Why Monitor Physical Habitat?

Physical habitat assessment methods aim to identify, survey, and assess physical habitats and the overall functioning and conditions of rivers and streams.

River Watch assesses two types of physical habitat; macro habitat and micro habitat. Macro habitat is a large environment where different species of plants and animals reside. Macro habitat includes parameters like the health and structure of the riparian zone, the entire streambed, the banks, etc. A micro habitat is a small environment where particular species live. Micro habitats can include pools of water, riffles, undercut banks, or another small section of a river or stream where a certain species may live.

Each fall you should be completing a physical habitat assessment of your sampling area whether or not you are collecting a macroinvertebrate sample. Assessing or evaluating the habitat quality of your sampling area every year is critical in determining the ecological integrity of that area and monitoring whether the habitat is changing. River Watch provides a specific form to visually assess your sampling site and record those details. Changes in the physical habitat of your site can impact the biological integrity of the river and the surrounding areas.

Please use the datasheet below for your macro physical habitat assessment. For this assessment you will evaluate a 200 foot stretch of your stream at your sampling site.

Macro Physical Habitat Datasheet

Station Name: _____ Station Number: _____ Date: _____

Instream Habitat Features	**A**	Indicate % of each habitat type in the stream reach (100 ft above **and** below sample) (may not add to 100%): • Cobble____% ☐ Gravel % _____ ☐ Sand_____% ☐ Snags_____% ☐ Vegetated Banks_____% • Submerged vegetation _____% ☐ Algae _____%		
Watershed Features	**B**	Predominant Surrounding Land Use **Right Bank:** ☐ Forest ☐ Dense housing ☐ Field/pasture ☐ Sparse housing ☐ Irrigated ☐ Commercial ☐ RR/hwy ☐ Industrial ☐ Park/Bike Path ☐ Other_____ **Left Bank:** ☐ Forest ☐ Dense housing ☐ Field/pasture ☐ Sparse housing ☐ Irrigated ☐ Commercial ☐ RR/hwy ☐ Industrial ☐ Park/Bike Path ☐ Other_____		
Localized Erosion	**C**	**% Bare Bank Soil** ☐ 80-100% ☐ 10-39% ☐ 40-79% ☐ 0-9%	**Erosion Amount** ☐ extensive ☐ localized ☐ some evidence ☐ no evidence	**Bank Movement** ☐ bank failures ☐ slight ☐ mod collapses ☐ none
Riparian Vegetation	**D**	Indicate the dominant riparian zone vegetation type and record dominant species: **Right Bank:** ☐ Trees ☐ shrubs ☐ grasses ☐ herbaceous ☐ other_____ ☐ dominant species_____ **Left Bank:** ☐ Trees ☐ shrubs ☐ grasses ☐ herbaceous ☐ other _____ ☐ dominant species_____		**Riparian Zone** ____ ft Wide Left Bank ____ ft Wide Right Bank
Aquatic Vegetation	**E**	Indicate the **dominant vegetation** type instream (not on banks): ☐ Rooted emergent ☐ Submerging floating leaf ☐ Rooted floating ☐ Free Floating ☐ Attached algae		**Portion of reach with aquatic Vegetation**: _____%
Instream Features	**F**	**Canopy Cover:** _____% of stream bank covered with Canopy/other	**% of Reach Stream:** ☐ Riffle_____% ☐ Pool_____% ☐ Run_____%	Estimated **Wet** Water Width _____Ft Estimated **Bank** Full Width _____Ft Estimated average stream **depth** _____Ft **Channelized** ☐ YES ☐ NO

Average Depth Profile of Representative Sample Transect

What is a transect? A transect is a straight line that cuts through a natural landscape so that standardized observations and measurements can be made. We are looking at creating a perpendicular line from one bank of your stream/river to the other bank. We want to collect average stream depths moving across this transect from one bank to the other. Select a location where you can safely wade across the river. Using your measuring stick, measure depths at 1 step intervals from bank to bank across the river and record each measurement below. Please mark your depth measurements in inches or feet (circle the measurement you used).

1. Measure the transect from bank to bank (wet water width): _____ ft.

Interval	Unit (ft/in)	Depth	Interval	Unit (ft/in)	Depth	Interval	Unit (ft/in)	Depth
1			**11**			**21**		
2			**12**			**22**		
3			**12**			**23**		
4			**14**			**24**		
5			**15**			**25**		
6			**16**			**26**		
7			**17**			**27**		
8			**18**			**28**		
9			**19**			**29**		
10			**20**			**30**		
	Sum			**Sum**			**Sum**	

Total of Sum depths: _____

Total Intervals Measured: _____

Average Depth (Divide Total Sums of Depths by Total Intervals Measured): _____

Physical Habitat Descriptions

For the Physical Habitat Datasheet (and micro habitat data)

This section evaluates Habitat Features, Watershed Features, Localized Erosion, Riparian Vegetation, Aquatic Vegetation and Instream Features **for the entire 200 foot segment surrounding your sample site (100 feet upstream, 100 feet downstream).** There are 6 sections in this description. Definitions to all terms found in these sections are provided below (as discussed in the US EPA's Rapid Bioassessment+6 Protocols).

Observe the entire reach (200 feet) and be as objective and consistent as possible. Many physical habitat features are **subjective or observational versus objective or a direct measurement**, however, if completed consistently, results are valuable to track changes in the physical landscape over time.

Section A: Instream Habitat Feature Descriptions

Instream Habitat Features	**A**	Indicate % of each habitat type in the stream reach (100 ft above **and** below sample) (may not add to 100%): • Cobble____% □ Gravel % _____ □ Sand_____%□ Snags_____% □ Vegetated Banks_____% • Submerged vegetation _____% □ Algae _____%

This section describes the different habitat types that are present in the streambed. This might not add up to 100%.

- Cobble, gravel and sand can all be present in the streambed. Sand and other fine sediment are usually the least productive macroinvertebrate habitat in streams as this habitat type has minimal interstitial space, or minimal space between grains of sand for macroinvertebrates to live. Interstitial space is critically important for macroinvertebrate diversity, for fish spawning, and some large cobbles and boulders also create habitat for juvenile fish. Despite this, sandy habitat may be the most prevalent in some streams.

Substrate Type	Diameter
Boulder	Larger than 10 inch-es
Cobble	2.5-10 inches
Gravel	0.1-2.5 inches
Sand	Less than 0.1 inches

- Snags and other woody debris are fallen branches, washed out or inundated shrubs/trees and small logs, which have been submerged in the water for a long time (not just fallen), and provide excellent colonization habitat for macroinvertebrates (fish too!). Accumulated woody material in pools (deeper slower water) is considered snag habitat.

- Overhanging and Vegetated banks occur when the river has eroded the soil beneath the roots of streamside plants. Submerged areas of undercut banks are good habitats. This type of bank generally provides good cover for macroinvertebrates and fish and is resistant to erosion. However, if seriously undercut, it might be vulnerable to collapse.

- Aquatic submerged macrophytes (large plants) are seasonal in their occurrence and may not be a common feature of many streams, particularly those that have ahigh gradient. These plants live submerged in the water and bank and can be seen with the unaided eye. Submerged macrophytes are important primary producers in aquatic ecosystems and they play an important role in maintaining the biological diversity and functional stability of aquatic ecosystems (Carpenter and Lodge, 1986; Scheffer et al., 1992). Macrophytes provide cover for fish and substrate for aquatic invertebrates. They also produce oxygen and provide food for some fish and other wildlife. Macrophytes respond to a wide variety of environmental conditions, are easily sampled, and do not require laboratory analysis.


Section B Watershed Features

Watershed Features	**B**	Predominant Surrounding Land Use **R**ight **B**ank:		**L**eft **B**ar
		☐ Forest	☐ Dense housing	☐ Forest
		☐ Field/pasture	☐ Sparse housing	☐ Field/
		☐ Irrigated	☐ Commercial	☐ Irrigat

This is a description of the land adjacent to ***both*** the left and right stream banks. These are always determined by looking upstream from the sampling site. For each bank check the predominant (top 1 or 2 most prevalent types) land uses 100 feet adjacent to the reach on each side.

