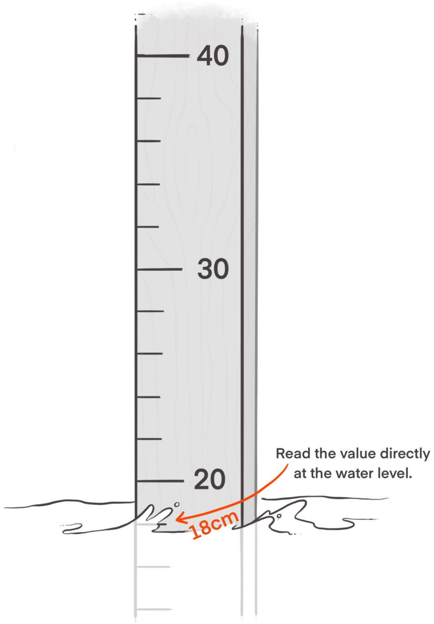


Figure 17. Recording water depth. Image credit: ALLARM

Monitoring Tips:

- Measure water depth at three points along the transect: 25%, 50%, and 75% of the wetted width.
- It is acceptable to record the water depth as 0 m if the measurement point falls on a sediment deposit, such as a sandbar or island, in the stream.

Stream Viewer Measurements

A stream viewer is tool that allows us to break the water surface and see the stream bed underwater (Figure 18). A stream viewer is used to measure:

- Substrate - size and composition
- Periphyton - coverage and thickness
- Embeddedness - amount of fine sediment settled on the streambed.

See Figure 19 for examples of these parameters.


Figure 18. Using stream viewers at 3 cross-section points along a transect. Photo credit: ALLARM

Monitoring Tips:

- Use the stream viewers at three points along the transect: 25%, 50%, and 75% of the wetted width.
- If the stream is not wide enough to make three measurements without the stream viewers overlapping, make the measurement at the 50% point and then move upstream or downstream for the 25% and 75% measurements. Be sure to note this on the site diagram.
- A team of two should work together to crowdsource measurements.

FIND THE STREAM VIEWER LOCATION

1. Center the stream viewer over the point where you measured water depth.
2. Look through the stream viewer and note if there are any obstructions (i.e. large woody debris, leaf pack, rooted aquatic plants). Do NOT remove any obstructions. If an obstruction exists, follow these steps to determine where to collect your observations:
    a. If aquatic plants are present: gently redirect them (do not remove) away from the stream viewer area to get a clear view of the substrate. If you can successfully clear the viewer window, collect the observations as directed.
    b. If there is an obstruction that cannot be redirected: move the stream viewer to an adjacent, undisturbed area (typically upstream or sideways direction) as close to the original location as possible. Collect the observations as directed and note on your datasheet that the stream viewer was moved.
    c. If you cannot find an area in close proximity to the obstruction: choose the location that is the least obstructed. Collect the observations as directed and record the percentage of the obstructed view as part of the total percentage (e.g. 50% obstructed, 10% gravel, 20% silt, 20% sand).
    d. If you cannot find an area without an obstruction (i.e. if the entire left side of the stream is covered with macrophytes): record "not possible to measure due to obstruction" on your datasheet.
    e. If the water is too cloudy or dark to see the streambed with or without the stream viewer: use your hands to feel the bottom of the streambed to estimate substrate measurements. Make a note on your datasheet that you cannot see the bottom of the stream in the Comments, Challenges, and Other Notable Observations section located on the first page.

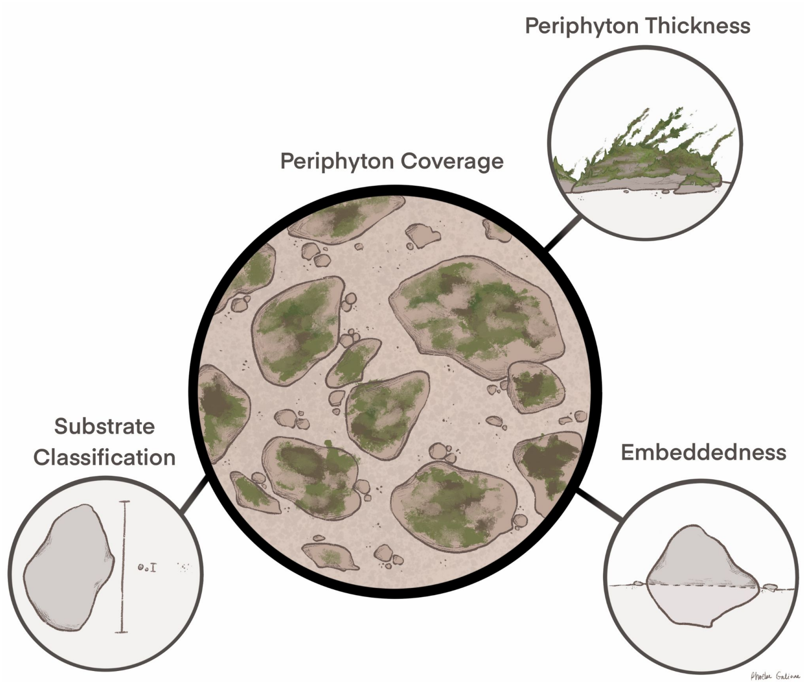


Figure 19. An example of using the stream viewer to obtain substrate size and type, embeddedness, and periphyton thickness and coverage. Image credit: ALLARM

TAKE PHOTOS THROUGH THE STREAM VIEWERS

1. Rest the camera on the top edge of the stream viewer so the lens is centered in the middle of the window and the entire streambed is visible through the camera.
2. Make sure the camera is focused on the streambed. Let the view fill most of the screen. It can be helpful to cover the stream viewer with a jacket or paper to reduce the glare.
3. Name the photo using the following nomenclature:

Nomenclature for Stream Viewer Photos

Stream Viewer	SV		
Transect Location	Up (upstream)	Mid (midstream)	Down (downstream)
Cross-section Marker	25%	50%	75%

Example: SVDown25
(stream viewer photo, at downstream transect, 25% along wetted width)

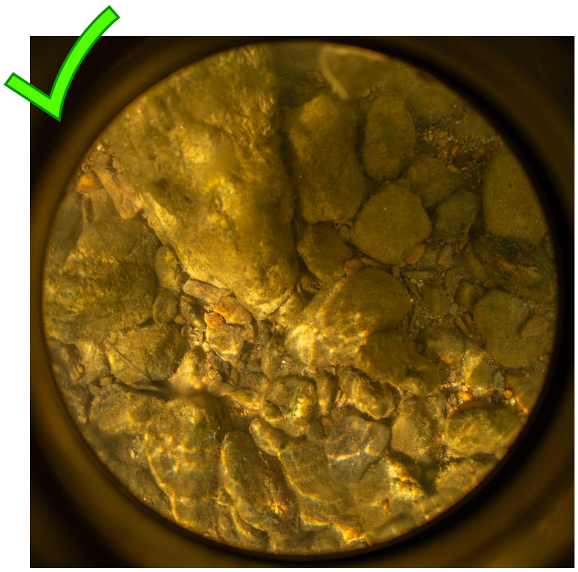


Figure 20. Example of a good stream viewer photo. The photo is clear, with no glare, and covers the entire streamview. Photo credit: Alliance

Figure 21. Example of a bad stream viewer photo. Photo has a strong reflection, is not clear and does not cover the entire stream viewer. Photo credit: Alliance

Monitoring Tips:

- Take at least one photo of the streambed through the stream viewer at the 25%, 50%, and 75% cross-section points.
- You make take additional photos if there are questions or unusual attributes.
- Take the photo <u>before</u> collecting your observations to be sure the streambed has not been disturbed.

