Guide to Aquatic Ecological Unit Inventory

Monongahela National Forest, WV

Last updated May 20, 2024
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Stream Reach Selection

Aquatic Ecological Unit Inventory (AEUI) stream reach locations are located throughout the Monongahela National Forest (MNF) and should be surveyed on at least a 5-year rotation. These stream reaches were selected to satisfy the MNF Land and Resource Management Plan requirement to monitor watershed conditions. The specific location of each reach was selected to be within the response reach of the stream. These mid-valley response reaches typically reflect geomorphic changes in the watershed. Upper reaches are typically more transport reaches, and lower reaches are typically more depositional reaches. These response reaches allow the MNF to document changes in stream morphology that may be from forest management activities or human impacts. Stream reaches were selected throughout the forest in each 6th level watershed (12 digit HUC) and are available in GIS. Sites are in a variety of locations, elevations, and geologies. Some stream reach locations were chosen to monitor specific project activities. Repeating these surveys every 5 years allows us to monitor watershed conditions over time and verify if habitat and aquatic species are trending towards an improved or degraded state or staying constant. Surveys may occur more frequently if funding and capacity provide opportunities for shorter intervals. Conversely, surveys may need to be skipped following large-scale flood events which result in restructured channel dimensions without adequate bankfull indicators. It may take 1-3 years for adequate bankfull indicators to re-establish. In this scenario, a subset of the AEUI survey may be beneficial (e.g., fish survey, pebble count, sediment sample etc. minus bankfull and associated measurements). The determination of what to collect and when to follow up will be determined by MNF aquatic specialists.

Field Survey

The following represents the typical sequence through the survey; however, adjustments may be made due to stream flow conditions, weather, etc. Depending on the number of crew members, multiple components may be collected simultaneously (e.g., one person conducting x-section and one person conducting a pebble count with the third crew member recording both data sets).

<u>Stream Reaches</u>

Locate the stream reach survey location with the aid of maps, GPS, and the previous survey location notes. Notes and photographs of the upstream, downstream and cross-section tag should be available from the last survey (usually 5 years previous). If sufficient effort to find the location fails to locate the site, a new site will be established. Locate the new site as close to the previous location as possible, avoiding side channels, tributaries and channel crossings. The site should be in the response reach of the stream. If a new site is established, notes, GPS coordinates, and photographs on tag locations will be collected. New tags should be placed on larger, sound trees visible from the stream but not directly on the stream bank. Species such as ash, hemlock, etc. prone to invasive disease/pests should be avoided.

Fish Population Surveys

Where recorded: waterproof fish notebook

Record the stream temperature within the reach to be sampled at the start of the sample.

Conduct a multiple-pass electrofishing survey on the representative stream reach from the closest habitat unit breaks near the downstream and upstream tags. The sample reach is isolated with block nets or otherwise (e.g., waterfalls, perched culverts) to minimize the potential for fish immigration/emigration.

Set up and test the electrofisher in an area outside of the blocked stream reach. Pulsed DC is the default waveform for samples, except in candy darter streams where smooth DC is used. Use the following process to set up the unit (Meyer et al 2020).

1. Set the electrofisher to pulsed DC at the preferred frequency (30 Hz), duty cycle (25%) and pulse width (4 ms). Voltage is set by the auto-setup function or by conservatively starting at 200 V and increasing to achieve the desired power output (100 W).
2. Outside of the reach to be electrofished, locate a riffle and a pool that are representative of the habitat inside the reach.
3. In the representative riffle, start with relatively low voltage and adjust voltage, with the anode at mid-water depth, to achieve average power output of 70–100 W.
4. Determine average power output in the representative pool with the anode at mid-water depth; output should be 100–130 W. The average between the riffle and pool readings should be ~100 W. If the average is higher or lower than 100 W, adjust voltage accordingly until the average target power output (~100 W) is achieved. On rare occasions, duty cycle (or pulse width) and pulse frequency may need to be slightly modified to achieve the target power output.
5. Move into the reach to be sampled and begin electrofishing. Closely monitor fish behavior and, if necessary, adjust voltage slightly to increase forced swimming behavior or reduce fish trauma.
6. Record the electrical settings and resulting power output and any adjustments needed.

Fish should be temporarily held in a dip net or bucket to observe recovery, which should ideally be immediate after shocking ceases. Reference "Standard Methods for Sampling North American Freshwater Fishes," from the American Fisheries Society for greater detail.

A minimum of 3 electrofishing passes are made to successively deplete the fish population within the isolated reach. Captured fish are processed at the end of each pass and retained in a live well. All game fish are weighed and measured (total length, mm) individually for each electrofishing pass. Non-game fish are processed by recording the total number and weight of all fish by species and the largest and smallest fish per species for each pass. If necessary and appropriate, fish can be anesthetized using clove oil solution. The sampling effort should be recorded as the number of seconds that were logged on the electrofishing unit(s) for each pass. Record the electrofisher settings for the sample and if any changes are made during the sample. Equal effort should be used during each pass (i.e., expend similar effort when trying to capture a fish; do not rush through the last pass (normally pass 3) assuming all fish are captured, etc.). Electrofishing time logged during each pass should be fairly consistent.

In theory, this population estimate method requires that an adequate number of fish be removed on each sampling pass so that measurably fewer fish are available for capture and removal on a subsequent pass. The assumptions of the depletion method are dependent upon constant fish catchability for each sample and that more than 20% (ideally, >30%) of the population be captured in each sample. In situ graphs of the number of fish captured per pass can quickly inform the accuracy and variance of the sample and if additional passes are needed to improve the population estimate. Depletion estimates are based on individual species (i.e., do not group brook and brown trout). Use Table 1 to help inform if another pass is needed.

Table 1. Examples of multipass e-fishing results, derived population estimates, and if an additional pass was needed.

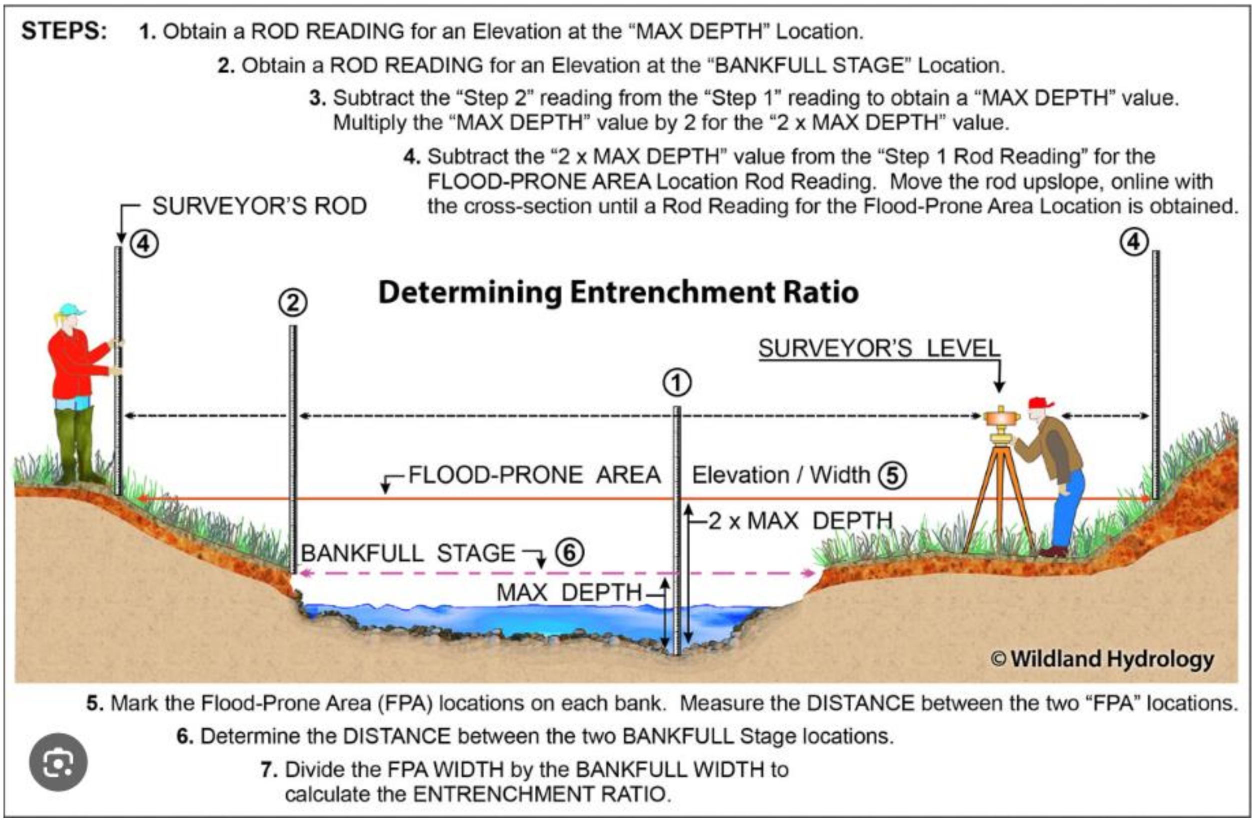
Pass 1	Pass 2	Pass 3	Population Estimate	Another Pass Needed?
8	8	7	131	yes
8	5	1	16	no
5	7	2	22	no
5	7	5	315	yes
4	8	3	36	yes
61	26	15	113	no
27	26	25	716	yes
6	5	4	33	yes
6	5	1	15	no
37	14	13	72	no
37	14	20	90	no
14	15	3	42	no
10	5	5	27	yes
20	5	5	31	no

If no game species are collected in the first two passes, the survey is complete.