- Forests: trees, evergreen or deciduous in a fairly undisturbed tract
- Field/Pastures: fields of grass, left undisturbed or used for grazing even if irrigated, not cropland, etc.
- Irrigated: irrigated land for any crop
- RR/Hwy: a railroad, highway or road
- Dense housing: like a suburban or urban area
- Sparse housing:10 acres or more per house/unit
- Commercial: commingled buildings or business as on a main street in town

- Industrial: refinery, brewing company, power plants etc.
- Other: anything that doesn't fit above (please describe)

Section C Localized Erosion

Localized	**C**	**% Bare Bank Soil** ☐ 80-100% ☐ 10-39%	**Erosion Amount** ☐ extensive ☐ localized

This section evaluates local erosion (the process in which materials are worn away and transported by natural forces – water, especially during rain events) and potential sources of sediment in the stream reach. A river carries a certain amount of sediment either in the water column (suspended) or moving along the bottom (bedload). How much sediment and what size particles are in the sediment load are a function of the stream volume (discharge) and velocity (flow). A river is designed to carry sediment from its headwaters to the mouth. Human activities and natural phenomena that remove vegetation and expose soil make the land vulnerable and can lead to a large quantity of sediment delivered to the river during precipitation driven runoff events. Many sources of sediment in a river are from diffuse, **non-point sources** like a poorly managed construction site versus a direct **point source,** like a pipe. You are evaluating evidence of diffuse or non-point sources of sediment and the amount of visible erosion. Some things to look for while assessing localized erosion include extensive reaches of non-vegetated banks, traveled foot/tire paths next to, down to or even crossing the stream, culverts/bridges, any bare dirt proximate to the bank, etc. Assess what percent of the stream reach you are surveying has evidence of erosion using the guide below.

There are three parameters to note:

% Bare Bank Soil: make an estimate of the area of bare soil (80-100%, 0-9%, etc.) in the riparian zone that is not bound by plants and their root structures or covered in concrete or rocks. These bare areas can be caused by wildlife, livestock or human access, roads and crossings, clearings or undercut banks.

Erosion Amount: estimate the amount of erosion that is present on the banks within the reach. Choose the category that best describes your estimate (extensive, some evidence, localized, no evidence).

- Bank Movement and Stability: Banks along a river can move or become unstable due to a lack of vegetation, roots or other mechanisms to keep the soil and bank from entering the water. Within your reach, assess whether the banks may have become unstable leading to a bank collapse/failure and show signs of degradation. Choose the category that best describes your estimate of bank stability or degradation (bank failures, moderate collapses, slight or none).

Section D Riparian Vegetation

Riparian Vegetation	**D**	Indicate the dominant riparian zone vegetation type and record Right Bank: Left Bank: ☐ Trees ☐ shrubs ☐ Trees ☐ ☐ grasses ☐ herbaceous ☐ grasses ☐ ☐ other ☐ other

This section describes the vegetation type on each bank. Riparian vegetation along the bank and transitioning into the upland ecosystem provide food and habitat for a variety of animals in some aspect of their life cycles. It can also provide a migration corridor for those animals, soil stability, water quality filtration, shade that cools the river, food for aquatic organisms and a buffer for the water body.

In this section, please describe the dominant vegetation type for each bank. You don't need to know the species, just the type (tree, grass, shrub/bush, or herbaceous) but if you do know species, please document. If there is no vegetation along the riparian zone, note ***other*** and please describe in the space provided (i.e. pavement, dirt, etc.) Evaluate for both left and right banks. Estimate the width of the riparian zone on each bank, noting that the width of the riparian zone is from the water's edge through the extent of the riparian vegetation up to where the vegetation changes from riparian species to more upland prairie or forest type vegetation. Record the width on the data sheet.

Section E Instream Aquatic Vegetation*

Aquatic Vegetation	**E**	Indicate the **dominant vegetation** type instream (not on banks): ☐ Rooted emergent ☐ Submerging floating leaf ☐ Rooted floating ☐ Free Floating

This section focuses on vegetation ***in the stream*** **only**, not on the banks. These species need water; need to be submerged or associated with water for some part of their life cycle. Typical examples range from cattails to liverworts, blue green, green and brown algae and periphyton. Evaluate the plants that are visible to the naked eye (macrophytes).

These are generally divided into two categories: vascular (contain mechanisms for transporting water and nutrients, think trees, flowering plants etc.) and non-vascular species (lack mechanisms for transporting water and nutrients, think algae). Aquatic vegetation is an important component of water bodies because they can provide food, oxygen and habitats for aquatic animals, supply food and habitat for birds, stabilize banks and beds, and remove some of the potential pollutants in runoff from the water. Factors that affect the type and distribution of water plants include climate, flow, velocity, light, temperature and water quality. Look in the water and estimate the dominant vegetation type in the entire length of the 200 foot stream reach using the guide below. Then estimate the percentage within the reach that is populated with vegetation.

- Rooted emergent or submerged is an aquatic plant rooted in wetland, lake or river substrate. These plants usually grow at the water's edge or in shallow water. Most of the plant is above water. These include common plants such as rushes, cattails and some grasses. Some are broad-leafed and some have narrow leaves.

- Rooted floating is a rooted aquatic plant that has come loose and is now floating in the stream.

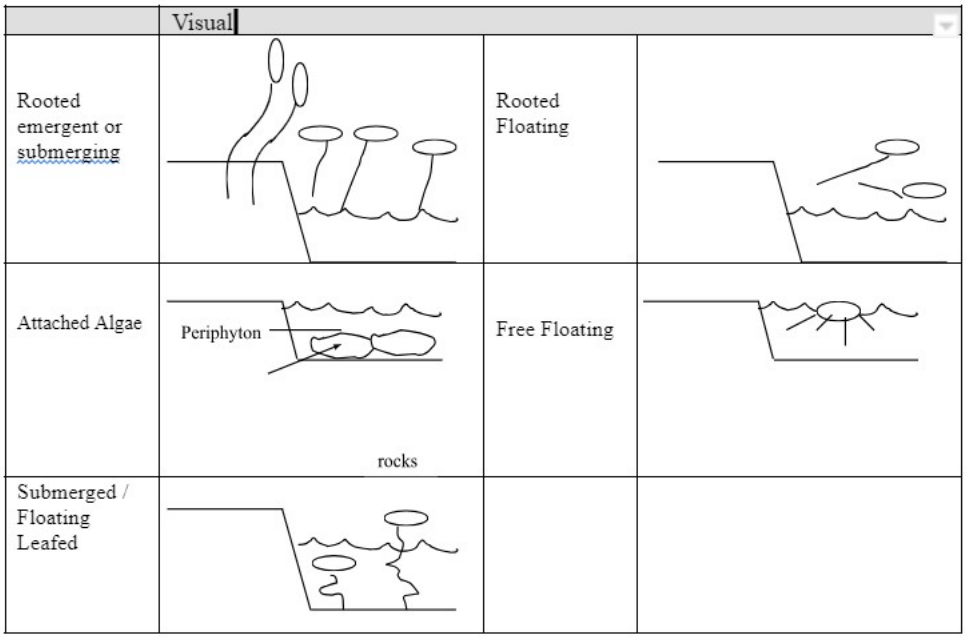
- Submerged/Floating leaf varieties have root systems attached to the bottom of the water body and in some cases, have leaves that float on the surface and/or flower parts that emerge from the water. These include plants such as water lilies, milfoils, watercress and ribbon weed.

- Attached Algae and diatoms grow on any submerged surface and are common in Rocky Mountain streams. They can include green filamentous algae seen in the photographs below. Algae grow in slower moving water and stagnant eddies; algae will be more common in nutrient rich streams with high concentrations in nitrogen and phosphorus.

Another form of algae common in Colorado streams is an invasive diatom called Didymo, also known as “rock snot”, see pictures below. Didymo can grow in dense coarse mats across a stream bottom and can have a wooly texture. Didymo is usually brown or yellow in color. It is an invasive species, not native to Colorado and it does not produce algal toxins.

Another form of attached green algae is Cladophora, it can be a nuisance but it is native to Colorado, does not produce toxins and is common in nutrient rich streams. It is a bright green filamentous algae that attaches to rocks and remains under water in contact with the bottom.

- Free floating is a plant that prefers to grow as it floats. They are not attached at any time and occur in relatively still water. The whole plant is floating with roots suspended in the water. These include common plants like azolla and exotic plants like water hyacinth.



*Algae is becoming a larger issue in rivers and streams and River Watch will include more information on potentially harmful algae below.

Section F Instream Features

Instream Features	**F**	**Canopy Cover:** _____% of stream bank covered with Canopy/other	**% of Reach Stream:** ☐ Riffle_____% ☐ Pool_____% ☐☐ Run_____%

This section evaluates instream features that provide quality habitat for macroinvertebrates. This is to be evaluated for the entire 200 foot stream reach.

- Canopy Cover: Trees and large shrubs provide shade and minimize temperature changes in the stream. It also provides food and habitat for emerging macroinvertebrates and food for fish as the insects fall into the river. Look up and down the stream, if the tree canopy covers the entire width of the open water, the canopy cover would be 100%. If any coverage occurs, estimate how much of the cover is generated from both the right and left banks and record.
- Stream Reach Description: Pools (slow, deep water), riffles (fast, shallow water), or runs (long, deep, slow, gliding pool) are the descriptors used to identify how the stream is moving through space. Identify the percentage of each type in your reach and note.
- Wet Water Width: The width of the water in the stream, from one wet edge to the opposite wet edge. If you have a measuring tape and can safely wade in the stream, measure this.
- Bank Full Water Width: The highest level that water could reach without flowing out of the banks onto adjacent land. Usually you can tell this by old wet watermarks or vegetation changes. If you have a measuring tape and can safely wade into the stream, measure this.