EVALUATE SUBSTRATE MATERIAL

After taking the photo, assess the substrate size using the classifications in **Table 2**.

Table 2: Size metric to evaluate substrate size

Boulder	Cobble	Gravel	Sand	Silt / Mud
> 25 cm (> Basketball)	5 - 24 cm (Basketball to golf ball)	0.5 - 4 cm (Golf ball to sesame seed)	< 0.5 cm (Gritty)	< 0.5 cm (Slimy)

1. Look through the stream viewer and estimate the percentage of different substrate sizes using the size metric in Table 3. Start with the largest size and work your way down to the smallest size. The percentages of all sizes must equal 100% (see Figure 22).
2. To assess sand vs. silt/mud, pick up the fine sediment and rub it between two fingers. Sant will feel gritty and silt/mud will feel slimy or slippery.
3. If any of the view is obstructed by aquatic vegetation or logs, note the percentage of the obstructed view on your datasheet as "Other" in the Substrate Classification.
4. Record the average estimate of both team members on your datasheet.

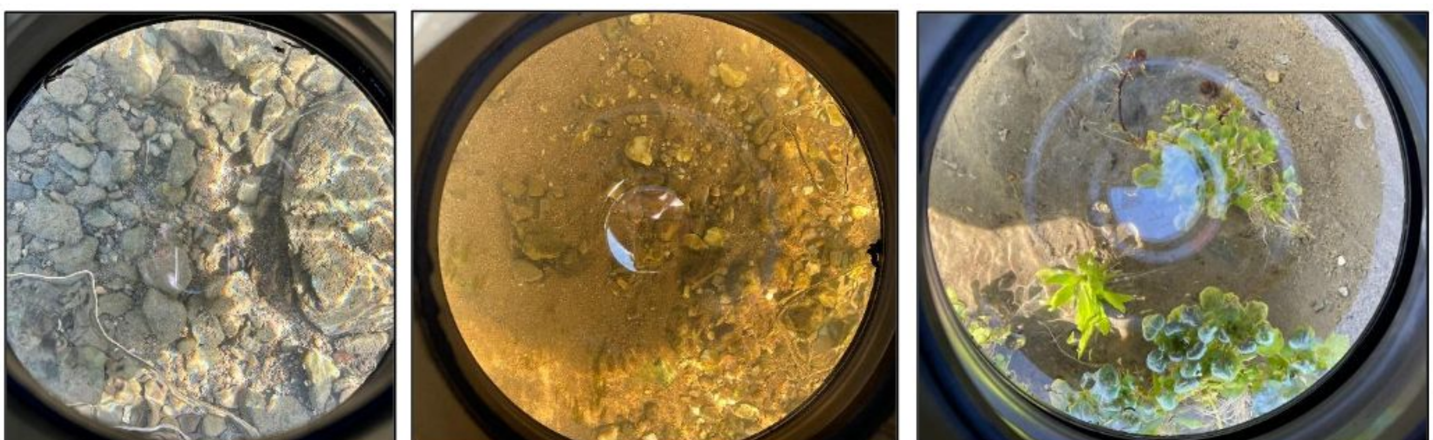


Figure 22. Examples of evaluated percent substrate classifications. Image credit: ALLARM and Alliance

EVALUATE PERIPHYTON COVERAGE

There may be different types of vegetation growing along the transect. Periphyton is the mixture of algae and other organisms growing on the surface of the rocks in the stream (not to be confused with rooted aquatic plants or lichen). Periphyton are a source of food for many stream organisms and are a critical component of stream ecosystems.

1. Look through the stream viewer and estimate the percentage of periphyton growing on the substrate. You may need to pick up a rock to look at and feel the type of growth present. Periphyton feels soft, furry, or even gelatinous. Lichen, on the other hand, fees hard and crusty.
2. Consult with a team member and record the average estimate of both you and team member on your datasheet.

Figure 23. Example of 25% periphyton coverage (green growth on the rocks). Photo credit: Alliance

EVALUATE PERIPHYTON THICKNESS

A thick growth of periphyton can occur where sunlight is intense, phosphorus is high, and grazers are scarce. It is expected that riparian tree cover and phosphorus control can reduce very thick growths of periphyton.

Evaluate the thickness of the periphyton only with the stream viewer at the three points along the transect. If periphyton is present, compare the periphyton thickness on the surface of the rock to the width of your finger.

1. Pick up a rock that contains periphyton growth and hold it under the water. Do not bring the rock out of the water, the periphyton will flatten.
2. Assess the periphyton thickness (vertical growth) using your finger as a guide.
3. Place your finger in between the growth to assess whether the periphyton growth is thicker or thinner than the width of your finger. If the periphyton is:
    a. <u>Thinner</u> than the width of your finger: record the thickness as < 2 cm.
    b. <u>Thicker</u> than the width of your finger: record the thickness as > 2 cm.

EVALUATE EMBEDDEDNESS

Embeddedness measures the extent to which rocks (gravel, cobble, and boulders) are surrounded by, covered, or sunken into the silt, sand, or mud of the streambed. High embeddedness reduces habitat for macroinvertebrates and restricts the healthy shallow subsurface stream flow through the streambed. Streams with high fine sediment loads are expected to have higher embeddedness, thus restoration practices that reduce sediment load may reduce embeddedness over a period of many years.

Note: *Embeddedness can only be measured if the dominant substrate type is gravel (0.5 - 4 cm) or larger.*

1. Swish the water above the substrate to remove newly settled fine sediment. Take note of how much of the larger substrate you can see above the fine sediment.
    a. If you swish the water above the substrate to remove settled fines and it doesn't reveal rocks below, do not measure the embeddedness and record "all fine substrate; no rock" on your datasheet.
2. Pick up an average-sized rock and look for the clean/transition/oxidation line (see "Clean Line" in Figure 24), which provides evidence that the rock was embedded. The portion of the rock buried in fine substrate will typically have minimal to no growth on it (i.e. diatoms, periphyton). As a result, it can appear to have a different color.
3. Estimate the percentage of the rock that was buried in the fine substrate by looking at the "cleaner" portion of the rock.
4. Record the average estimate of both team members on your datasheet.