Valley Segment and Stream Reach Survey

Where recorded: Valley Segment and Stream Reach Form; Cross-section is recorded on the cross-section data sheet as well as key points recorded on Valley Segment and Stream Reach Form.

Locate and flag the bankfull elevation at a representative riffle as noted below under the Channel Cross-Section heading. Reference the cross-section diagram below for survey points.



Channel Cross-Section: Conduct a stream channel cross-section in a riffle representative of the reference reach, preferably in the same location as previously identified, surveyed, and marked with XS tags. If previous cross-section location is not preferred (large wood or other obstruction in location, bank slump or undercut, etc.) a new location will be established in a location that best represents that stream reach. Cross-sections are ideally surveyed in straight, unbraided channel sections. Note new location in field book; tag, photograph, and GPS new location.

Cross-sections are conducted from river left to river right (left and right looking downstream). Stream channel cross-sections should include the entire perimeter of the bankfull channel and the entire flood-prone area (or a minimum distance of 4 times the bankfull width if flood-prone is greater than 4 times bankfull width). Survey the max. bankfull depth (thalweg). Survey the bankfull elevation on the bank with the best indicators, then survey the corresponding elevation on the opposite bank. Calculate 2 times the maximum bankfull depth and the elevation for the flood-prone area according to the data sheet. Flag the flood-prone elevation on both sides of the stream. Survey elevations of the stream channel at ¼, ½ and ¾ across the bankfull width. Complete calculations #1-12 on the data sheet. At a minimum, record the following features in the notes: left and right **flood-prone**, left and right **bankfull**, left and right **water's edge**, **thalweg**, and **inflection points of slope breaks**. Record points at a maximum interval of 1 m distance, although typically much closer when variation in elevation exists.

Channel and Valley Slope: Measure the percent stream channel slope and valley slope in the vicinity of the stream reach cross-section. This measurement is calculated as the **change in**

elevation divided by the **stream length** (stream slope) or **valley length** (valley slope) over a distance of at least 2 meander wave lengths or 20 channel widths. Channel and valley slope locations may extend beyond the reference reach upstream and downstream tagged locations in order to capture the minimum distance needed. Record in #13 and #14. Valley slope may be transcribed from the previous survey if the reach does not need to be moved. Use Figure 1 and the following site descriptions to aid in the survey points:

- Elevation Change: For stream elevation change, this measurement is taken at the edge of water from riffle crest to riffle crest over a distance of at least 2 meander wave lengths or 20 channel widths and between the same locations used to determine stream length and valley length. A survey level (*e.g.* laser level) and stadia rod should be used to survey the elevation change. If a site is moved or values were not transcribed from the previous valley slope measurement, valley slope is collected on the floodplain or terraces outside of the stream channel.
- Stream Length: Stream length is measured in the vicinity of the stream reach cross-section. This measurement is taken along the bankfull center line from riffle crest to riffle crest over a distance of at least 2 meander wave lengths or 20 channel widths and between the same locations used to determine elevational change and valley length. The bankfull center line may not correspond to the thalweg.
- Valley Length: Valley length is measured in the vicinity of the stream reach cross-section. This measurement is taken parallel to the long axis of the valley over a distance of at least 2 meander wave lengths or 20 channel widths and between the same locations used to determine elevational change and stream length.

Reach Sinuosity: Reach sinuosity is calculated as the **stream length** divided by the **valley length** over a distance of at least 2 meander wavelengths, or 20 channel widths as noted above. Record in #15.

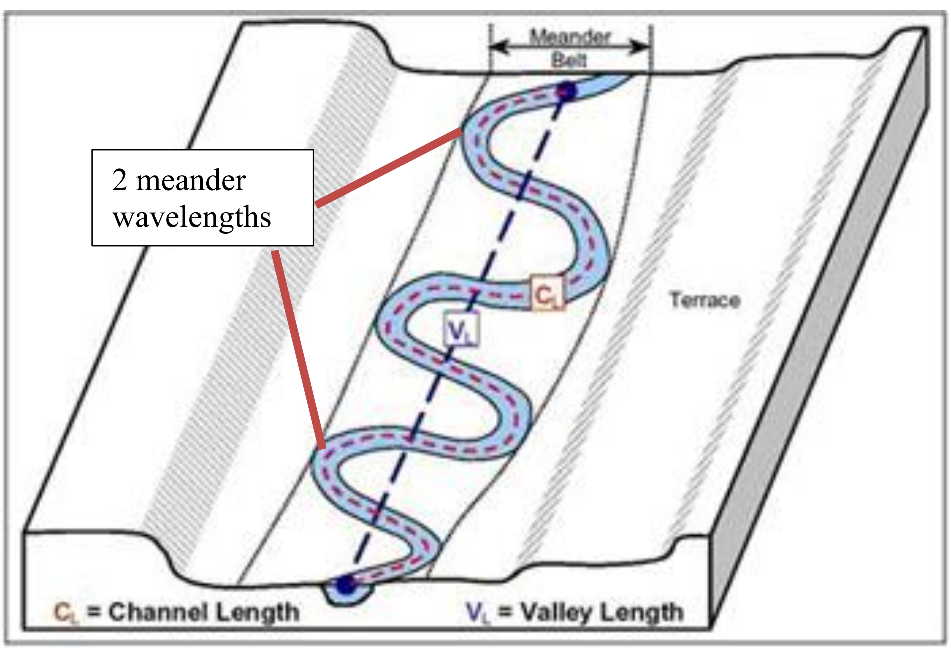


Figure 1. Locations to measure channel length and valley length

Pebble Count

Where recorded: record on pebble count field form; summarize on riffle stability index form

A Wolman pebble count is conducted in the vicinity of the stream reach cross-section to characterize substrate composition in riffles, help classify the stream reach according to the Rosgen stream classification system and contribute to the determination of Riffle Stability Indices. A minimum of 100 particles should be tallied according to the specified particle size classes listed in Table 2 (modified from American Geophysical Union, Lane 1947). Substrate should be measured along evenly spaced transects that run perpendicular to the channel through one or more riffles in or near the stream reach. The heel-to-toe method is used to randomly identify substrate particles to be sampled. Observers start with their heel at bankfull and reach down to the boot tip with a pointed finger without looking at the substrate to reduce bias. The first particle touched is measured with a ruler with the size categories marked. The observer then places heel to toe and repeats. Transects always start and end at the bankfull elevation, so once a transect is started, it must be completed even if it causes the sample size to exceed the minimum of 100 particles.

Table 2. Streambed particle size categories

Category	Particle Size (mm)	Particle Description
1	< 2	sand/silt/clay
2	2 – 4	very fine gravel
3	4 – 8	fine gravel
4	8 – 16	medium gravel
5	16 – 32	coarse gravel
6	32 – 64	very coarse gravel
7	64 – 128	small cobble
8	128 – 256	large cobble
9	256 – 512	small boulder
10	512 – 1024	medium boulder
11	1024 – 2048	large boulder
12	2048 – 4096	very large boulder
13	> 4096	bedrock

Stream Classification

Where recorded: Valley Segment and Stream Reach form

Determine the Rosgen (1994) stream classification for the reach using the Rosgen Classification Key (Figure 2) which provides a flow chart using the number of **stream channels**, **entrenchment**, **width:depth ratio**, **sinuosity**, **stream slope**, and **dominant particle classification**. This may be recorded after field collections (e.g., on the drive back) but should be completed as part of the survey effort and reported back to provide a simple accuracy check.