- Channelized: When you look within the stream reach up and downstream, can you see the stream meander (bend) at all? Answer this with a yes or no answer. If you cannot see any meanders, then the stream may be channelized due to a road, railroad or other reasons. Channelization is exactly what it sounds like, the human process of straightening and deepening channels in rivers. Channelization, which reduces sinuosity, is the process of straightening, widening or deepening stream channels to increase water conveyance and provide anthropogenic services (i.e., flood protection, navigation, drainage to facilitate agriculture and development; Emerson 1971, Gillette 1972, Brooker 1985).

  The straightening aspects of channelization often increases erosion. Removing the bends in the river effectively disconnects the river from the flood plain and the river cannot deposit the sediment it carries. By removing the natural bends from rivers, the water has a longer time to build up speed and stream power. This means the water pulls much more of the surrounding soil with it.

Most channelization and maintenance practices restrict the growth of riparian (streamside) vegetation. This vegetation filters sediments, shades the stream, and provides needed plant materials that seasonally fall into the stream. These plant materials become food and habitat for organisms.

Channelization is a major modification to natural rivers that results in habitat simplification and reduction in frequency of specific, life-supporting habitat types (e.g. pools, spawning gravels). Channelization also destabilizes erosion/deposition dynamics, shortens residence time during which excess nutrients may be processed, and increases risks of downstream erosion and channel destabilization with accompanying loss of use or property. Negative impacts on biological communities are well documented not only within channelized reaches but at substantial distances downstream. The significance of this metric in the stream's ability to recover is based on multiple effects: degraded habitat, altered primary physical processes, destabilized instream conditions, persistence of negative effects for decades, and high expense of reengineering channel sinuosity.

- Average Stream Depth: The estimate or measurement of stream depth in several places along a transect in the stream.

1. Measure the transect from bank to bank : 14

Interval	Depth (ft/in)	Depth	Interval	Depth (ft/in)	Depth
1	Inches	8	11	Inches	18
2	Inches	17	12	Inches	16
3	Inches	32	12	Inches	8
4	Inches	36	14	Inches	6
5	Inches	44	15		
6	Inches	42	16		
7	Inches	36	17		
8	Inches	40	18		
9	Inches	28	19		

Toxic Algae

More commonly known as “blue green algae”, cyanobacteria are a vital part of aquatic ecosystems. They are a primary producer, capturing nutrients and carbon dioxide as they do photosynthesis. Cyanobacteria are an ancient organism credited with being among the first organisms to conduct photosynthesis and transfer oxygen to our atmosphere. Cyanobacteria naturally occur in lakes and rivers on every continent and have been observed everywhere, including Colorado. Not all forms of cyanobacteria produce toxins. Cyanobacteria are reported in Colorado as “planktonic” blooms (surface blooms that typically appear in large, stagnant waterbodies like a reservoir). When cyanobacteria form large blooms, and produce toxins they are often referred to as harmful algal blooms (HABS) or toxic algae.

This is because most Cyanobacteria have the ability to produce toxins, known as “cyanotoxins.” Cyanotoxins are harmful to people and wildlife who ingest the water with toxins, and they can irritate skin in contact with the water. While cyanobacteria are capable of producing toxins they don’t always produce them, it is also unknown if the toxins are a defense mechanism against herbivory (grazing) or if there is another evolutionary advantage to the toxins. It is unclear what triggers the production of the toxins in cyanobacteria. They can grow in large numbers, creating a dense mat or bloom and not produce toxins while other blooms may look small and diffuse but can be very toxic to humans and wildlife.

It has recently come to our attention that cyanobacteria may also form mats on the bottom of river and stream beds (aka “benthic cyanobacteria”), which is also capable of producing cyanotoxins. In 2022, cyanobacteria were detected in one of Colorado’s rivers, we want to bring this information and tools to River Watch Volunteers so you may keep your eyes out for benthic harmful algal blooms.

Causes of Algal Toxins

When nutrients and water temperatures are high, algae may form dense growths called “blooms”. Excessively high levels of nutrients (nitrogen and phosphorus) favor blooms of cyanobacteria. Anthropogenic sources of nutrients that runoff into lakes and rivers include lawn fertilizer, animal waste, discharge from wastewater treatment systems, and agriculture fields with fertilizer. This input can cause eutrophication, or excessive plant or algal growth. Picking up animal waste, using less fertilizer and phosphorus-free fertilizers, and maintaining a healthy riparian zone around waterways so other vegetation can intercept runoff are all ways each of us can reduce nutrient loading and resulting algae blooms.

Public Health Considerations

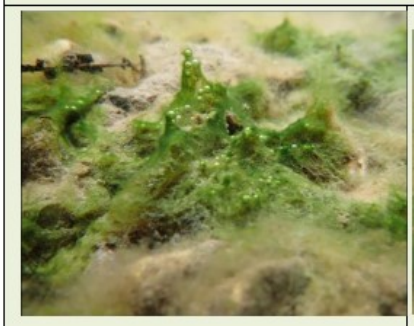
Algal toxins produced by cyanobacteria may harm humans, dogs, wildlife, and livestock if ingested, or may irritate skin, eyes, ears, and nose. To prevent exposure, do not drink lake or river water, and avoid contact with floating algae mats or suspicious algae blooms. Do not allow pets or livestock to wade, swim, or drink water with suspicious algae blooms. Do not allow dogs to eat dried algae mats. Follow the instructions on any posted caution or warning signs.

What to Look For

- Floating mats of algae
- Water that looks like green paint
- Turquoise or blue-green algae
- Algae growths that smell bad

Visual Characteristics of Benthic Cyanobacteria Blooms

Color: diverse, ranging from vibrant yellow-green, drab olive, to burgundy and dusky brown or black.



Shape: may look fuzzy (but no long strands), form hollow orbs, or grow in leathery mats with veins or ribs.



Location: form dense growths that appear as a film along the bottom and may become detached and float to the surface. May also attach to aquatic plants.

If you suspect a cyanobacteria bloom is present in a waterway, it is best to avoid direct contact with the water. And when in doubt, just STAY OUT!
Contact ToxCall
303-692-2606
cdphe_toxcall@state.co.us
Additional Information/References:
EPA http://www2.epa.gov/nutrientpollution/harmful-algal-blooms
CDC http://www.cdc.gov/nceh/hsb/hab/

Fishing and boating are safe when a lake is under a Caution status, but users are advised to avoid contact with floating algae mats or green paint-like surfaces while swimming, wading or water skiing.

Fish caught in a blue-green algae outbreak are safe to eat, so long as they are rinsed with clean water and only the filet portion is eaten. Hands should be washed with clean water after handling the fish.

Why Monitor for Macroinvertebrates?

Freshwater (Aquatic) macroinvertebrates

Aquatic macroinvertebrates are insects in their nymph and larval stages that spend part of their lives in water. They play a key role in nutrient cycling and are indicators of stream health. Freshwater environments are generally considered to include inland waters not influenced by tides from the ocean or natural salty waters. Invertebrates are all the animals that do not have an internal skeleton of cartilage or bone. Macroinvertebrates are large enough to see with a naked eye. In rivers, these organisms are benthic (meaning they live on the bottom, between and under the substrate). They have an enormous range of morphological adaptations, feeding niches, life cycle variations, habitat niches and movement variations.

Indicators of Stream Health

The Clean Water Act uses chemical parameters and associated standards to indirectly determine stream health. In this Sample Plan, Chapter 3 (Monitoring), we discuss the three components of a river ecosystem as being chemical, physical and biological.

Monitoring can tell us how well a river is functioning and if it is healthy or at risk. Understanding how monitoring fits into the bigger picture is essential in implementing a River Watch monitoring program. One way to assess the health of an aquatic ecosystem is to categorize monitoring parameters into three areas **chemical**, **physical**, or **biological**. The River Watch program measures parameters in each of these three categories. When assessing the health or status of a system, like your body or a stream, you want to measure the **stress, exposure** and **responses** to possible pollutants. A comprehensive watershed monitoring plan would incorporate all six of these elements as much as resources allow.

Furthermore, all three monitoring parameters can be a stressor, exposing harm to organisms that live or use the river. These organisms are indicator species and exposure to a stressor can cause a response in these species. That response can be **chronic** or **acute**. To characterize or quantify exposure, a monitoring program's study design will include ways to measure **magnitude, frequency and duration** of exposure to determine if it is at a level to cause a chronic or acute impact. That impact will also depend upon the organism, the size, age, species, ability to move, time of year, and path of exposure (ingestion, physical, etc.). **Magnitude** is the degree of exposure above a threshold, (large or small). **Frequency** is how often the organism is exposed, every day to once year, or even once a life time. **Duration** is how long an exposure occurs. This may be every day, every day or only for five minutes per day, or once a year for one day, etc. If the exposure is of sufficient magnitude, frequency and duration and the organism dies, that is considered an **acute exposure** (often high magnitude, not frequent and a short duration). If the exposure over time causes anything from a skin condition to death that is considered **chronic exposure** (lower magnitude, very frequent and a longer duration). Chemical standards are developed by doing toxicity tests on organisms to determine how much they can take before suffering chronic or acute effects. The Clean Water Act standards include an acute and chronic level when data is available.