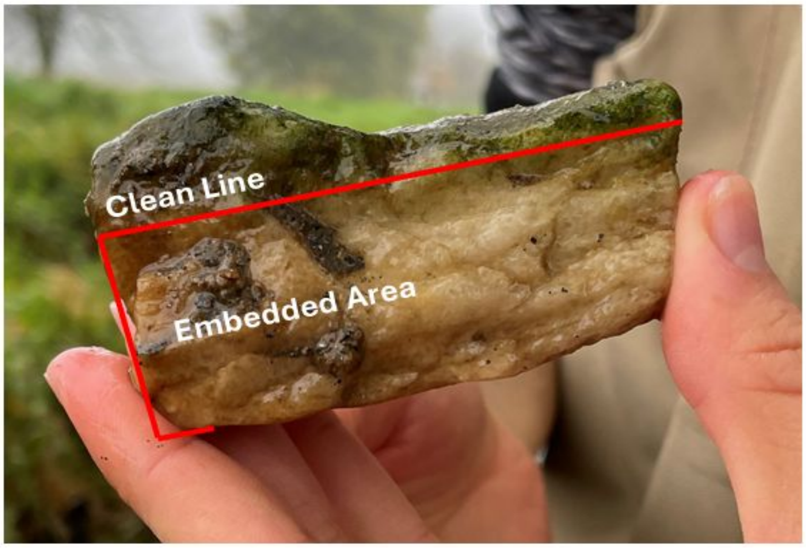


Figure 24. A clean line on a rock pulled from the stream bed, indicating it is 80% embedded. Photo credit: Alliance

Canopy Cover

Canopy cover is a critical measurement of how well mature trees along the stream reduce light intensity reaching the streambed.

Note: *Measure canopy cover only if the trees have leafed out.*

1. From the 50% cross-section point of the transect, look up to assess the percent of canopy covering the stream.
2. Record the percentage of canopy cover on your datasheet.
   a. If there are no trees in sight: record 0% canopy cover on your datasheet.
   b. If the canopy is completely covered by leaves, record 100% canopy cover.
   c. If the canopy cover has not leafed out: record N/A on your datasheet.

Figure 25. Example of a stream with a 75% canopy cover. Photo credit: ALLARM

Biological Habitat Assessment

Healthy streams contain a variety of structure and types of habitat for macroinvertebrates, fish, amphibians, and other riparian animals. Check all of the biological habitats that are present along the transect line. Evaluate the biological habitat within a 4-meter corridor along the length of the transect (total of 4 meters, 2 meters on each side of the transect).

Assess the following:

Logs / Large Woody Debris

Fallen trees or parts of trees that are thicker than an arm.

Small Woody Debris

Small twigs and sticks that have fallen off of bushes or trees.

Leaf Packs

Clumps of dead leaves frequently caught between stones, sticks, and roots along the stream banks.

Cobbles

Rocks that are tennis ball sized to basketball sized.

Boulders

Rocks that are baseketball sized and larger.

Riffles

Area characterized by broken water surface, moderate or swift current, and relatively shallow depth (often < 18 inches).

Photo credits: Alliance and ALLARM

Biological Habitat Assessment Continued

Assess the following:

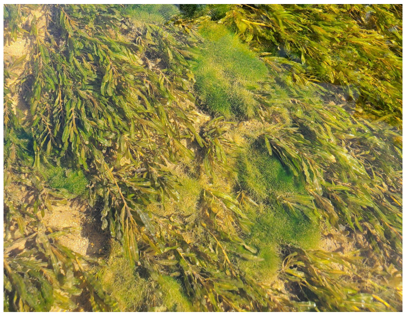
Tree Root Wad

Dense mats of roots at or beneath the water.

Overhanging Vegetation

Trees, shrubs, etc. that hang over the stream surface providing shade and cover. Does not includes grass or vines.

Aquatic Vegetation



Beds or patches of rooted aquatic plants (not algae or periphyton; should be rooted in the streambed).

Undercut Banks with Roots

Banks that have eroded so that roots of surrounding shrubs and trees emerge from the bottom of the overhanging bank.

Bank Slumps

Parts of the streambank that have slid down the slope to the wetted width.

Bank Cracks

Bank cracks are visible breaks in the streambank.

Photo credits: Alliance and ALLARM

Riparian Areas Assessment

A healthy stream is dependent on a naturally vegetated riparian zone in which it is hydrologically and ecologically connected. Riparian restoration practices are intended to re-establish these connections.

Each transect will extend two bankfull widths from the bank height into the riparian area to assess riparian health. Evaluate riparian health within a 4-meter transect corridor (2 meters on each side of the transect along the full transect length). See Figure 26 below.

1. Review bankfull width at each transect reach and multiply it by two to determine the riparian transect length. Your riparian transect must be a minimum of 10 meters and a maximum of 30 meters. Example:
    a. Bankfull width of 11 meters = Riparian transect length of 22 meters.
    b. Bankfull width of 3 meters = Riparian transect length of 6 meters, but we have a 10 meter minimum so the transect will be 10 meters.
2. Record the transect length on your datasheet in meters for each bank.
3. Take your tape measure and measure the riparian transect from the left and right bank (start from where you measured bank height/bankfull width) onto the adjacent land to the calculated length.
4. Measure two meters on each side of the transect line to create a riparian corridor four meters wide. You can use pieces of equipment to temporarily mark the edges of the corridor if needed.

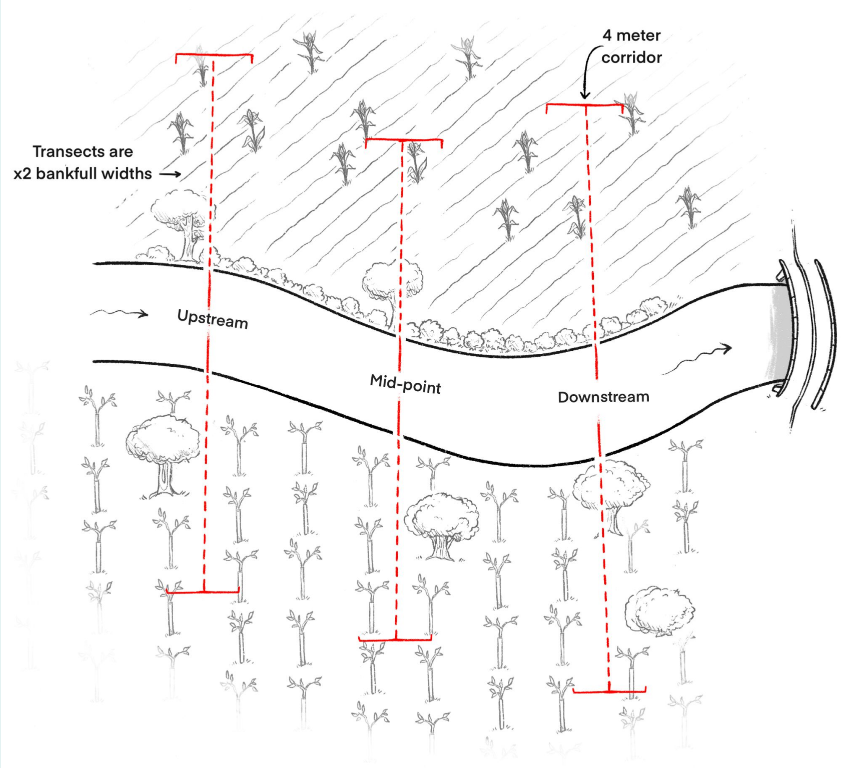


Figure 26. Evaluated riparian health on either side of the stream. Image credit: ALLARM