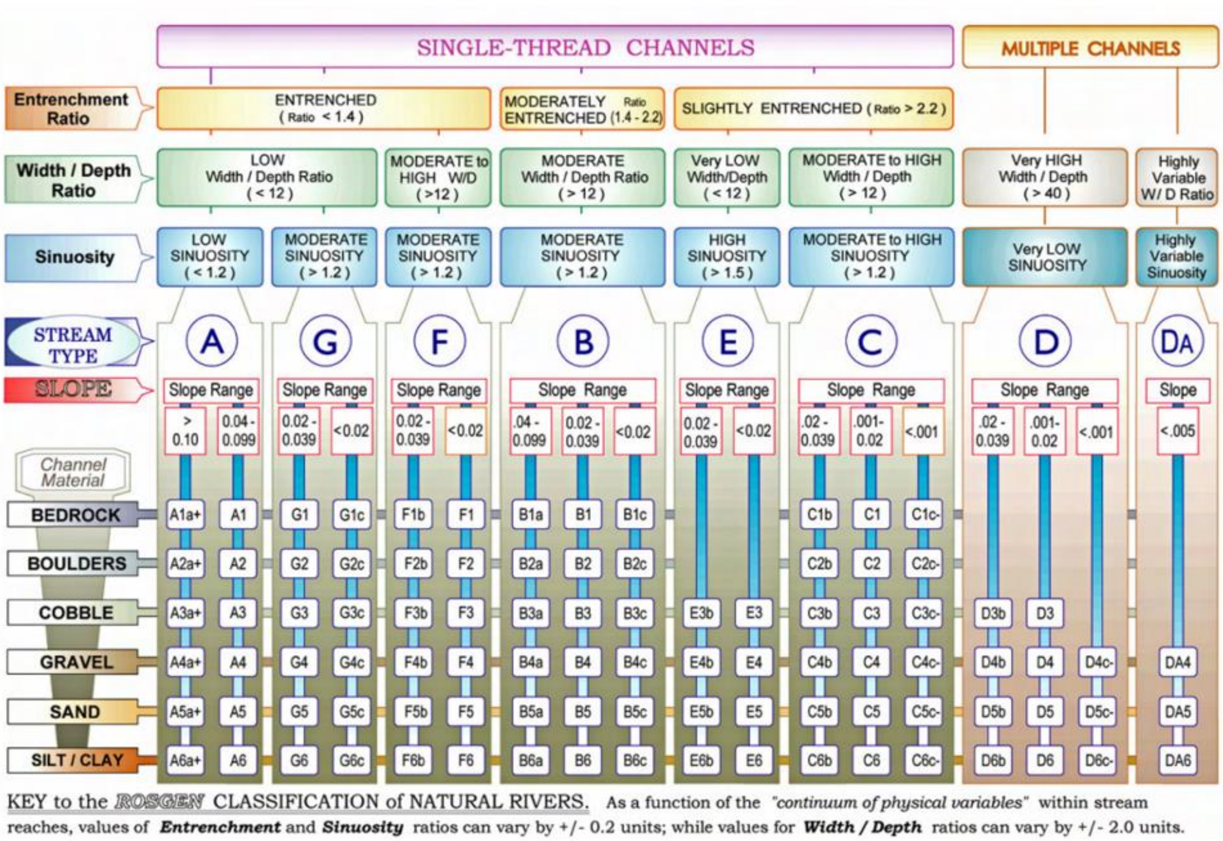


Figure 2. Rosgen Stream Classification Key

Gravel Bar Sample

Where recorded: riffle stability index form

Measure approximately 30 of the largest and recently transported particles on one or more gravel bars located in the vicinity of the stream reach cross-section and pebble count. Freshness of movement is evaluated by relatively brighter color, lack of particle embeddedness, lack of stain, and lack of algae or moss coating the particle. The intermediate axis is measured and recorded (mm) for each particle. After field collections, calculate the geometric mean size of these particles and use this information with pebble count data to obtain the Riffle Stability Index (RSI) according to Kappesser (2002).

Fine Sediment Sample

Where recorded: fine sediment form in the lab

Use the shovel method with a standardized 8" concave blade shovel, (Grost et al 1991; Hames et al 1996) to collect suitable spawning gravels and put the sample in a one-gallon zip-lock bag for transport to the lab. Three samples are collected at each reference reach, ideally from three separate areas of the reach.

Samples are collected facing upstream unless in stronger currents whereby it may be necessary for one or more crew members to stand around the gravels to create a calm zone, so sediment does not flush from the sample. The blade is held in a vertical position perpendicular to the stream bed and worked straight down into the gravel by applying pressure on the footplate while moving the handle from side to side. After the blade is fully inserted or as deeply as possible, the shovel is pulled straight back until the blade is parallel to the stream bed surface. This procedure often requires a pull/push motion to maintain the pivot point in the gravel at the junction of the footplate and the handle. Finally, the handle is grasped near the blade and the shovel is carefully removed from the stream bed while maintaining a horizontal position to avoid spilling material. The sample is placed in a bag labeled with the stream reach and collection date. After fine material has settled out of the water in the bag, the excess water may be drained for lighter transport taking care not to lose any sediment.

Fine sediment samples should be collected from gravel deposits that represent the best potential brook trout spawning substrate in or near the surveyed stream reach. Typically, these samples will be collected from pool tail-out areas where hydrologic properties often result in a sorting of gravels that are most frequently used during spawning. If no suitable collections of spawning gravels occur in the reach where fish were sampled, gravels may be collected from upstream or downstream as long as habitat and stream geomorphic conditions are similar. Avoid collecting directly adjacent to roads/angler access points or upstream/downstream of conditions that may skew the more generalized sediment dynamics in the reference reach (e.g., tributary).

Once the samples are collected, the dry weight of the particles is determined by oven drying the sample for at least 72 hours at 60º C and sifting it for 7 minutes with a sifter and scientific sieve pans as specified in Table 3. Percent fines is calculated as the weight of all sediment smaller than 4 mm (particles that pass through 4 mm sieve) divided by the weight of all particles smaller than 37.5 mm (particles that pass through 37.5 mm sieve – used to define suitable spawning gravel for brook trout) and the weight of all sediment smaller than 1 mm (particles that are retained in the pan sieve) divided by the weight of all particles smaller than 37.5 mm.

Table 3. Sediment sample mesh sizes

Mesh Size (mm)	Sieve Designation
pan	pan
1	18
2	10
4	5
6.3	¼
8	5/16
37.5	1 ½

Stream Habitat Inventory

Where recorded: Stream Habitat Inventory Form

Stream habitat is inventoried from the closest habitat break near the downstream tag to the closest habitat break near the upstream tag (synonymous with the fish survey points). Habitat is classified based on the flow conditions on the date of sampling, not speculating on higher or lower flow conditions. Generally, habitat inventories should occur when flows are near baseflow conditions for the season. Higher flows tend to homogenize habitat breaks and make the assessment more difficult and less accurate.

Channel Units: Aquatic habitat units result from reciprocal influences of a stream's physical channel characteristics and its hydrologic properties. Channel units are distinguished by breaks in the habitat type along the course of a stream. Breaks between channel units (or aquatic habitat types) can be obvious physical features, such as a wood jam separating two pools or a small waterfall separating a pool and riffle. However, it is not uncommon for breaks to be more subtle transitional areas between two habitat units. In these situations, questions can arise as to the actual location of the channel unit break or whether the perceived break is substantial enough to delineate two distinct habitat units in the stream inventory. To help resolve this question, consider the definitions, diagrams, and example photos below for the different habitat types with a focus on the habitat criteria for the streambed (slope and substrate composition), the hydrology (water depth and velocity), and the habitat unit size (or relative significance).

Generally, habitat units should be at least as long as the wetted width. Units that do not meet this criterion can be lumped in with an adjoining habitat unit of similar character. However, habitat units that do not meet the "longer than wider" criterion but have distinctively different habitat characteristics from upstream or downstream units should be classified as a separate habitat unit. This is particularly true for short pool units that span the channel. Ultimately, use best professional judgment to decide when and where to split out a habitat unit. It is important to rely on your training to maintain a level of consistency and repeatability to the thought processes used to make these determinations throughout the survey and throughout the season.

Habitat Unit Number: Record the number of the main channel habitat unit. The numbering procedure starts with unit number 1 at the lower end of each reach and increases sequentially by one in an upstream direction for each additional habitat unit in the main channel.

Habitat Unit Channel Code: Record the channel code for the habitat unit as either **main (M)** channel unit, **adjacent (A)** to the main channel unit, or **side (S)** channel unit.

- Main channel: the channel carrying the majority of flow

- Adjacent habitat unit: distinctive habitat types within bankfull that warrant a distinctive habitat characterization. For example, a deep pool behind a boulder on the margin of a long riffle which only covers ¼ of the channel width. Also known as a secondary habitat feature. Two similar habitat units split by dry bars within bankfull should be surveyed as one unit with consideration of the dry section (e.g., removing that section from the wetted width (Figure 3).

- Side channel: channels and associated habitat are separated by island-like features or bars which are generally at or above bankfull elevation and are as long as the bankfull width (Figure 4).

Figure 3. Example of adjacent pool habitat differing from the main channel run.