Monitoring the response community provides data on those stressors and the exposure to them. The response community would include monitoring plants, animals and/or humans directly. Humans are difficult to monitor directly, however, patterns of disease, sickness or other conditions can be monitored; that is the science of epidemiology. Bacteria like E.coli provide an indicator of health and is often the parameter used to protect recreation standards in many states through clean water acts. All waters have **bacteria** to break down organic material for food and just like your stomach, some are good and some are harmful. Bacteria in waterbodies are can be helpful, but some are very harmful, like some cyanobacteria. **Aquatic vegetation** can be an indicator for excess nutrient loading.

Aquatic macroinvertebrates are effective indicator species because they spend most of their life cycle in the water. Macroinvertebrates typically live a year or less, are not that mobile relative to fish, easy and feasible to collect, occupy diverse habitats, have diverse life cycles, are not artificially managed, differ in their tolerance to different pollutants (stressors) and respond to human disturbances in predictable ways. **Fish** are also good indicators as they are further up the food chain, reside in different habitats, have different tolerances to pollutants and their response is predictable for some human disturbances. However, fish are more expensive to monitor and difficult to collect. There are fewer of them and they can be managed (stocked, etc.) by humans. Each biological community provides a unique line of evidence for impairment or health that adds to information from biological, chemical and physical habitat monitoring.

Macroinvertebrate Collection and Micro Physical Habitat Assessment Instructions

Overview – Must Read

1. River Watch uses two macroinvertebrate collection protocols, which requires identification of the dominant substrate as **Rocky** or **Sandy**. A secondary protocol is optional, and allows other types of nets, provides a simple diversity index immediately and organisms are returned to the river. Optional instructions follow these core instructions. Physical habitat assessments can be completed once a year independent of collecting macroinvertebrates
2. The primary objective for collecting macroinvertebrate data is to compile a species list over time and space to identify indicator species that might signify changes in community structure or function. One macroinvertebrate sample will be collected at a minimum of ONE station per group within a contract year (if funding and capacity allow). Your responsibility is for collection only. A Colorado Department of Public Health and Environment approved taxonomist will complete identification to a genus/species level.
3. During the macroinvertebrate collection season, RW staff will inform the volunteer if they will be collecting a sample for identification. RW staff will ship you sample bottles with alcohol to preserve your sample. You will determine whether to use **Rocky or Sandy Substrate** datasheets. Ten percent of participating groups will be chosen to provide a quality control sample.
4. **There are three** physical habitats and analyses associated with a macroinvertebrate sample. A **depth profile** in a representative habitat, a **micro-habitat stream bottom composition** and **macro-reach scale assessment**. Of these three, the micro-habitat, (where you collect bugs), **must be completed** with each macroinvertebrate sample – and will be different for Rocky versus Sandy. The micro-habitat assessment describes the bug's habitat or environment and will document changes in aquatic environment over time. The macroinvertebrate and physical habitat datasheets must be submitted with each collection. Complete all three assessments if safe and possible. A depth profile, macro-habitat assessment and physical habitat datasheet **can** be completed without a macroinvertebrate sample.
5. **ALWAYS** collect a water quality sample the same time/day as the macroinvertebrate sample. Collect your water quality sample before you collect your bug sample. This tells us the "condition" of the river for the bugs at the time of collection. A water quality sample includes pH, temperature, dissolved oxygen, alkalinity, hardness and both total/dissolved metals. If possible collect a nutrient sample as well.
6. Full instructions for both macroinvertebrate collection and physical habitat assessment are in this manual. River Watch also has videos available that illustrate many of the steps and definitions.
7. Each bug collection and/or habitat assessment is a sampling event, given a unique sample identification that is a combination of station number, date and time. If water quality samples are collected at the same time, all these samples will have **the same** sample identification.
8. Ship macroinvertebrates, datasheets and chain of custody within three weeks after collection. This will help to insure we can have the bugs identified prior to the end of each contract/school year.

Equipment for Macro Collection

Equipment provided by River Watch:

- A modified D-net (18" x 8"); the net is a 500-micron mesh net.
- Two forceps to pick organisms from net
- A 600-micron sieve (#30)
- One small brush
- Two containers with alcohol preservative – one 500 mL and one 1000 mL bottle (four bottles if you are to collect a QA/QC sample).

Additional equipment provided by you:

- 5 gallon clean white sample bucket, (do not use the River Watch water quality sample bucket)
- A squirt bottle (can be any water bottle with a squirt nozzle)
- A timing device that can time 60 seconds (a second hand on a watch)
- Waders
- A ruler to measure substrate sizes > or < than 12", 6" and 3"
- A broom, pole or pipe with inch and foot marks on it to measure depths
- A tape measure (can be marked string or twine) to measure stream widths
- Rubber gloves (optional) and magnifying glasses (optional)
- A large **white** enamel or plastic tray – or white trash bag (easy to see bugs on)

Field Preparation Overview

Identify if you are a **Rocky or Sandy** substrate station. Print out the **Macroinvertebrate Collection Data Sheets** for your collection (pages 1 and then either the Rocky or Sandy substrate pages). Start by filling out page 1 with your station/date/time information. Check **all** appropriate boxes. If you have been chosen to collect a **QA/QC sample**, check that box also. Check what you collected or assessed that day, water quality, metals, nutrients, depth profile, and micro and macro habitat (if you are collecting macroinvertebrates, you will need to check micro and macro habitat and depth profile)?

Label each macroinvertebrate sample bottle with river name, station name, station number, time and date on a macro label using a pencil.

1. Gather gear from list above, including water quality sampling gear.

2. Remember you will collect water quality sample **BEFORE** any macroinvertebrate sampling as this method involves disturbing the substrate and could contaminate a surface water sample. **Depth profiles should be completed last with your physical habitat macro assessment.**

NOTE: Following these instructions means your data can be used by decision makers. If you do not follow our protocols, the use of the data you collect is limited. Not following our protocols means the data is not comparable to other data sets and the data

Choosing Bug Sites and Recording Sampling Event

The first step is to determine if your segment is one classified as **rocky or sandy**. This is important because you want to sample where the bugs live. The delineation is based on whether your river sample site is dominated by hard bottom substrate (rocky) or sandy bottom.

- A rocky bottom means more than 80% of the reach is boulder, rubble, and cobble and gravel thus you should use the “Rocky Substrate” datasheet and protocols.
- If more than 80% of substrate is covered by sand/silt or fines, even if you see rocks, cobble and gravel, then you will use the “Sandy Substrate” Datasheet and protocols.

This method is semi-quantitative. The same substrate area is standardized and the effort is consistent at 240 seconds. It is accepted that this method produces an effective species list.

Below is the macroinvertebrate collection data sheet. The instructions for rocky protocol collection and sandy protocol collection will follow the data sheets.

Fill out the first data sheet regardless of which protocol you are using to collect your sample:

Macroinvertebrate Collection Data Sheets

Macroinvertebrate Collection Data Sheets
(Sample Site Information and Depth Profile)

Station Name_____ Date of sample ___/___/___ Time ___:___

River_____ Station number:_____

Group (School)_____ **Substrate** : **ROCKY** ☐ **SANDY** ☐

RW Net and method ☐ or Other_____ **# of Kicks/ dips conducted?** ☐

☐ Field Data Collected	☐ Depth Profile Completed
☐ Metals Collected	☐ Micro-habitat (4 kicks/dips) completed
☐ Nutrients Collected	☐ Macro-habitat reach assessment
☐ QA Macro Sample Collected	☐ Yes or No -Is this your normal water quality station?

Part 1:

a. Draw a picture of the sample site (from bank to bank, 200 feet above/below sample area):

Left bank or **right** bank-looking upstream (circle one)

Left bank or **right** bank looking upstream (circle one)

b. Flow direction on diagram → OR ← (circle one)

c. Draw in stream attributes such as riffle, dams, fallen trees, pools, roads, tributaries, bridges, wetlands, riprap, pipes, and other landmarks to identify reach, Label appropriately, include larger sheet if desire.

d. Draw a square representing bug sample location and a number in each square representing each 1 of 4 kicks.