Riparian Areas Assessment Continued

5. Count the number of trees within the corridor. Tree counts will distinguish between pre-existing/established trees and trees planted within the restoration project. Each time this assessment occurs you will:
    a. Count the number of pre-existing/established trees (trees that were present prior to restoration).
        i. Count just the total number of trees (with a single trunk) that are taller than your gage stick.
        ii. Do not count shrubs (multi-trunk) or other vegetation.
    b. Evaluate the Planted Buffer (trees or shrubs that are planted as part of the restoration project that have a stake, tree tube or other evidence of being planted). **Note:** This is only done during the post-restoration sampling events.
        i. Count the number of trees that are less than 5 cm in diameter at breast height (your gage sticks have been made to this height).
        ii. Count the number of trees that are greater than 5 cm in diameter at breast height.
        iii. Count the number of dead (empty tree tubes) or fallen trees.
6. Draw a sketch of the riparian area on the site diagram.
7. Make note of and photograph any concerns and whether maintenance is required. Concerns could include invasive species present (note if you can ID any), tree tubes removed or down, dead trees, etc.

Standardized Stream Reach Photos

Standardized photos are crucial to contextualizing the additional information and data gathered at the restoration site and may help capture change over time. Monitors will take photos each time they conduct a visual-physical assessment. In total, monitors will take 12 standardized photos along the stream reach. Six photos will include a white board description of the type of photo and upstream/downstream indicators and six photos will be the photo used to document the site conditions.

Nomenclature for Stream Reach Photos:

- (25/50/75) Reach length information
- Orientation with streamflow - are you looking downstream (Down) or upstream (Up)? Always take the downstream looking photo first, then the upstream looking photo.
- Photo number (1-6)
- **Example**: 25Down1 for the 25% reach point, facing downstream, and photo 1

Additionally, record on the white board where the left or right bank (L/R) are located and the monitoring date. If you are not using the white board, you can annotate the photos on your phone using the appropriate nomenclature.

FINDING THE LOCATIONS FOR THE STANDARDIZED STREAM REACH PHOTOS

Review and find the reference markers (yellow flags) for the 25%, 50% and 75% reach length points working downstream to upstream. If needed (ie. the marker is missing), use your tape measure to find the photo location from the instructions on the Site Background sheet. Mark where the photos are taken on your site diagram.

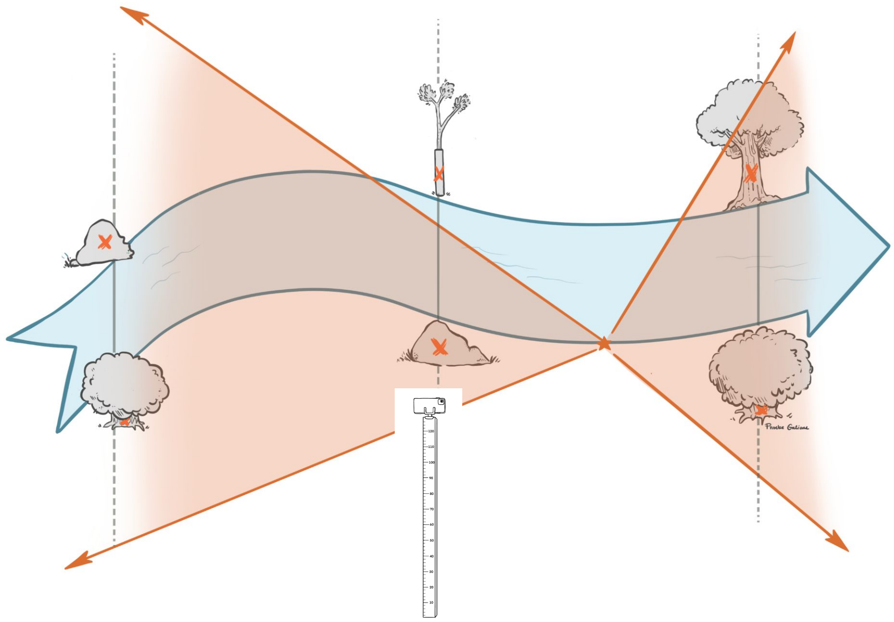


Figure 27. Standardized photo location for the 25% photo point. Photos are taken looking up and downstream. The photo should be taken from the top of the gage stick. Image credit: ALLARM

25% STANDARDIZED PHOTO POINT

Start at the 25% point, which should be located between the downstream transect and the mid transect (Figure 27).

1. Locate the 25% point along the bank and, look downstream.
2. Place the gage stick phone holder on the marker. Use the widest angle possible on your camera or device. Position yourself so that the transect markers are in the center of the photo's field of view. Frame the photo using the downstream transect markers and align the bank along the edge of the photo.
3. Fill out your whiteboard, with the photo ID (25Down1), label the left and right banks, and the date.
4. Place the whiteboard in the photo, close enough to the camera so you can read the writing, and take the first photo.
5. Remove the whiteboard but do not move the camera or gage stick. Take another, unobstructed photo of the same view. **Note:** Only take one photo to reduce confusion later. If you take multiple photos, delete the unnecessary ones immediately.
6. Turn to face upstream and repeat the above process, naming the photo 25Up2 on the whiteboard, or on the photo on your phone, and updating the bank labels.

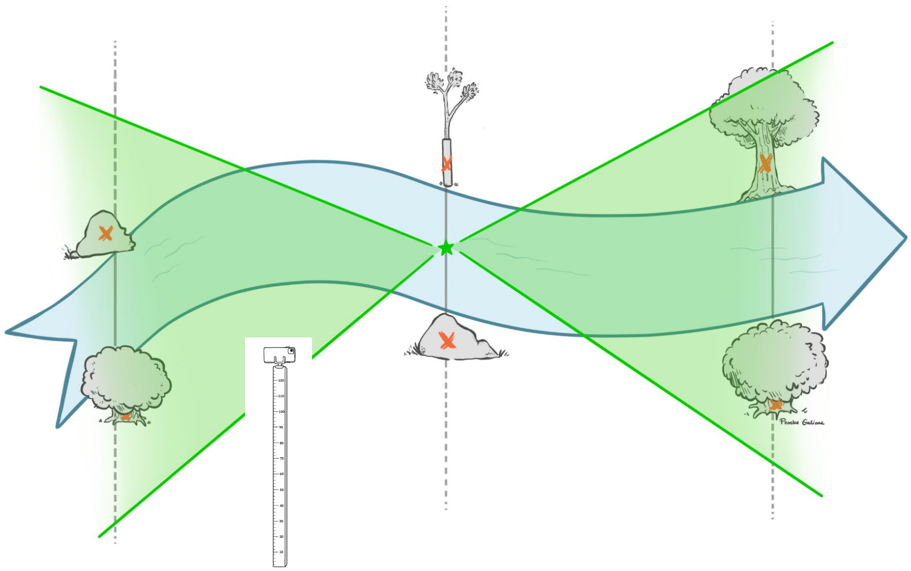


Figure 28. Standardized photo location for the 50% photo point. Photos are taken looking up and downstream from the center of the stream. The photo should be taken from the top of the gage stick. Image credit: ALLARM

50% STANDARDIZED PHOTO POINT

The 50% photo point should be located along the mid transect (Figure 28). Since this is in the same location as the cross-section measurements, this photo should be done after the cross-section measurements are completed.