In areas where adjacent units overlap in the wetted channel, it is necessary to identify the overlapping channel units as adjacent to ensure that only one habitat unit length is recorded for subsequent fish population density calculations.

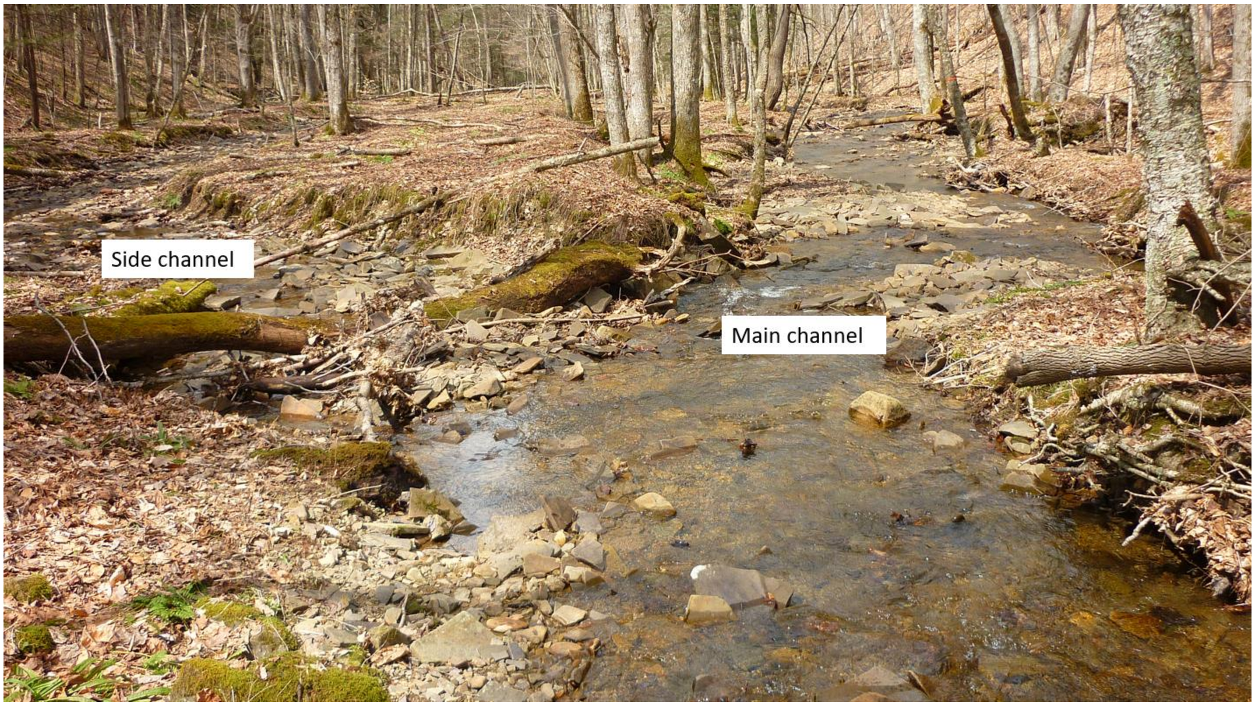


Figure 4. Example of main channel and side channel separated by elevations above bankfull.

Side Unit Number: Record the side unit number only for **adjacent** and **side** channel habitat units. The numbering procedure starts with number 1 for the side unit that flows into a main channel unit. The number increases sequentially by one in an upstream direction for each additional side unit associated with that particular main channel unit. The side unit number (if necessary) is re-set at 1 for every main channel unit.

Habitat Unit Type: Habitat units are classified as **cascade (C)**, **riffle (R)**, **run (RN)**, **pool (P)**, **glide (G)**, or **underground (U)** habitat (Table 4 and Figure 5). Pools are sub-classified based on the dominant formative feature – **LWM (W)**, **boulder (B)**, **bedrock (BD)**, **beaver (V)**, **meander (M)**, **standing tree (T)**, **confluence (C)**, **landslide (L)**, **culvert (Cu)**, **artificial (A)**, or **other (O)**. An effective strategy to determine the dominant feature driving pool formation, where more than one feature is present, is to envision the unit without each feature and determine which feature has the greater influence on creating and/or maintaining the pool.

Refer to the definitions in Table 4 and Figures 5 through 15 to stay calibrated to varying stream habitat conditions.

Table 4. Habitat unit type descriptions

Unit Type	Code	Definition
Cascade	**C**	**Fast water,** turbulent, gradient ≥12%; highly turbulent series of short falls and small scour basins, with very rapid water movement; also include sheets (shallow water flowing over bedrock) and chutes (rapidly flowing water within narrow, steep slots of bedrock) if gradient ≥12%
Riffle	**R**	**Fast water, shallow,** turbulent, gradient <12%; shallow reaches characterized by water flowing over or around rough bed materials that break the surface during low flows; flat-bottomed in cross-section with a poorly defined thalweg; also include rapids (turbulent with intermittent whitewater, breaking waves, and exposed boulders), chutes (rapidly flowing water within narrow, steep slots of bedrock), and sheets (shallow water flowing over bedrock) if gradient <12%
Run	**RN**	**Fast water, deep,** non-turbulent, gradient <12%; deeper than riffles with little or no surface agitation or flow obstructions; usually have a defined thalweg, may be U- or V-shaped bottom profile
Pool	**P**	**Slow water, deep,** non-turbulent, gradient <1%; generally deeper and wider than habitat immediately upstream and downstream, concave bottom profile, usually U-shaped, although bedrock pools can have any bottom profile (residual pool depth > 0)
Glide	**G**	**Slow water, shallow,** no surface turbulence, gradient <1%; flat cross-section profile; The slope of the channel bed is opposite the slope of the water surface.
Underground	**U**	Stream channel is **dry** or not containing enough water to form distinguishable habitat units

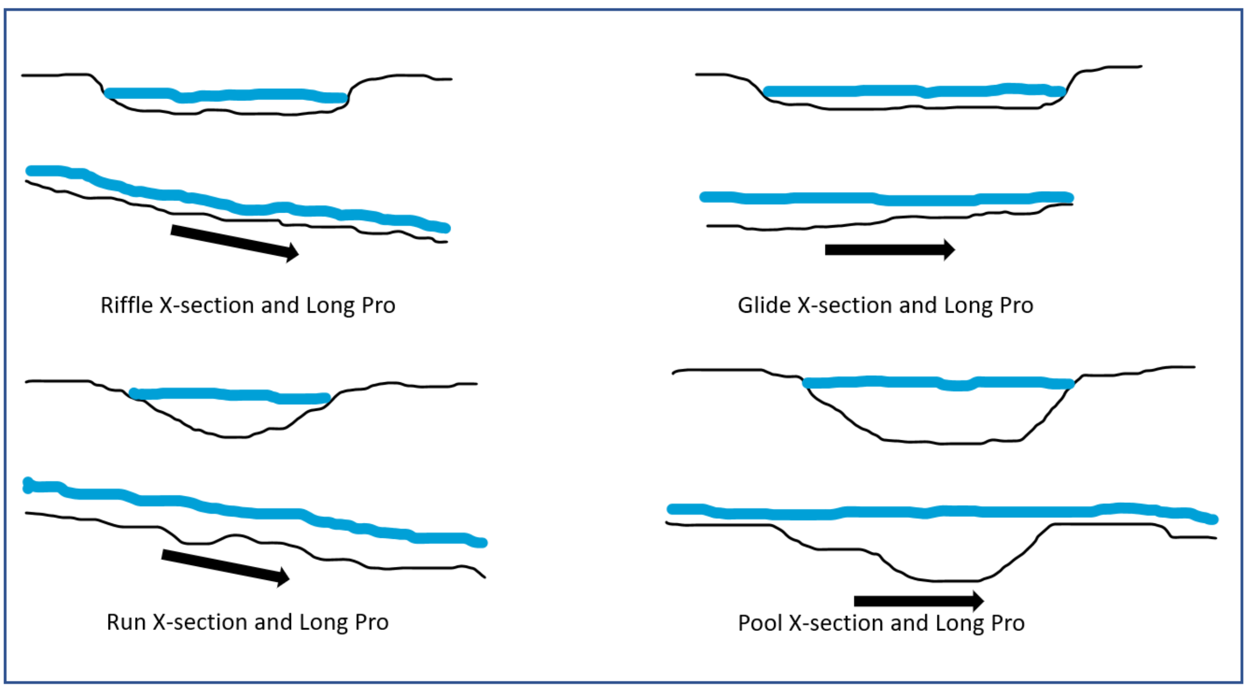


Figure 5. Cross-sections (top) and longitudinal profiles (bottom) of the four primary habitat types (arrows are flow direction for Long Pro).