Part 2: Average Depth Profile of representative sample transect:

From the Physical Habitat datasheet, please record the average depth profile here:

_____ Feet or Inches (Circle one)

Macroinvertebrate Collection Data Sheet Instructions

Part 1:

Determine the general area to collect the sample by surveying a stream reach based on the decision filters below for the relevant protocol. Some steps apply to both protocols.

a. Identify your sample segment: Identify and measure a 200 foot segment:

For ROCKY substrate samples, look for a segment that you can kick in two fast AND two slow riffles. You will kick in each of these 4 locations for 60 seconds each (a total of 240 seconds). Riffles are the shallow fast moving sections of the river with velocities between 1.5-2.5 feet/second. Slow riffle areas have velocities between 0.5 and 1.5 feet/second, still moving but much slower, sometimes deeper. More information below.

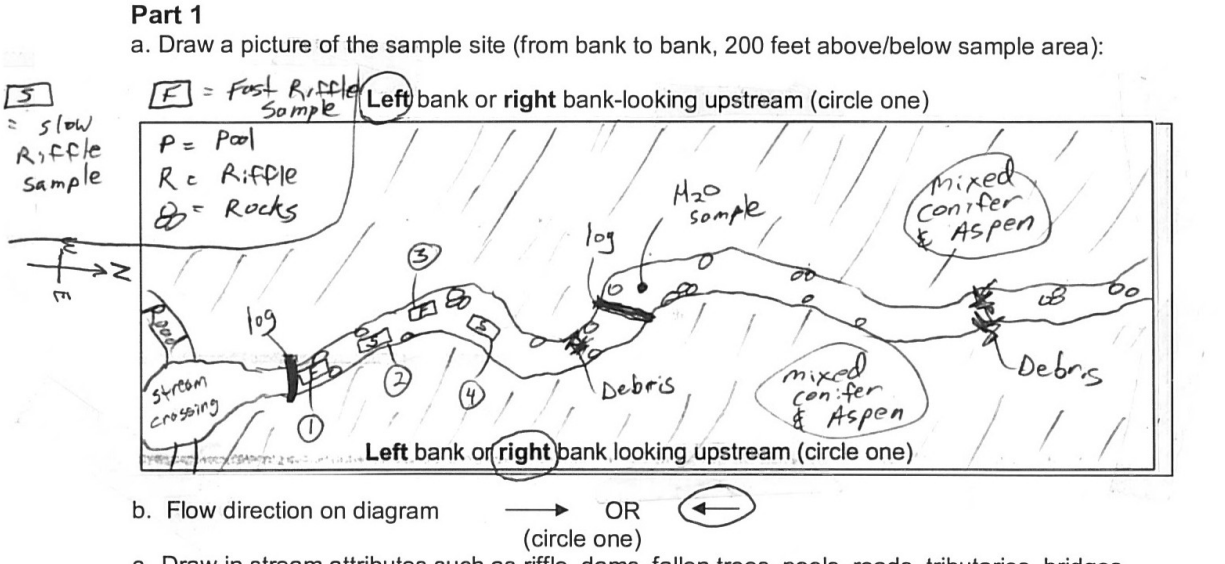
For SANDY substrate sampling, look for a segment you can sample in multiple habitats within the reach (i.e. submerged vegetation, large woody debris, vegetated banks, water column and substrate) for a combined total of sampling for 240 seconds. More information below.

b. If possible, you want to be at least 100 feet upstream from any road or bridge structure and away from any major tributaries, discharges or return flows.

c. Choose reaches with habitats that are representative of the entire stream (i.e. riffles that looks like all the other riffles in the area).

d. Explore. You may have to walk along the entire area of your 200 foot segment to find habitats to sample. They do not need to be right next to each other

Macroinvertebrate Collection Data Sheet Part 1 Example:



Part 2:

Depth Profile

This section of the datasheet is for recording a depth profile of a representative habitat transect. A depth profile provides a visual of the habitat, if done at the same place year to year, you can see changes in the profile or habitat (times of year too).

This will be the final step after collecting water quality data, macro sample AND physical habitat data.

- Using the Physical Habitat Datasheet (part 2): If you can, take the tape measure and hold or stake it across the river at a 90 degree angle from the bank, at a height 1-2 feet off the river surface.
- Take the depth measuring device and measure depths at about 1 foot or step intervals from bank to bank.
- Start on one bank where the water reaches the side and measure and record the depth, move a foot and measure and record depth, continue until across transect. Please record what unit of measure you are using. We prefer that you use feet and inches. Use another piece of paper if there are not enough spaces on the datasheet. Please only collect this data if it is safe! Sandy substrate river channels will shift frequently within the banks leaving sandbars. Some sandbars become established islands and vegetation takes hold.

Example:

1. Measure the transect from bank to bank : 14

Interval	Depth (ft/in)	Depth	Interval	Depth (ft/in)	Depth
1	Inches	8	11	Inches	18
2	Inches	17	12	Inches	16
3	Inches	32	12	Inches	8
4	Inches	36	14	Inches	6
5	Inches	44	15		
6	Inches	42	16		
7	Inches	36	17		
8	Inches	40	18		
9	Inches	28	19		

Record your Average Depth on part 2 of the Physical Habitat Datasheet as well as on the Macroinvertebrate Data Collection sheet.

ROCKY Substrate Composition for Each Kick (page 2 of 3)

DO NOT USE IF SAMPLING SANDY SUBSTRATE

Part 3 Substrate Composition kick #1:

a. Total Time Sampled Rocky Substrate habitat _____ seconds
b. Average Depth of rectangle sampled = _____inches or _____unit?_____

c. Circle: Fast Riffle (1.5-2.5 ft/sec) OR Slow Riffle (0.5-1.5 ft/sec)

1 2

Inorganic Substrate Components			Organic Substrate Components		
Should ALWAYS add to 100%			**May NOT add up to 100%**		
Substrate Type	Diameter	% Composition in sample	Substrate Type	Describe Characteristics	% Composition in sample
Bedrock	>11 inches		Detritus	Sticks, wood, coarse plant material, CPOM	
Boulder	>256mm, 10 inches				
Cobble	64-256mm, 2.5-10”		Muck-Mud	Black, very fine organic material, FPOM	
Gravel	2-64 mm, 0.1-2.5“				
Sand	0.06-2 mm, Gritty				
Silt	0.004-0.06mm		Marl	Grey, shell fragments	
Clay	<0.004, slick/slimy				
	TOTAL %			**TOTAL %**	

Part 3 Substrate Composition kick #2:

d. Total Time Sampled Rocky Substrate habitat _____ seconds
e. Average Depth of rectangle sampled = _____inches or _____unit?_____

f. Circle: Fast Riffle (1.5-2.5 ft/sec) OR Slow Riffle (0.5-1.5 ft/sec)

1 2

Inorganic Substrate Components			Organic Substrate Components		
Should ALWAYS add to 100%			**May NOT add up to 100%**		
Substrate Type	Diameter	% Composition in sample	Substrate Type	Describe Characteristics	% Composition in sample
Bedrock	>11 inches		Detritus	Sticks, wood, coarse plant material, CPOM	
Boulder	>256mm, 10 inches				
Cobble	64-256mm, 2.5-10”		Muck-Mud	Black, very fine organic material, FPOM	
Gravel	2-64 mm, 0.1-2.5“				
Sand	0.06-2 mm, Gritty				
Silt	0.004-0.06mm		Marl	Grey, shell fragments	
Clay	<0.004, slick/slimy				
	TOTAL %			**TOTAL %**	

ROCKY Substrate Composition for Each Kick (page 3 of 3)

DO NOT USE IF SAMPLING SANDY SUBSTRATE

Part 3 Substrate Composition kick #3:

g. Total Time Sampled Rocky Substrate habitat _____ seconds

h. Average Depth of rectangle sampled = _____inches or _____unit?_____

i. Circle: Fast Riffle (1.5-2.5 ft/sec) OR Slow Riffle (0.5-1.5 ft/sec)

1 2

Inorganic Substrate Components			Organic Substrate Components		
Should ALWAYS add to 100%			**May NOT add up to 100%**		
Substrate Type	Diameter	% Composition in sample	Substrate Type	Describe Characteristics	% Composition in sample
Bedrock	>11 inches		Detritus	Sticks, wood, coarse plant material, CPOM	
Boulder	>256mm, 10 inches				
Cobble	64-256mm, 2.5-10”		Muck-Mud	Black, very fine organic material, FPOM	
Gravel	2-64 mm, 0.1-2.5“				
Sand	0.06-2 mm, Gritty				
Silt	0.004-0.06mm		Marl	Grey, shell fragments	
Clay	<0.004, slick/slimy				
	TOTAL %			**TOTAL %**	

Part 3 Substrate Composition kick #4:

j. Total Time Sampled Rocky Substrate habitat _____ seconds

k. Average Depth of rectangle sampled = _____inches or _____unit?_____

l. Circle: Fast Riffle (1.5-2.5 ft/sec) OR Slow Riffle (0.5-1.5 ft/sec)