1. Step to the midpoint of the stream along the transect line and look downstream.
2. On your whiteboard, label the photo ID (50Down3) and update the left and right bank labels.
3. Use the gage stick phone holder and frame the photo using the downstream transect markers.
4. Take a whiteboard and unobstructed photo following the same procedure as above.
5. Turn to face upstream and frame the photo using the upstream transect markers.
6. Take your final two photos, writing 50Up4 on the whiteboard and update the left and right bank labels.

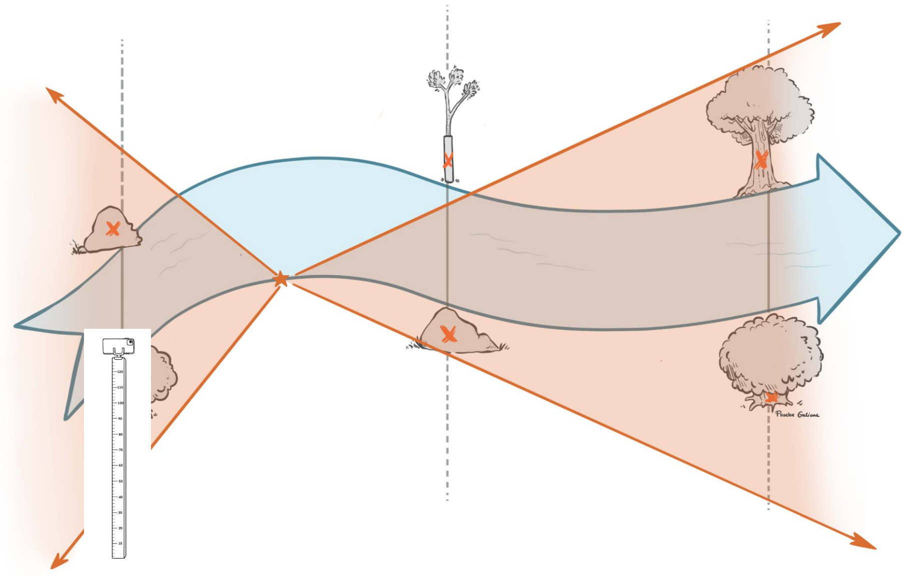


Figure 29. Standardized photo location for the 75% photo point. Photos are taken looking up and downstream from the stream bank. The photo should be taken from the top of the gage stick. Image credit: ALLARM

75% STANDARDIZED PHOTO POINT

The 75% photo point should be located between the mid transect and the upstream transect. Take the photo from the bank and be sure to indicate from which bank this photo was taken on your site diagram. See Figure 29 for photo reference points.

1. Move to the 75% point along the bank (use a tape measure if needed), look downstream.
2. On your whiteboard, label the photo ID (75Down5) and update the left and right bank labels.
3. Using the gage stick phone holder and frame the photo using the mid transect markers.
4. Take a whiteboard and unobstructed photo following the same procedure as above.
5. Turn to face upstream and frame the photo using the upstream transect markers.
6. Take your final two photos, writing 75Up6 and the left and right bank labels on the whiteboard.

Total Photo Coverage

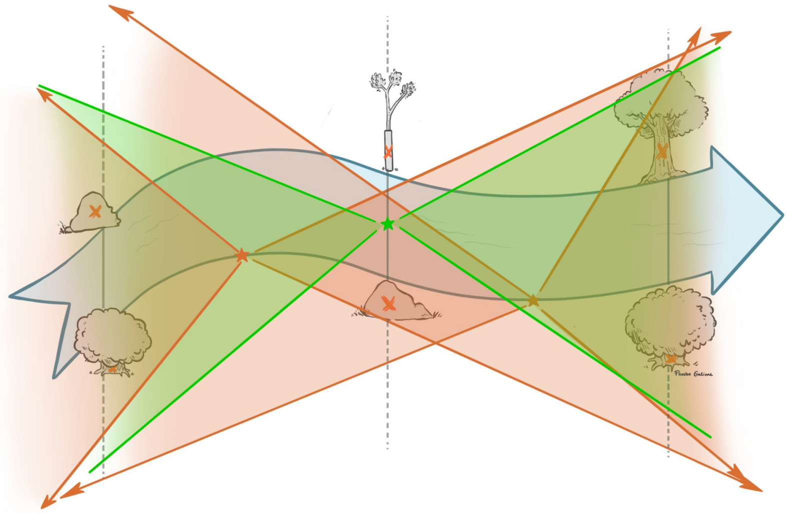


Figure 30. Capture 6 photos from the prescribed angles. Image credit: ALLARM

In total you will take twelve standardized site pictures, 6 with a labeled whiteboard and 6 corresponding unobstructed photos (Table 3).

Table 3: Summary of site photos taken throughout the stream assessment reach.

Photo Number	Nomenclature	Description of Photo
	25Down1_WB	Whiteboard photo from 25% looking downstream
1	25Down1	Unobstructed photo from 25% looking downstream
	25Up2_WB	Whiteboard photo from 25% looking upstream
2	25Up2	Unobstructed photo from 25% looking upstream
	50Down3_WB	Whiteboard photo from 50% looking downstream
3	50Down3	Unobstructed photo from 50% looking downstream
	50Up4_WB	Whiteboard photo from 50% looking upstream
4	50Up4	Unobstructed photo from 50% looking upstream
	75Down5_WB	Whiteboard photo from 75% looking downstream
5	75Down5	Unobstructed photo from 75% looking downstream
	75Up6_WB	Whiteboard photo from 75% looking upstream
6	75Up6	Unobstructed photo from 75% looking upstream

General Characteristics of the Reach

All of these observations will summarize the entire length of the assessment reach (30, 60 or 90m) for your site. It is helpful to assess these characteristics with the entire monitoring team and “crowd- source” your responses from the team. For example, the team may walk back downstream after finishing Transect #3 to review the characteristics along the entire reach. These observations provide a broader context to help scientists interpret the data you provide throughout the rest of this survey.

REACH CATEGORIZATION

1. Estimate the surface area covered in riffles, pools, and runs across the reach. The total percentage should add up to 100.
2. While estimating the percent riffle coverage, also count the number of separate riffles and add that number to the datasheet.