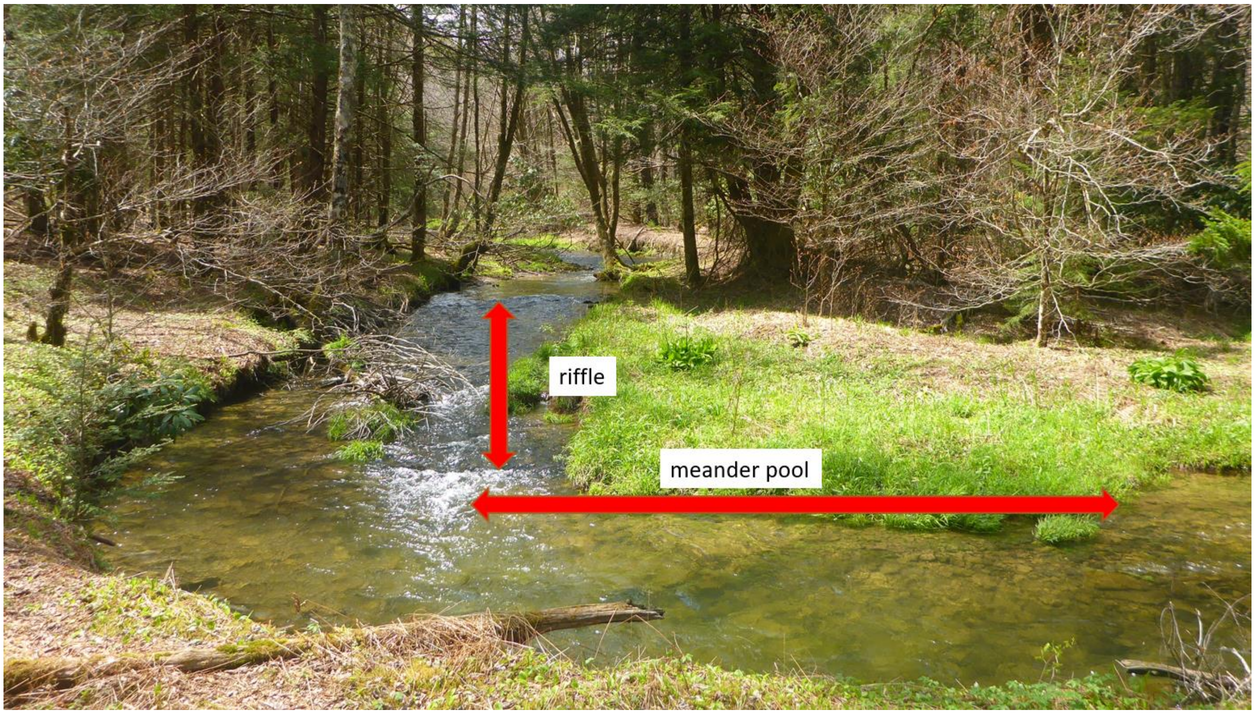


Figure 6. Riffle flowing into pool (meander is the formative feature)

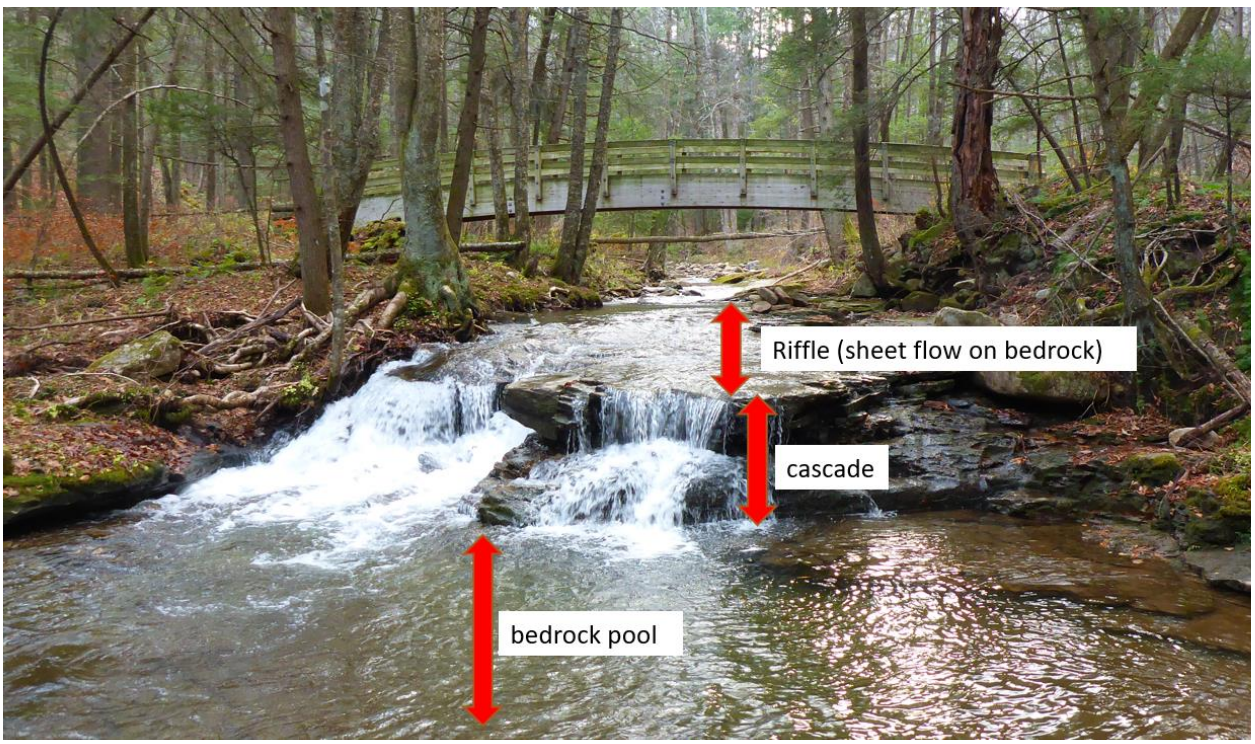


Figure 7. Riffle on flat bedrock flowing over short cascade into bedrock pool.

Figure 8. Pool formed by meander with standing tree and LWM. Note pool formation upstream of tree and LWM indicating the dominant feature although the tree and LWM contribute to the pool complexity, gravel sorting, etc.

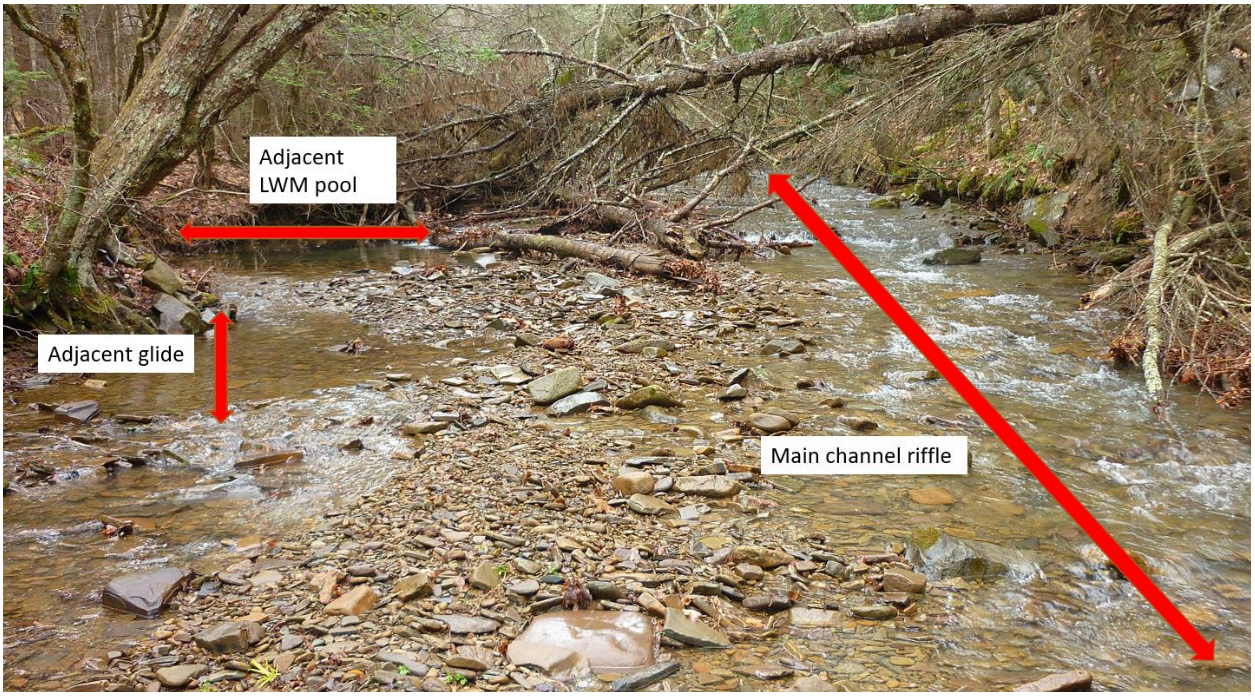


Figure 9. Main channel riffle with adjacent LWM pool and glide. Note the mid-channel separation bar is in bankfull.