1 2

Inorganic Substrate Components			Organic Substrate Components		
Should ALWAYS add to 100%			**May NOT add up to 100%**		
Substrate Type	Diameter	% Composition in sample	Substrate Type	Describe Characteristics	% Composition in sample
Bedrock	>11 inches		Detritus	Sticks, wood, coarse plant material, CPOM	
Boulder	>256mm, 10 inches				
Cobble	64-256mm, 2.5-10”		Muck-Mud	Black, very fine organic material, FPOM	
Gravel	2-64 mm, 0.1-2.5“				
Sand	0.06-2 mm, Gritty				
Silt	0.004-0.06mm		Marl	Grey, shell fragments	
Clay	<0.004, slick/slimy				
	TOTAL %			**TOTAL %**	

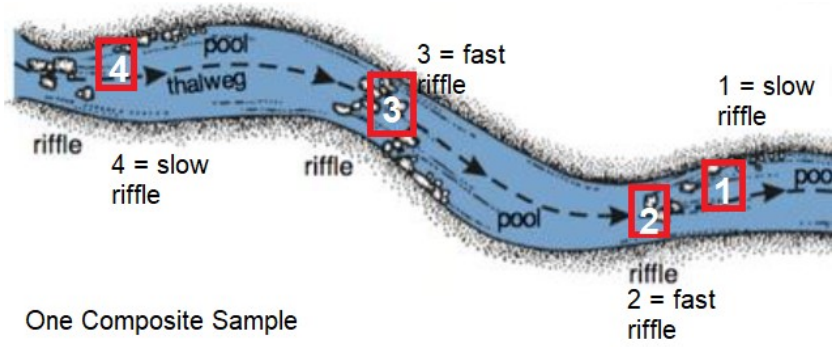
Rocky Substrate Collection Instructions

Rocky Substrate Collection Instructions

(If you are a Sandy Substrate, Go to the Sandy Substrate Collection Instructions)

Minimize tromping in the river before actual sampling. Have **Rocky Substrate Datasheets** ready. A team approach here can be very effective, if all teams understand their role prior to arriving in the field. Assign one team to collect water quality samples, one to draw the map, one to collect the bugs, one to time and record bug collectors information, one to conduct physical habitat assessment, and one to conduct the depth transect profile.

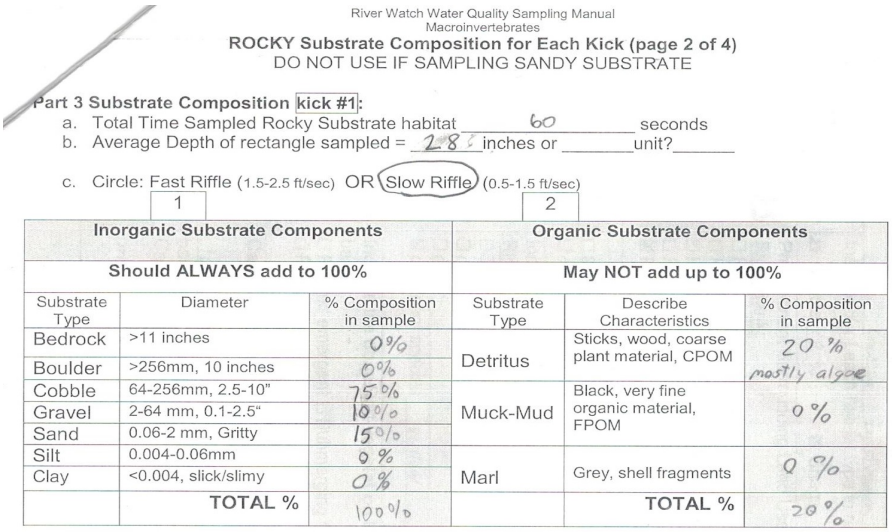
1. **Collect Water Quality Sample**
2. **Determine four specific sites:** (two fast riffles and two slow riffles) where you will collect a kick net sample. **Your sample is a composite of four separate kick sub-samples collected into the net.** You must identify four locations where you will collect these sub-samples. With minimum disturbance to the stream substrate, find two riffle areas where the water is flowing fast (1.5-2.5 feet per second) and two riffle areas that are flowing slower (0.5 to 1.5 feet per second), but still flowing. Use the floating device, timing and tape measure to estimate flows if you need too. See diagram below:



3. **Estimate kick area:** Approach the most downstream riffle for the first kick. Visualize an area on the stream bottom that is equivalent to about a 5.5 x 3 feet (or 1 x 1 .7 meter) square area. Another way to measure this kick area is to lay the net down and make a mental map of the area that roughly covers from the length of the handle to the width of the net. This will be the kick area. In this area, fill out the datasheet for the micro habitat of the area you will be kicking in.

   Substrate Rocky Composition, Kick #1: Kickers and recorders will work together on this step.

   a. Document time (60 seconds if following instructions).
   b. Circle fast or slow riffle for this kick.
   c. Record the average depth of the rectangle you sampled (in inches if can). Be careful when measuring depth, so you do not disturb the bugs you are trying to collect.
   d. Complete Column 1, substrate composition, using the size guidelines provided. KICKER estimates the percent of each substrate size and the RECORDER records the estimate in the appropriate shaded box. **THE TOTAL SHOULD ADD up to 100%.**
   e. Complete Column 2, organic components. Within the rectangle, which is your 100% sample area, how much detritus, muck/mud or marl is present? THIS WILL LIKELY **NOT** ADD up to 100%.



River Watch Water Quality Sampling Manual
Macroinvertebrates

ROCKY Substrate Composition for Each Kick (page 2 of 4)
DO NOT USE IF SAMPLING SANDY SUBSTRATE

Part 3 Substrate Composition kick #1:

a. Total Time Sampled Rocky Substrate habitat 60 seconds
b. Average Depth of rectangle sampled = 2.8 inches or _____unit?_____

c. Circle: Fast Riffle (1.5-2.5 ft/sec) OR Slow Riffle (0.5-1.5 ft/sec)

1 2

Inorganic Substrate Components			Organic Substrate Components		
Should ALWAYS add to 100%			May NOT add up to 100%		
Substrate Type	Diameter	% Composition in sample	Substrate Type	Describe Characteristics	% Composition in sample
Bedrock	>11 inches	0%	Detritus	Sticks, wood, coarse plant material, CPOM	20 % mostly algae
Boulder	>256mm, 10 inches	0%			
Cobble	64-256mm, 2.5-10"	75%	Muck-Mud	Black, very fine organic material, FPOM	0 %
Gravel	2-64 mm, 0.1-2.5"	10%			
Sand	0.06-2 mm, Gritty	15%			
Silt	0.004-0.06mm	0 %	Marl	Grey, shell fragments	0 %
Clay	<0.004, slick/slimy	0 %			
	TOTAL %	100%		TOTAL %	20 %

4. **Net placement:** Place the net in the water making sure the net is on the stream bottom (if possible) and do not let water flow over the top of the net. It is best if you can see water flowing through the net. Eddies, dead flow areas or areas water is flowing back upstream behind large rocks will not work as flowing water is needed to carry the bugs into your net as you disturb the substrate. Once your kick area is defined, the net is set and the water is flowing through the net, you are ready to conduct your first kick.
5. **Conduct kick #1**:
   a. One person will hold the net (as described above) with the opening facing downstream just above the water till the timer tells you to go.
   b. Second person will kick and disturb from upstream to downstream.
   c. A third person will time for 60 seconds.
   d. Have the data recorder label this kick #1 and identify it as a fast or slow riffle collection.
   e. When you are ready to sample: When timer tells you to begin, place the net in the water.
   f. The kicker with start at the downstream end of your rectangle with the net close enough to your feet so that dislodged organisms will go into the net and not around it (not more than one foot away). The kicker uses their toe and heels to disturb, dislodge, uproot the upper layer of substrate and dig into the river bottom sediment. Do not kick the larger substrate out of the way. Larger rocks or debris (logs, vegetation, etc.) should be picked up and brushed while immediately upstream of the net, so bugs will flow into the net. The goal is to get all bugs no matter where they are in that rectangle to flow into the net. Smaller debris like twigs and leaves should be kicked into the net and examined later for clinging bugs.
   g. Pull the net up out of the water when the timer tells you 60 seconds have passed.
   h. Move to next riffle for collection.
6. **Repeat steps 3-5 for kicks #2, #3 and #4**: Raise the net out of the water between each kick so that no organisms are lost. Carry the net to each riffle location and do not remove the anything in-between kicks. After all sites are sampled, process the sample as described below.
7. Process your sample using instructions on page 342.
8. Complete Physical Habitat Data Sheet.