AQUATIC VEGETATION CLASSIFICATION

1. Assess water color. If it is difficult to determine color by looking into the water, fill your turbidity tube and view the water color through the side. Examples include clear, brown, pea green, hint of green, milky, and chalky.
2. Estimate the percentage of aquatic vegetation along the stream reach or the percentage of the area within the stream channel that looks “green”.
    a. Aquatic vegetation Includes: aquatic plants, macrophytes, filamentous algae (thin green or brown clumps of algae longer than your finger), and periphyton.

BANK CONDITION

For each of the listed categories estimate the percent of both left and right bank that the bank condition covers. Only assess the actual bank (where the bank angle was measured) and not into the floodplain or riparian zone. If there are trees along the bank and grasses behind those trees, you would label it as trees not grass.

Figure 31. Example of a fortified bank with rip-rap. Photo credit: ALLARM

1. Grasses/herbaceous plants
2. Trees/Shrubs
3. Soil
4. Bedrock
5. Fortified bank with artificial materials:
    a. Concrete: Smooth solid panels/blocks, or entire walls.
    b. Rip-rap: Large jagged rocks/boulders that are not naturally occurring. Often rip-rap along the stream is construction leftovers.
    c. Lumber: big framed timbers to fortify a bank held in place with rebar.
6. Bank impacts (animal/human/vehicle tracks).

FLOODPLAIN INUNDATION

1. Look for evidence of floodplain inundation above bankfull. This may include:
    a. Water rings or stains around trees.
    b. Flattened vegetation.
    c. Lines of leaves, twigs, or trash carried and deposited by flooding.
2. Record whether evidence exists on both the right bank and the left bank, circle yes or no.

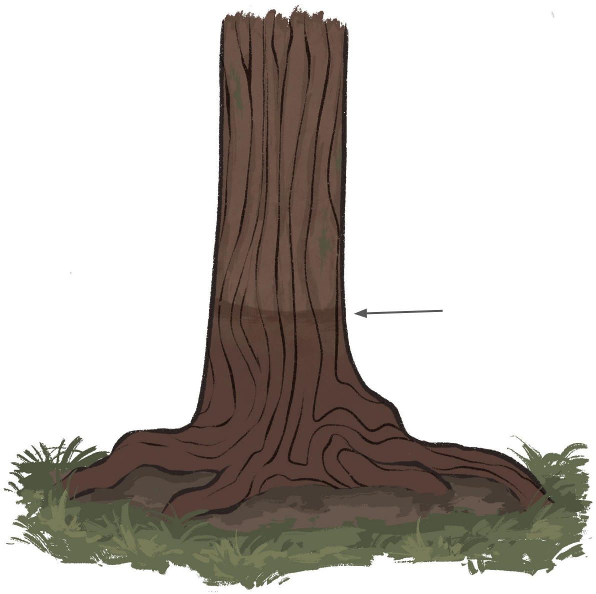


Figure 32. Water ring as a sign of floodplain inundation. Image credit: ALLARM

Figure 33. Flattened vegetation as a sign of floodplain inundation. Photo credit: Alliance

IMPACTS OF ANIMALS

Observe the assessment area and identify where, if any, animals are present and answer the following questions on your datasheet.

1. Are they fenced out of the stream?
2. Is the fence keeping animals out of the stream?

Figure 34. Cows fenced in next to a stream. Photo credit: Alliance

BENTHIC MACROINVERTEBRATE SAMPLE COLLECTION

Benthic macroinvertebrates are a key indicator of stream health and an important metric to track the ecological uplift from restoration practices. This protocol was modified from the Chesapeake Bay Program Macroinvertebrate Sample Collection Protocol, developed to fill in gaps in the Chesapeake Index of Biotic Integrity (IBI). The sampling process requires the collection and retention of the macroinvertebrates in the sample. The entire sample (not picked) will be preserved for later processing in a lab. Importantly, these samples will be evaluated down to the family level taxonomy (at a minimum).

During this process you are going to collect twelve sub-samples that will be combined to yield one sample. The twelve sub-samples should be collected by completing six double-wide kicks within the assessment reach (30 m, 60 m, or 90 m) of the selected stream within the installation area of the BMP. If there are not enough riffles within the assessment reach, the sampling reach can be extended to up to 100 m total. ***Note:*** *The six sub-samples should not be collected along the transect lines.*

Monitors should use the Rocky Bottom method if possible, within the assessment reach at the site. Should the site not be viable for Rocky Bottom sampling, Muddy Bottom sampling can be done in its place. If the Muddy Bottom protocol is selected it will be used for all samples collected. Check your paperwork to confirm which method you will be using on site. Then follow either the Rocky Bottom or Muddy Bottom method below.

If you have enough volunteer monitors, you can have two teams of people, one collecting the visual- physical data, while the other team collects the benthic sample (Figure 34). If this occurs, be sure to collect your turbidity tube measurements before the sediment is disturbed for the benthic sample.

Figure 35. Example of a team performing the protocol. Photo credit: Alliance

Figure 36. Example of a stream with riffles. Photo credit: Alliance

Rocky Bottom Method

ASSESS THE VIABLE HABITAT

You will first need to assess the viable habitat (riffles) to collect the sample from across the stream reach (30 m, 60 m, or 90 m)(Figure 36). If you do not have enough riffles within the stream assessment reach, you can extend the reach upstream up to 100 m total. Use the following considerations to find your six sub- sampling locations with a Rocky Bottom reach:

- Make sure there are at least six viable locations (you will complete two kicks at each location for a total of 12 kicks) within at least two different riffles along the 100m reach where you will be able to rub cobbles with your hands and disturb the substrate beneath the cobbles (i.e. does not have bedrock).
- Look for a variety of riffle-run habitats including different velocities and stone sizes as these microhabitats are important to different species. Kicks on the 100m reach should be distributed and representative of the riffle-run habitat (slow flowing shallow riffles and fast-flowing deeper riffles).
- Look for locations throughout the width of the stream to include left middle and right areas.
- If there are not six viable locations for sub-sampling within a riffle, Muddy Bottom monitoring may be done in its place. Follow the protocol for Muddy Bottom Sampling at the end of this in lieu of following sections below.

COLLECT YOUR FIRST SUB-SAMPLE

Start at the downstream end of your reach and work upstream sub-sampling the riffle-run habitat when collecting your sample. Check your net and bucket to make sure there are no holes or tears in the mesh.

1. The collection process used is referred to as a "kick". A kick is done to disturb the sample area 2–4 inches down into the substrate. The sample area for a single kick is one width of the net and two net widths upstream. Properly place the D-net—one partner should rest the D-net along the bottom of the stream facing upstream while the other stands directly in front of the net. Ensure that there are no gaps underneath the net where the sample could be lost.