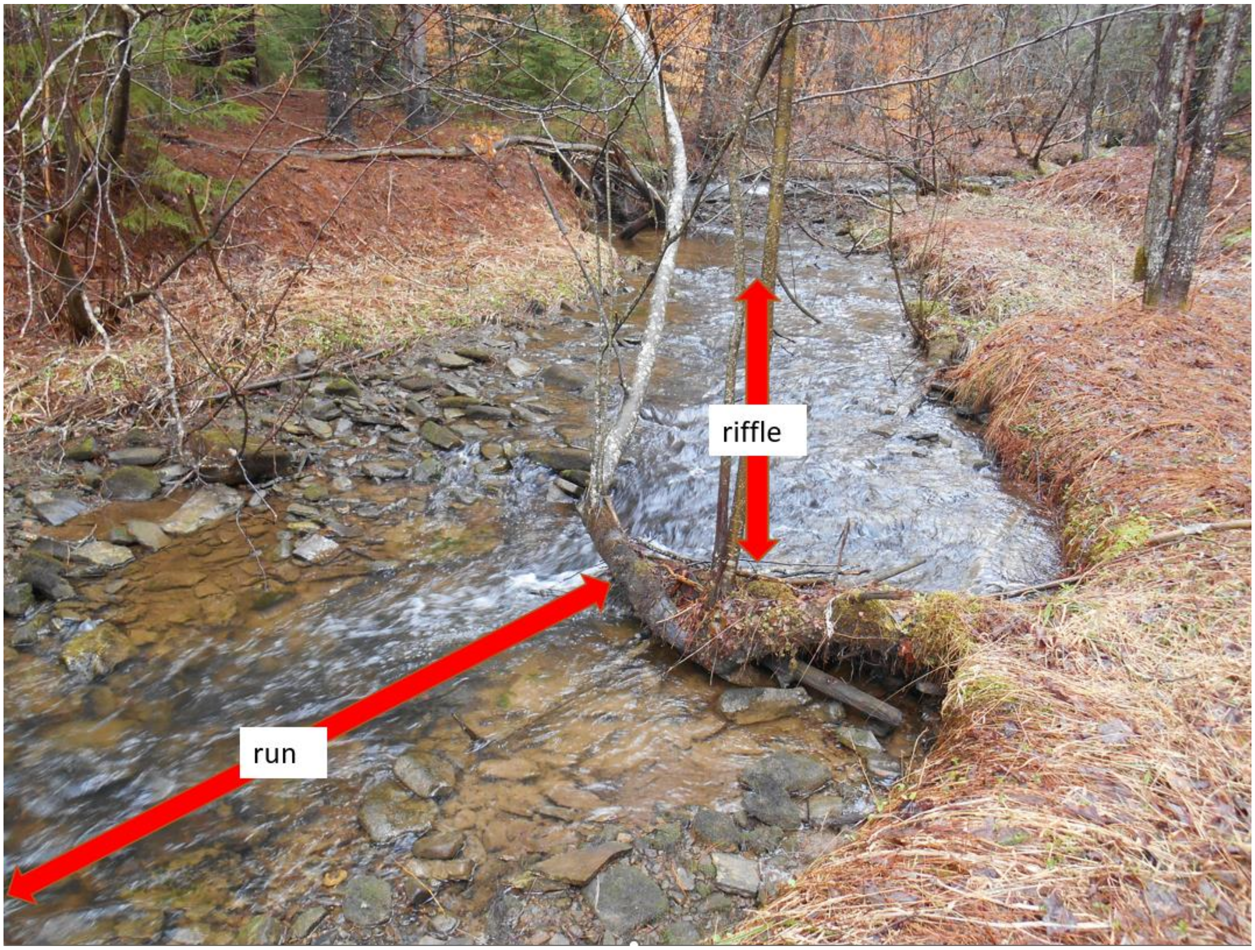


Figure 10. Riffle flowing into run. Unit separation caused by bank tree. Note variation in X-section depth profile

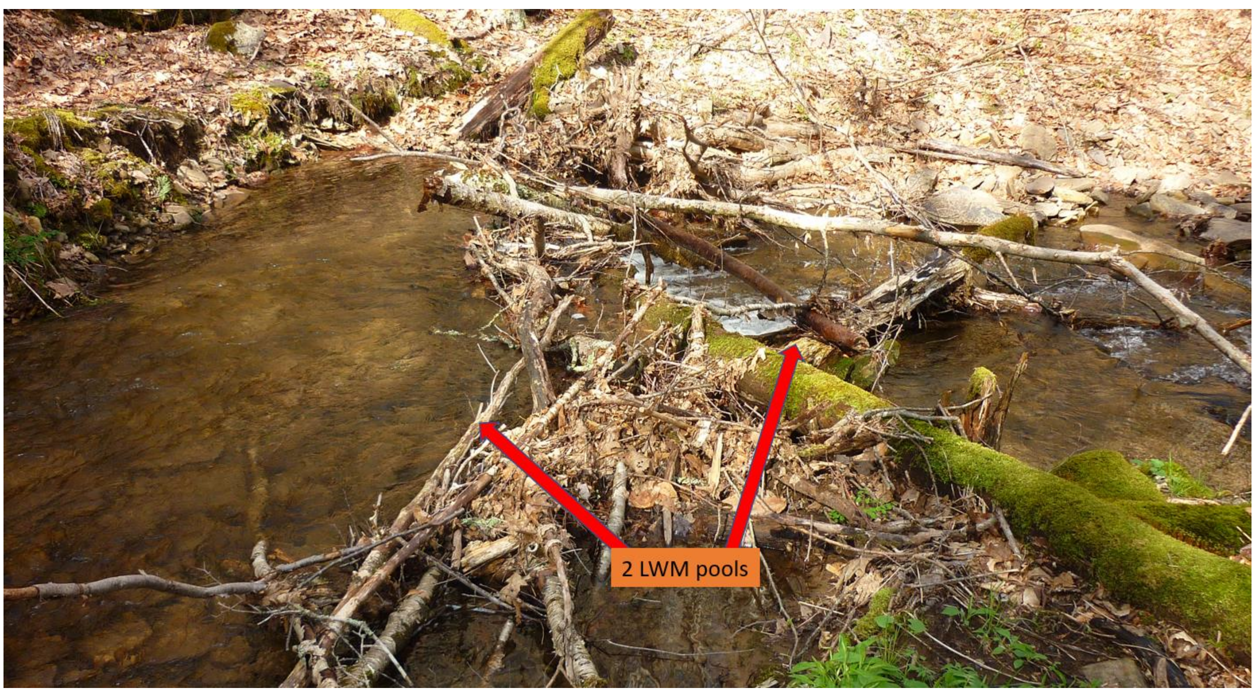


Figure 11. Example of two adjacent habitat units of the same type. Backwater pool behind LWM and scour pool below LWM