SANDY Substrate Composition for Each Kick

(DO NOT USE IF SAMPLING ROCKY SUBSTRATE)

Station Name_____ Date of sample ___/___/___ Time ___:___

River_____ Station number:_____

Group (School)_____ ☐ ☐

Part 3 Substrate Composition kick or dip #1: Complete the Table a:

Habitat Type	% present	% present / 240 seconds
vegetated banks		
submerged vegetation		
snags/debris		
water column		
sandy substrate		
Total 100%		

Average Depth of rectangle in sampled water column = _____inches _____unit?_____

1 2

Type of Habitat sampled			**Organic Substrate Components**		
Time should Add to 240 Seconds			**Will Likely NOT add up to 100% Complete for overall sample reach**		
Habitat Type	Describe Characteristics	Time sampled (seconds)	Substrate Type	Describe Characteristics	% Composition of sample
Vegetated Banks			Detritus	Sticks, wood, coarse plant material, CPOM	
Submerged Vegetation			Muck-Mud	Black, very fine organic material, FPOM	
Snags/Debris			Marl	Grey, shell fragments	
Water Column					
Sand/Subs					
	TOTAL TIME (=240)			**TOTAL %**	

Sandy Substrate Collection Instructions

(If you are a Rocky Substrate, Go to the Rocky Substrate Collection Instructions)

Minimize tromping in the river before actual sampling. Have **Sandy Substrate Datasheets** ready. A team approach here can be very effective, if all teams understand their role prior to arriving in the field. Assign one team to collect water quality samples, one to draw the map, one to collect bugs, one to time and record bug collectors information, one to conduct physical habitat assessment, and one to conduct the depth transect profile. **This protocol requires planning at the site.**

1. **Collect Water Quality Sample**.
2. **Identify the habitat types to "kick" or "dip" your net.** Sandy substrate tends to shift and doesn't have the large interstitial space in rocks that many bugs prefer. In this habitat, the bugs will be in the water just above the substrate versus in the sand, or in aquatic vegetation in the stream amongst debris or along the banks. Habitat types to look for are:
    a. vegetated banks
    b. submerged vegetation
    c. snags/debris
    d. water column
    e. sandy substrate

- Overhanging and Vegetated banks: Occur when lower banks are submerged and have roots and emergent plants associated with them. Submerged areas of undercut banks are good habitats. They are sampled in a fashion similar to snags by jabbing and disturbing the area upstream of the net. Bank habitat can be kicked first (with larger net) to dislodge organisms with net placed downstream to retrieve any bugs.
- Aquatic submerged macrophytes (large plants): Seasonal in their occurrence and may not be a common feature of many streams, particularly those that are of high gradient. These plants live submerged in the water and bank and can be seen with the unaided eye. Collect sample from aquatic plants that are rooted on the bottom of the stream or in the bank, and are submerged in the water by drawing the net through the vegetation from the bottom to the surface of the water. In shallow water, sample by bumping or jabbing the net along the bottom in the rooted area, avoiding sediments if possible.
- Snags and other woody debris: Fallen branches, washed out or inundated shrubs/trees and small logs, which have been submerged in the water for a long time (not just fallen), provide excellent colonization habitat. Accumulated woody material in pools (deeper slower water) is considered snag habitat. To sample this habitat you would jab into the snag (with the net) and kicking around the snag with a net held downstream.
- Sand and other fine sediment: Usually the least productive macroinvertebrate habitat in streams; this habitat may be the most prevalent in some streams. Collect sample from banks with no vegetation or soft soil by bumping the net along the surface of the bottom rather than dragging the net through the soft substrates, this reduces the amount of debris in the sample.

Identify **ALL** potential habitat types within the 200 foot reach (definitions of habitats are listed above). The distance you are looking at will depend on the width of the stream. If your stream is 20 feet wide you may have to walk/look at a longer stretch than if the stream is 150 wide. You may find all habitats within 100 feet if can access bank to bank. **You may not have all of these habitats**, and that is fine.

In essence, you will be conducting four "sampling efforts, kicks or dips", identifying the percentage of habitat types that exist, converting that to a percentage of **240** total seconds and sampling each habitat for that percentage of time.

3. **Estimate the amount or percentage of each habitat exists in the reach**, for the "reach" being assessed. Divide 240 seconds (equivalent of four, 60 second kicks) by the percentage of habitat. The example below shows all five habitats are present, vegetated bands at 40% and 40% of 240 seconds equates to 96 seconds that habitat will be sampled. You will kick or dip into each habitat for the calculated percentage. Record the percentage of habitat and equivalent seconds in the first part of **Part 3 Sandy Substrate datasheet**. Example:

Habitat Type	% present	% present/ 240 seconds
vegetated banks	40	96
submerged vegetation	10	24
snags/debris	25	60
water column	15	36
sandy substrate	10	24
	100%	240 seconds

4. **Implement the plan and determine specific areas you will "kick" or "dip" your net for the calculated time**.

   Within that habitat sub-area, start at the most downstream site (and move upstream) with minimal or no wading in the habitat you plan to sample. You will decide within that area how much of each habitat you have and the equivalent time to spend on it in that area. You decide, there is no right or wrong – adapt to your site and use your best judgement. **The goal is to include all habitat types at a relative "effort" equal to their presences to get a representative sample.** For illustration, let's use the above example and show two approaches.

   You may spend all your time in one occurrence or several occurrences of a habitat. For example above one "kick/dip" could be one large snags/debris (60 sec) or if there are three snag/debris areas, sample each for 20 seconds each (3 x 20 = 60 sec). Vegetated banks are allotted 96 seconds, you could sample one or several dividing number of occurrences by time. The key is to think about where the bugs are living and get the best representative habitat. If sampling one type for 20 seconds really doesn't "get" enough effort thing focus on doing fewer of that habitat type longer. One approach is to complete sampling of one habitat type and move to another. The second approach is to mix habitat sample types as you move upstream- as long as you keep track of the time accurately and minimize or avoid disturbing habitat yet to be sampled.

   Regardless, **composite the sample as you go**, be careful how you dip the net into the next habitat. The contents of the net will be cumulative. That can be a factor in deciding what habitats to sample first. Don't be too worried about the seconds, it is relative, do your best.

Habitat Type	% present	% present / 240 sec	Approach 1	Approach 2 As You Move Upstream
vegetated banks	40	96	Sample all of these areas then move to next	1. Sample 2 vegetated banks at 32 seconds each, knowing there is one more to sample further upstream
submerged vegetation	10	24	Sample all and move to next	2. Sample one occurrence of this for 24 seconds,
snags/debris	25	60	Ditto	3. Sample one habitat for 30 sec, 4. Sample the vegetated bank for 32 sec 5. Sample another snag/debris for 30 sec
water column	15	36	Ditto	6. Sample a medium depth area for 36 sec
sandy substrate	10	24	Ditto	7. sample a sandy riffle for 24 sec
	100%	240 (rounded)		

5. **Net placement in each habitat**. Approach the most downstream location. Visualize an area in the habitat you have selected that is equivalent to about a **1 x 1 .7 meter area**. Another way to measure this area is to lay the net down over the habitat type and make a mental map of the area that it covers from the length of the handle to the width of the net. This will be the area that you will probe, dip and collect your sample in. This is the area you will sample for your estimated time, spreading out the time in each habitat for that habitat. This just helps you visualize, for example: if I am going to spend 24 seconds here, I want to cover that imaginary rectangle in that 24 seconds. This is the "area" part of them semi-quantitative method.

   Raise the net all together out of each habitat type between each kick so that no organisms are lost from the net. Carry the net to the next habitat location. Be careful not to lose any bugs when placing net in the next habitat type. After all sites are sampled, process the sample as described below. **MOVE ON TO SAMPLE PROCESSING which is the same for both Rocky and Sandy.**

Tips to collect in Sandy:

a. One person operates the net.

b. Second person assists pulling the net out of habitats to preserve the composite if necessary.

c. A third person can time (very important role here).

d. A fourth person fourth is the recorder.

e. Implement the sample plan, composite samples and record sampling on Part 3 and 4 of the Sandy Substrate datasheet.

f. Move to the next location; be careful to not lose organisms in switching habitats or dipping into the water. Repeat for all habitats selected. Another team can complete macro-habitat.

Micro-Habitat Assessment:

6. **Data Sheet Part 3: Sandy Substrate Composition, Habitat Type, average water column depth where sample collected.**
   a. Assess the % of habitat types you have and how many seconds of 240 each will be sampled. Record this on the Sandy Datasheet.

Habitat Type	% present	% present / 240 seconds
vegetated banks	40	96
submerged vegetation	10	24
snags/debris	25	60
water column	15	36
sandy substrate	10	24
	100%	240

   b. Complete Column 1 on Sandy Substrate Dip #1, listing the time sampled for each habitat. **Put 0% in habitats not sampled**.
   c. Describe habitat with more details if needed.
   d. Record the % this habitat was present in the reach. This percent should correlate with the time sampled in this habitat.
   e. Total the time sampled and percent should total 240 seconds and = 100%.
   f. Record the average depth of the rectangle if sampled in the water column (in inches).
   g. Complete Column 2, organic components for each habitat sampled. WHERE appropriate (not for all types), within the sample rectangle, which is your 100% sample area, how much detritus, muck/mud or marl is present. THIS WILL LIKELY **NOT** ADD up to 100%.