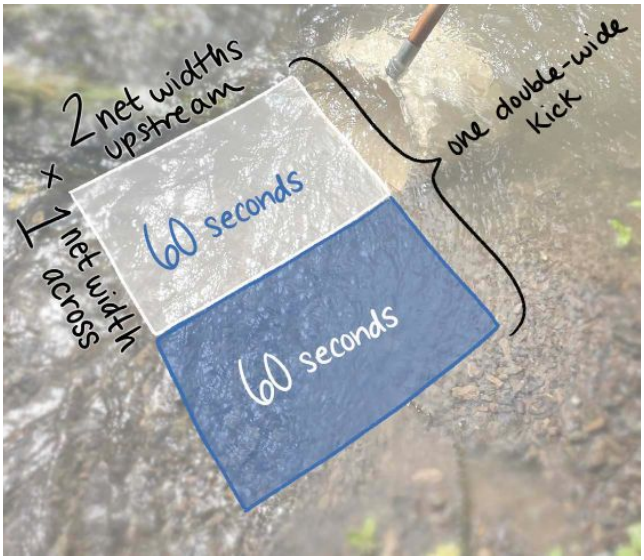


Figure 37. For a double-wide kick, after a location is monitored, place the net directly adjacent to the location and being again. Image credit: Alliance

2. When everyone is set, start the timer for 60 seconds and start the kick process. One kick is done for 60 seconds total.
    a. For the first 40 seconds, use your hands to pick up and rub rocks in the sampling area (white section in Figure 37) to dislodge macros clinging to them. The timer will indicate when 40 seconds is up.
    b. For the last 20 seconds, gently disturb the substrate in front of the net down 2-4 inches using a flat stone or handheld shovel/rake, trying to get the water to run a muddy brown. DO NOT use your feet, since people often grind down, instead of kick up—a flat rock is easier to use correctly. The targeted area should be the width of the net across, and two net widths upstream.
3. Once the 60 seconds are over, move the net directly beside where you just sampled and repeat the process (Blue area in Figure 37). These two samples combined constitute the "double-wide" kick.
4. Carefully lift the D-net out of the water, ensuring that the opening in the net is facing upwards.
5. To complete a double wide kick, repeat this process directly adjacent to the first spot.

EMPTYING THE NET INTO THE BUCKET

Empty the contents of the net into the bucket after every double-wide kick. If there isn't a lot of debris in the sample, you may be able to wait and empty the contents after two or three kicks.

1. Sit the bucket into the stream so that it is half full of water. You can use a pool in between the riffles, just be sure to go to a pool downstream if you have not finished your kicks within the current riffle.
2. Carefully dump the contents of the net into the sieve bucket.
3. Turn the net inside out and rinse any missed part of the collection into the bucket (Figure 38).
4. With a squirt bottle filled with stream water, rinse net into the sieve bucket to get any last clinging part of the sample.
5. Double check the net to make sure you didn't miss any organisms, hand pick or rinse any additional organisms into the bucket.

Figure 38. Washing the net into the bucket. Photo credit: Alliance

Once the net is cleaned, repeat this process five more times moving upstream with each kick to get 6 double-wide kicks (12 total kicks). Remember, these kicks should be done in at least two different riffles within your reach and should cover the left, middle, and right of the stream, as well as slow and fast moving riffles. Keep your bucket with you and continue to empty the contents of the net into the bucket as you move along.

FINAL RINSE AND BUCKET CHECK

1. Once all of your kicks have been completed, do a final rinse of your net into the bucket and check the sample bucket for large debris and species that should not be included in the sample.
2. All large stones, debris, leaves etc., should be carefully washed, inspected for organisms and discarded. Try to put as little material as possible into the sample bucket.
    a. **Remove:** fish, mussels, salamanders, turtles, large sticks, stones > 3 cm, and trash.
    b. **Keep:** Crayfish, all leaf litter, and small sticks and pebbles.
3. Once you have your final sample, gently wash the sides of the sieve bucket with stream water to get everything to the bottom of the bucket.
4. Fill your squirt bottle(s) with stream water as you will need it to transfer the sample later, take all of your equipment and your bucket and move out of the stream.

TRANSFER YOUR SAMPLE

1. Move to an easily accessible place, such as the shore of the stream or to a parking lot area, in order to transfer your sample to the sample jar.
2. Before any organisms are placed into the collection container, fill out and insert the waterproof label into the collection container to avoid harming the sample later on (see Figure 39). Using a pencil, fill out the label provided with your sampling kits (should be a small piece of rite-in-the-rain paper) with the following information:

Station ID	Date (m/d/yyyy)
MOURUN1	9/26/2021
Latitude (decimal degrees)	**Longitude (decimal degrees)**
37.874	-79.379
Certified Monitor(s)	
Sophie Stern and Liz Chudoba	

Figure 39. Example of the label. Everything on the label should match your data sheet exactly. Image credit: Alliance

3. Using a sharpie, write the same information on the lid of the sample jar.
4. Dump the contents of the bucket into the white bin provided with your sampling kit. Rinse the contents of the bag or bucket into the bin using the stream water in your squirt bottle - this can be done several times until the bag or bucket are totally clean.
5. The bin, now a mix of water and the sample, can be tipped and run through the 500 micron sieve. It is easier if the sieve is held at an angle so the sample is collected in a corner that can easily be transferred into the sample jar.

7. Water can be run back and forth between the bin and sieve several times to get all remaining contents available for the sample jar.
8. Dump the water out of the squirt bottle and fill with ethanol.
9. Carefully transfer the sample from the sieve to the sample jar. Use the ethanol squirt bottle to wash all contents from the sieve into the sample jar.
10. Check to make sure the label is still in the container, then add more ethanol until you have double the volume of the solids alone (Figure 40).
11. Close the lid well. If needed for transport, secure the jar with duct tape and place in a plastic bag.

FILL OUT THE DATA SHEET

Fill out the front and back of your datasheet before you leave your location. On the front, fill out all of the information about your sampling day. On the back, include a stream diagram. Be sure to label the riffles, each kick location, and the length of stream reached.

CLEAN UP

Gather all of your supplies and equipment. Clean all equipment—nets, bucket, boots, etc.— by washing them off in the stream. If you're not going to another stream that day, your equipment and boots just need to be dry for 48+ hours prior to another sampling event. This drying happens in the sun which can act as an excellent disinfectant. If you're going to another stream that same day, you must decontaminate your equipment before leaving the site using either a 10% bleach solution (nine parts water to one part bleach in a spray bottle) or Alconox (a biodegradable soap product dissolved in water in a spray bottle). Spray down boots, nets, and all other gear at least 50 feet away from the stream, and scrub with a bristled scrub brush. Dry gear with a towel before entering the next stream site.

STORAGE AND RETURN

Store samples in a cool dry place away from direct sunlight or flammable materials. Bring your sample(s) and all equipment to your CMC Service Provider (such as ALLARM, the Alliance, etc.).

Figure 40. A sample preserved in ethanol and with the sample label. Photo credit: Alliance

Muddy Bottom Method

Should the site not be viable for Rocky Bottom sampling, Muddy Bottom sampling can be done in its place. Sampling is conducted from downstream to upstream by jabbing the D-frame net into productive and stable habitats 20 times.

ASSESS VIABLE HABITAT

Different types of habitat should be sampled in rough proportion to their frequency within the reach. Unique habitat types (i.e., those consisting of less than 5 percent of stable habitat within the sampling reach) should not be sampled. Use the following considerations to identify proportional representation of habitat types.