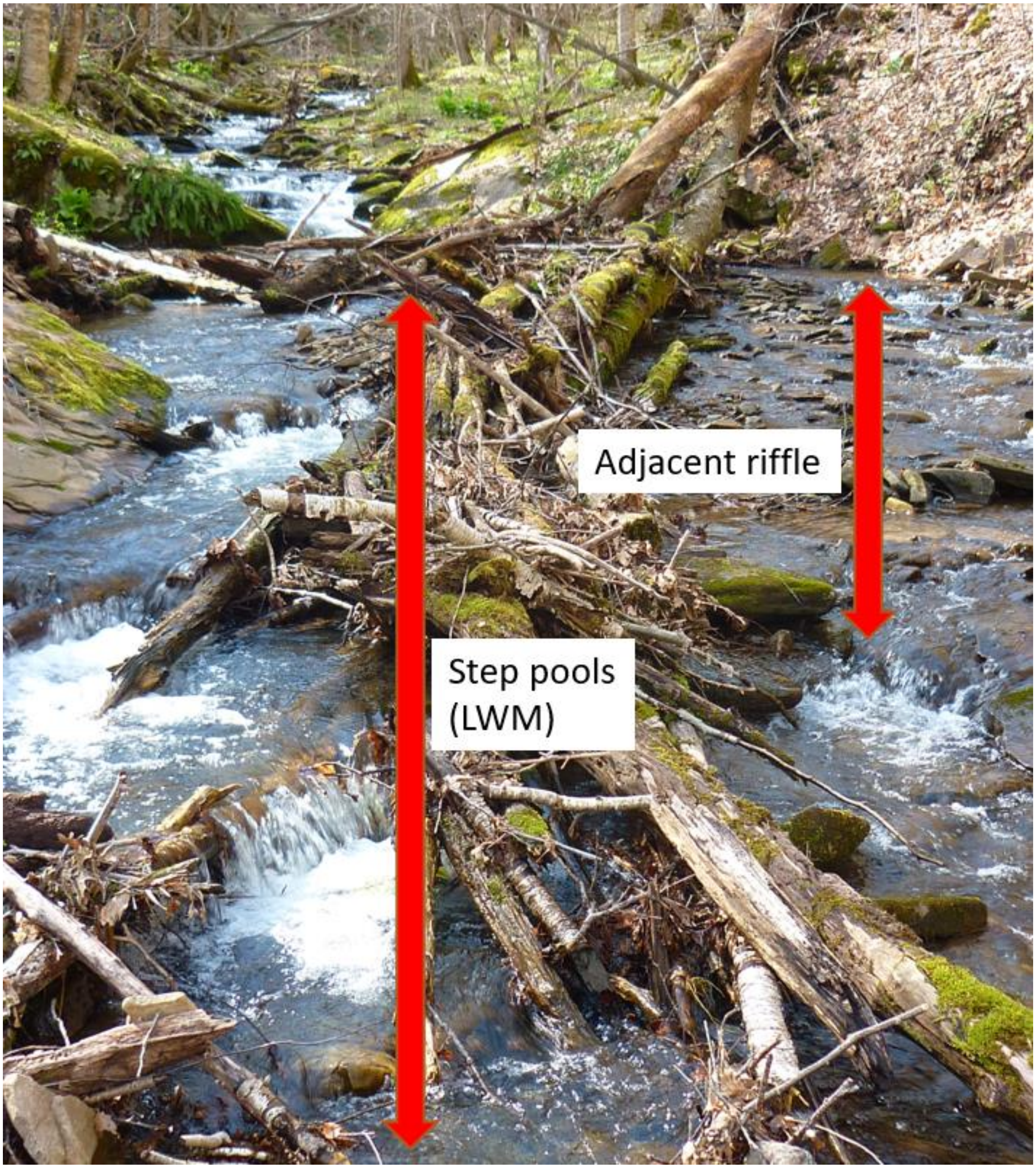


Figure 12. Step pools (both LWM and boulder) on river right and adjacent riffle on river left, separated by LWM. Note the main channel is narrower but is carrying a larger volume of water than the riffle.

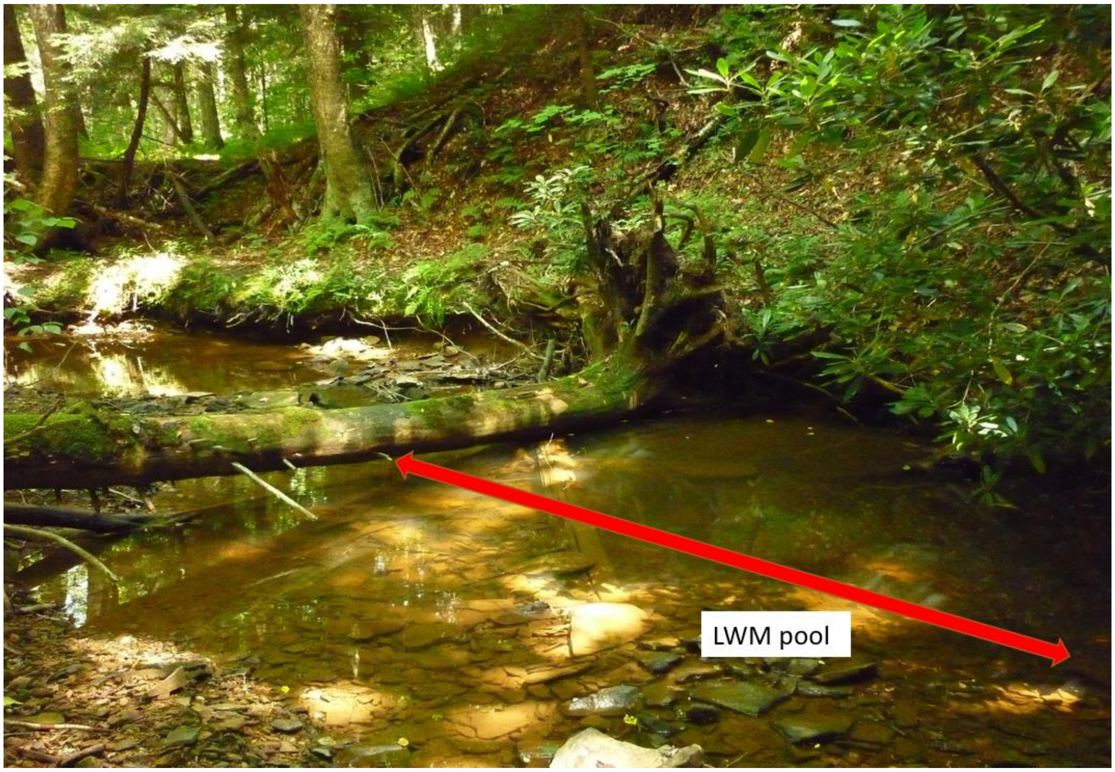


Figure 13. LWM is the pool formative feature in the meander. Note the absence of a pool upstream of the fallen tree.

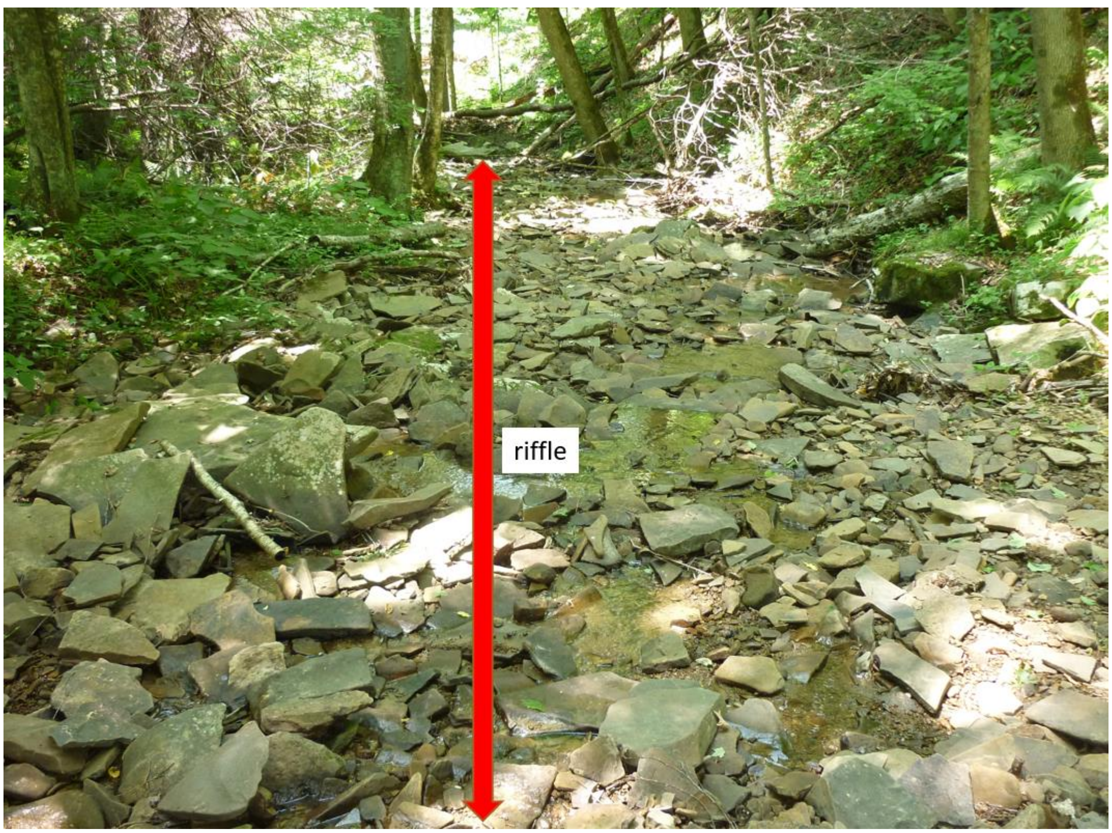


Figure 14. Riffles are often very dry in many MNF streams during summer.

Figure 15. Run flowing into boulder pool. Streams in boulder dominant systems will have very different characteristics from cobble-dominant and smaller bedload systems, especially in riffles and runs.

<u>Unit Length</u>: Measure the **length** on the habitat unit to the nearest 0.1 meter with a measuring tape or field surveyor's rope along the middle of the channel.

<u>Average Width</u>: Measure the **average wetted width** of the habitat unit perpendicular to flow to the nearest 0.1 meter at a location that represents the average width. Habitat units that are highly irregular in width or extend long distances may require several width measurements; record the average of these. Dry surfaces, such as gravel bars, which bisect habitat units should not be included in width measurements. Width measurement(s) should be measured with a measuring tape, field surveyor's rope, or stadia rod.

<u>Average Depth</u>: For all habitat types except pools, average wetted depth is obtained by measuring (to the nearest 0.01 meter) the wetted depth of the habitat unit at one-fourth, one-half, and three-fourths across the transect(s) used to determine the average wetted width. Sum all depth measurements collected across each width transect and divide that sum by the product of 4x, where x = the number of width transects used to collect depth measurements. Record the average depth to the nearest 0.01 meter.

In pool habitat, the average depth is determined in a manner similar to other habitats except the transect used to measure depths at one-fourth, one-half, and three-fourths across the wetted width is located by finding the point along the thalweg that corresponds to the average of the (maximum pool depth + maximum depth at the pool crest). The transect that is perpendicular to the flow and passes through this point on the thalweg is used to obtain the 3 depth measurements that are summed and divided by 4 to obtain the average wetted depth in pool habitat.

Maximum Depth: Measure the maximum depth of the water surface to the nearest 0.01 meter with a stadia rod in slow water habitats (i.e., pools and glides).

Maximum Depth at Pool Crest: Measure the maximum depth of the water surface to the nearest 0.01 meter with a stadia rod **at the pool tail crest** (downstream end of pools) for scour pools or **at the pool head crest** for dammed pools. The pool tail crest is the lowest point in the grade control which dictates the pools elevation (i.e., the first place the pool would spill out if the stream were dry and the pool received rain).

Bank Instability: Visually estimate the **length of unstable bank (to the nearest meter)** on river left and right independently. Unstable banks show evidence of breakdowns or calving, slumping, tension cracks or fractures, or vertically eroding. Bank instability is normally within bankfull, but any instability where high water would likely cause a connected effect (e.g., substantial erosion, tree fall, etc.) should be included.

Dominant Substrate: Record the size class code of substrate material that **covers the greatest amount of surface area in the wetted channel** of the habitat unit based on visual observation. Size classes are shown in Table 5. The proper axis used to size particles for stream substrate characterization is shown in Figure 16.

Sub-dominant Substrate: Record the size class code of substrate material that **covers the second greatest amount of surface area in the wetted channel** of the habitat unit based on visual observation.

Table 5. Pebble size classes for estimating the dominant and subdominatn substrate material during channel unit surveys

Code	Size (mm)	Particle	Upper Limit Examples
S	< 2	sand/silt/clay	Thickness of a nickel
G	2 - 64	gravel	Racquetball
C	64 - 256	cobble	Basketball
B	256 - 4096	boulder	VW beetle
BD	> 4096	bedrock	none

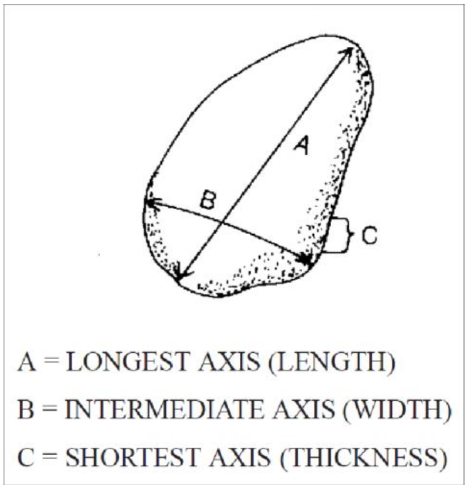


Figure 16. Proper axis used to size particles for substrate sampling. Estimate substrate size along the intermediate axis (b-axis). The b-axis is not the longest or shortest axis, but the intermediate length axis. It is the b-axis that determines the size sieve the particle could pass through. It is not unusual to bias these visual estimates by focusing on the larger substrates; take care to avoid doing this.

Cover Composition: Visually estimate the **percentage of in-stream cover (slow water units only)** to the nearest 10% (or 5% for cover elements that represent less than 10%) based on the 2-dimensional surface area of the channel unit. Cover elements consist of **large substrate**, **bedrock ledges**, **undercut banks (non-vegetation associated)**, **LWM**, **aquatic vegetation**, **terrestrial vegetation (includes standing live trees and roots)**, and **whitewater**. The total percent cover should not exceed 100% of the channel unit area. The amount of space under boulders, bedrock ledges, wood jams, and undercut banks should be thoroughly explored to determine the extent of coverage and available habitat.

Large Woody Material**:** Large woody material (LWM) is inventoried in each channel unit according to the specified **LWM size classes** listed in Table 6. Pieces of LWM must be dead and down (2 points of contact) and at least partially within the 3-dimensional bankfull channel width before it can be counted. Pieces of LWM can only be counted once in categories 1-4. Therefore, pieces that span more than one habitat unit should be counted in the unit that it is most influential in providing habitat or cover. Pieces of LWM primarily outside the bankfull elevation and not resulting in obvious habitat formation, cover composition, or hydraulic influence should not be counted (e.g., a large tree outside the flood-prone elevation would be a category 4 but only a few branches extend to within the bankfull and are not influencing the bankfull flow in an appreciable, detectable manner).

An **aggregate** is a collection of two or more pieces of LWM that meet the minimum size requirement, whose fluvial geomorphic function is overwhelmingly a reflection of the sum of all LWM pieces together rather than a reflection of the individual pieces acting as separate entities.

- The LWM aggregate is more functional than the mere sum of its individual LWM pieces.
- The function of the aggregate is different than the expected function of the individual pieces in isolation.

Aggregates often consist of smaller pieces of wood which contribute to the cohesiveness of the structure but are not counted in the inventory. If two or more pieces of category 1, 2, 3, and 4 LWM occur as part of an aggregate, record them as the number of pieces of LWM in an aggregate, as well as individually in their corresponding size categories. Also record the number of individual aggregates.

Table 6. Large woody material (LWM) classification.

Category	Length (m)	Diameter (cm)	Description
1	1-5	10-55	short, thin
2	1-5	>55	short, thick
3	>5	10-55	long, thin
4	>5	>55	long, thick
Number in Aggregate	1 or longer	10 or thicker	number of pieces of LWD counted as class 1, 2, 3, or 4 that occur as part of an LWD aggregate
Number of Aggregates			number of individual aggregates

Photos: Photos are taken of the cross-section (with tape and bankfull flags visible), and the upstream and downstream ends of the reach. Have a crew member in the photo for scale with hand signals for the US (pointing up), DS (pointing down) and cross-section (arms crossed at the forearm). Photograph the Valley Segment and Stream Reach Form with the header completed prior to tag photos to aid in photo ID. Record photo numbers on Valley Segment and Stream Reach form.

Notes: Record notes of site location and tag locations. Also note any irregularities, questions, resource concerns and awesome discoveries.

Standard Equipment

Job Hazard Analysis	SPOT unit	Lunch
Backpack	First Aid Kit	Drinking Water
Rain Gear	FS Portable Radio, Batteries	Toilet Paper
Hard Hat	Camera w/batteries	
Safety Field Vest	Wading Boots/Waders	

Stream Survey Equipment

Tatum (Clip Board)	GPS Unit
Topographic maps	Aluminum Tags, Nails, Steel Stamps
Aerial Photos (optional)	Laser Level
Protocols	Stadia Rod
Data Forms (blank)	Measuring Tape(s)/Field Surveyor's Rope
Field Notebook	Cross-section Pins
Pencils/Markers	Pin Flags
Calculator	8" Concave Shovel (Spawning Gravel Samples)
Flagging	Sediment Bags (Spawning Gravel Samples)
Thermometer	Extra Batteries (for All Electronic Equipment)
Previous Survey Data and Photos	Plastic Ruler (for pebble counts)

Aquatic Biota Survey Equipment

Fish Population Surveys
Electro-fishing Unit/Batteries (extra cathodes, anodes, batteries)
Measuring Board
Weight Scale, batteries
Dip Nets
Block Nets
Buckets
Live Well
Fish Anesthetic (Clove Oil, etc.)
Field Fish Survey Notebook
Scientific Collection Permit
Fish ID information

Task List - Recommended Effort

Project Map Marked with Survey Location(s) & Previous Data	Aquatic Habitat Survey (3 people)
Channel Cross-Section Survey (3 people)	Fish Populations Survey (3 people)
Channel Sinuosity Survey (2 people)	
Valley/Channel Slope Surveys (2 people)	Photo of Sample Site (2 people)
Pebble Count (3 people)	Tagged Sample Site (1 person)
Bar Sample - 30 Count (2 people)	Field Notes
Spawning Gravel Samples - 3 (2 people)	