1. Stream-bottom:
   a. ***Riffles*** have relatively fast velocity, shallow steam depth, steep surface gradient, and a straight to convex channel profile. Riffles are usually topographic high areas produced by the accumulation of coarse materials. A reminder - if there are enough riffles to perform six subsamples, the Rocky Bottom protocol should be used.
   b. ***Non-riffle*** encompasses all other forms (i.e., pools, runs, and slack areas) and generally contain intermediate to fine particle substrate.
   c. ***Submerged aquatic vegetation*** serves as habitat for macroinvertebrates and may constitute large areas of the available substrate.
2. Stream-edge:
   a. ***Overhanging vegetation*** includes terrestrial shore-zone plant material that is living, submerged, and provides in-stream cover for aquatic organisms.
   b. ***Submerged tree roots*** include living root material from shoreline or overhanging vegetation that is submerged and provides in-stream cover for aquatic organisms.
   c. ***Woody debris*** includes other woody material beyond living tree roots (such as logs,branches, and snags).

COLLECT YOUR SUB-SAMPLE

Proportionally allocate sampling effort (20 total jabs/sweeps/kicks) to the different habitat types. A single jab consists of thrusting the net into a productive habitat for a distance of 1 meter, followed by 2-3 sweeps of the same area to collect dislodged organisms for 20 seconds. The collected sample is washed by running clean stream water through the net 2-3 times.

EMPTY THE NET INTO THE BUCKET

Samples should be cleaned and transferred to the sieve bucket at least every five jabs/kicks, more often if necessary. Do not let the net become so clogged with debris that it results in the diversion of water around the net rather than through the net. If clogging occurs, discard the sample that is in the net and redo that portion of the sample in a different location.

1. Sit the bucket into the stream so that it is half full of water. You can use a pool in between the riffles, just be sure to go to a pool downstream if you have not finished your kicks within the current riffle.
2. Carefully dump the contents of the net into the sieve bucket.
3. Turn the net inside out and rinse any missed part of the collection into the bucket.
4. With a squirt bottle filled with stream water, rinse net into the sieve bucket to get any last clinging part of the sample.
5. Double check the net to make sure you didn't miss any organisms, and hand pick or rinse any additional organisms into the bucket.

MOVE TO THE NEXT LOCATION

Once the net is cleaned, continue collecting your sample while moving upstream. Keep your bucket with you and continue to empty the contents of the net into the bucket as you move along.

After completing the 20 jabs and transferring to the sieve bucket, continue at the section "**COLLECT YOUR FIRST SUB-SAMPLE**" in the Rocky Bottom Protocol above.

Site Clean Up and Departure

Before leaving the monitoring site, make sure:

- All forms are completed.
- All equipment, personal items, water bottles, trash, etc. is picked up.

BIOSECURITY MEASURES

Sites will include a wide variety of landscapes - farms, public parks, private property, etc. Since we are actively entering each stream to collect data, we must follow biosecurity steps to minimize the risk of transferring invasive species to and from sites on our waders and equipment. Follow the appropriate biosecurity protocol for your monitoring site below. This includes general biosecurity or Cattle Farm Biosecurity.

General Biosecurity

1. Scrub all equipment and boots. This can be done with soapy water (either from a bucket or in a spray bottle), at least 50 feet away from the stream.
2. Rinse all equipment with fresh water (can use stream water if using Alconox soap).
3. Dry gear either with a towel or leave out to air dry. All equipment must be completely dry at least 72-hours before the next site visit.

*If you are visiting multiple sites in one day, dry the gear with a towel. All gear must be completely dry before visiting another site.

Cattle Farm Biosecurity

When this protocol is in place, all boots and equipment (gage sticks, stream viewers, benthic net and bucket (if applicable), and wagon) must be cleaned and disinfected following each farm visit before getting back into your vehicle.

<u>Before the visit</u>

Ask the project leads if there are any specific farm biosecurity requirements in addition to this protocol. Check your biosecurity equipment to ensure everything is stocked. Fill containers (at least 2 gallons per site) with fresh tap water to take with you.

<u>During the visit</u>

1. Avoid parking near animal facilities to the maximum extent possible and do not enter any animal facilities under any circumstances unless directed by the landowner or project lead.
2. Avoid stepping in feces while walking around the farm to the greatest extent possible.
3. If possible, disposable boot covers should be worn over cleaned and sanitized boots while walking to and from the monitoring site. **Boot covers cannot be worn in the stream.** Used boot covers should be placed in a trash bag and discarded at home.

<u>After the visit</u>

1. Use soapy water in a bucket and brush to clean boots, gage sticks, stream viewers, and benthic net and bucket.
2. Dry equipment with a towel or let sit in the sun for a few minutes.
3. Next, spray all equipment with the Lysol disinfectant spray.
4. Let the lysol spray-ed equipment air dry for a few minutes. Dry with the towel before putting equipment in your car.
5. Spray down the outside of all car tires with Lysol once you leave the farm's line.
6. Immediately clean your towel and clothes in the laundry.

Monitoring Packing List

General Items

- ❏ Datasheets (visual and benthic) -one for each team member, keep one clean until the end to record final results
- ❏ Field manual
- ❏ Volunteer binder
- ❏ Site binder
- ❏ Clipboard
- ❏ Pens, pencils, sharpie marker
- ❏ Paint and/or field tape
- ❏ 100-meter field tape measure
- ❏ Gloves
- ❏ Large trash bag
- ❏ Water cooler
- ❏ Binder clips (in case it is windy)
- ❏ Towel
- ❏ First aid kit
- ❏ Hand sanitizer or wipes
- ❏ Bug spray/Sunscreen
- ❏ Old shoes, waders, or hip waders
- ❏ Life jacket (optional)
- ❏ Camera / phone

Visual-Physical Items

- ❏ Gage stick (x3), one with cell phone holder
- ❏ Protractor with arm and level
- ❏ Transparency tube
- ❏ DBH tape
- ❏ Thermometer
- ❏ Stream viewer
- ❏ Ruler, metric
- ❏ Level
- ❏ Whiteboard and whiteboard marker

Benthic Items

- ❏ D-net with 500 um mesh
- ❏ Sieve bucket with 500 um mesh or DIY equivalent
- ❏ Collection container
- ❏ 95% ethanol preservative
- ❏ Spray/squirt bottle (x2)
- ❏ Forceps
- ❏ Duct tape or gallon plastic bags
- ❏ Waterproof labels for sample jars
- ❏ Decontamination supplies - scrub brush, bleach solution and alconox
- ❏ Fishing license(s)

Biosecurity - General and Cattle Farms

- ❏ Boot Covers (required for cattle farms)
- ❏ Soap (Dawn or Alconox)
- ❏ Lysol spray (required for cattle farms)
- ❏ Gallon containers of fresh water (2 per site)
- ❏ Scrubbing brush
- ❏ Bucket
- ❏ Spray bottle