Sample Processing

The goal for processing is to get all of the macroinvertebrates from the kick net into the sample jar. You want to keep large debris out of the jar, and the jar should contain as little water as possible. This allows the preservative to work on the organisms effectively. The preservative is a high grade alcohol that keeps organisms from disintegrating and getting mushy for later identification. If the sample is too watery, the preservative is diluted and organisms will get mushy and can't be identified. If you process (wash and scrub) large material correctly, the lab can focus on identifying bugs versus processing material. Small bunches of organic material such as algal mats need to be left in the sample.

1. Once the sample is collected from all sample habitats or locations, carry the net to the shore. Fill the bucket 1/2 to 2/3 full of stream water. Gather the sample material into one corner of the net. Grab the corner of the net from the bottom outside, holding the clump in your hand(s) and turn the net inside out into the clean sample bucket. Knock or wash any obvious macroinvertebrates, debris, algae clumps or masses into the bucket. Rinse the net from the **OUTSIDE** into the bucket if necessary. Examine the net closely for organisms that may be stuck in the net. Pluck these organisms off with forceps and place directly into the sample jar containing alcohol.
2. Look in bucket for large rocks or debris you can handle, bare twigs or leaves (not algae masses). Pick them up one at a time. Hold them over the sieve and look for organisms. Rinse the object with squirt bottle over the sieve; pluck the organisms off with forceps and place in the sample jar. **Do not rinse over the alcohol filled sample jar.**
3. Separate the organisms from the debris by "swirling" the sample in the bucket. Add more water if you need to and really swirl! The lighter organisms and debris will rise to the top of the water and the heavier sediment will not. Look for bugs to float to the top. Pour off the top water and floating material into the sieve, leaving the sand and gravel in the bucket.
4. Repeat the swirling until lighter material and bugs no longer rise to the top. Swirling needs to be aggressive enough to dislodge clinging organisms. This will take a MINIMUM of 15 swirls; maybe 20 to make sure all organisms are dislodged. Use more water if you need to. Limit scraping or any movement that would smash the bugs. Pick up a handful of gravel or substrate and look closely to see if it moves or you can see any bugs. If so, swirl again.
5. If you have algal masses, place them on the sieve and let as much water as possible drain out of the mass. Do not smash the mass as you will smash the bugs. Water from these masses will dilute the alcohol. The bugs in these masses are hard to see with the naked eye and require further sorting. When drained, place mass into sample jar.
6. After the last swirl and all floating bugs have been GENTLY placed into the preserved sample jar with forceps, pour the contents of the bucket onto the sieve in ***manageable*** batches. Spread the material and look for bugs. Then place sieve material onto a white tray looking for organisms one last time. Pluck bugs from sieve and place in preservative. If you are collecting a QA/QC sample, place any remaining algae mats or clumps of debris in a second sample jar, draining as much water as possible. If you are not collecting a QA/QC sample, dump thoroughly processed debris from the pan. Repeat in batches until all debris has been processed.

7. If you have been selected to collect a QA/QC sample, you will have received 4 jars partially filled with alcohol.
    a. Find four riffles in the sample collection area that are wide enough to collect two samples right next to each other.
    b. Collect your “normal” macro sample as described above. Two fast riffles, two slow riffles, filling out the datasheets and process the sample as normal.
    c. Once your normal sample is complete, collect a “duplicate” sample right next to your initial sample moving downstream to upstream, like you would a normal sample at all four kicks.
    d. Process your sample in a separate bottle marked “QA Macro Sample” using same sample processing protocols on page 342.
    e. Clean your net, sieve, brush and buckets

8. Once all debris from the net is processed, rinse the net, sieve and pan thoroughly in the river, until no debris is visible. It is best to let the net dry as soon as possible to avoid mold growth.
9. Label your sample and any QA sample you may have accordingly with a magic marker on the outside of the jar. Include sample #, station #, date and time. Place the other label inside the macroinvertebrate samples. The inside label is smaller and requests collector’s name. These labels are located on page 337 of this sampling protocol **AND MUST BE FILLED OUT IN PENCIL**.
10. **The evening of sampling, carefully decant the initial alcohol used and then pour in rest of fresh alcohol. If you have collected a QA/QC sample, decant that one also and replace with fresh alcohol.** Decanting will lessen the amount of water in the bottle that would hasten the degeneration of the bugs. Place sample label(s) from Step 2 of Laboratory Preparation in jar(s) and cap snugly.
11. Ship or deliver your sample(s) within **three** weeks of collection. Include all data sheets and chain of custody. Complete a Field Data sheet to go with the macroinvertebrate and physical habitat data sheets. Include water quality data if it was collected (preferred). Keep a copy of data sheets. A macroinvertebrate sample, with or without a chemical sample is a sampling event.

Macroinvertebrate Labels

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

River Name ______________________________
Station Name _____________________________
Station Number ___________________________
Date ______________ Time ______________
Sample Collector _________________________

Preserved with 95% ethanol / method 1

Supplemental Macro – Reach Physical Habitat Part 4 Worksheet

Use to help get a complete picture for Part 4 Macro- Reach Physical Habitat Datasheet

Walk a 100 foot section within a stream reach, measuring the following physical parameters at each transect within the section. Randomly pick three representative transects before you begin. Discuss the ecological significance of each parameter.

Parameters	Transect 1	Transect 2	Transect 3	Average
Water Width	ft	ft	ft	ft
Bank full width	ft	ft	ft	ft
Channel depth	ft	ft	ft	ft
Dominate substrate (boulder, rubble, cobble, gravel, sand)	ft	ft	ft	ft
Bank stability (good, fair, poor)	ft	ft	ft	ft
Riparian zone width	ft	ft	ft	ft
Riparian zone vegetation type(s)				

Check one of the following and discuss each possible condition (excellent, good, fair and poor):

What is the condition of the stream side vegetation on both banks?
□ excellent □ good □ fair □ poor

What is the stability of both banks?
□ excellent □ good □ fair □ poor

Look up and down stream, what is the habitat diversity including pool-to-riffle-run ratios?
□ excellent □ good □ fair □ poor

What is the substrate condition? Consider whether it is embedded, if sedimentation is evident and if it is what the RCC would predict.
□ excellent □ good □ fair □ poor

What is the overall cover available for all life stages of fish (instream and bank)?
□ excellent □ good □ fair □ poor

Rate the overall physical habitat.
□ excellent □ good □ fair □ poor

Comments: _____

Data recorded by_____ Date recorded _____

Optional Macroinvertebrate Collection

Method for equipment limitation (no required RW equipment) or data objectives other than RW

If your data objectives differ from the RW required macroinvertebrate protocol. For example, if education is the only objective or if you do not have a RW set of bug equipment, you can conduct the following macroinvertebrate studies.

Collection Designs

To establish your monitoring objective, as what questions are you trying to answer with this bug collection? What are you trying to learn? For example:

- If you intend to demonstrate the influence of an impoundment on benthic diversity, then collect benthic macroinvertebrates above and below the impounded reach.
- If you are interested in testing the River Continuum Concept, then collect benthic macroinvertebrates along the headwaters, mid-reach, and lower reach of a river system.
- You could also compare what the Sequential Comparison Index (SCI), a qualitative index, indicates about water quality with the Water Quality Index.

Choose the time of year, station location and sample frequency that will best answer your questions.

Optional RW Macroinvertebrate Supplies

1. A homemade or purchased net, most biological field supply companies have these nets. A three-foot-long net made of screen-door-mesh should be used. This provides a consistent mesh size since there is only one size mesh for screen door. You may use the metal or nylon version. Nylon is more “user-friendly.” If you wish to capture a “different” size macroinvertebrate, make a second net with a mesh size less than 0.5 mm. Use old broom stick handles, dowel rods or boards about 4 feet in length (larger than the net). Screws or staples can be used to attach the net to the poles. Make sure the bind is strong enough to endure a current flowing through the net.
2. Use a large **white** enamel or plastic tray, or a white trash bag under the net and rinse material from the net into the white surface in order to find bugs. Pick the bugs from the white surface and place in ice cube trays.
3. Forceps, tweezers and several ice cube trays, preferably white
4. Rubber gloves (optional) and magnifying glasses (optional)
5. A squirt bottle (can be any water bottle with a squirt nozzle)
6. A timing device that can time 60 seconds (a second hand on a watch)
7. Waders
8. Quart Mason® type jars for collecting live material to be placed in aquariums.

9. If completing the micro-habitat substrate composition using the core substrate size datasheet, a depth profile or macro-stream reach physical habitat then bring:

   a. A ruler to measure substrate sizes > or < than 12”, 6” and 3”

   b. A broom, pole or pipe with inch and foot marks on it to measure depths

   c. A tape measure (can be marked string or twine) to measure stream widths

Optional RW Macroinvertebrate Method

1. A three-foot-long net made of screen-door-mesh should be used, see above how to make one or purchase. The modified D-net provided by River Watch works as well. If using this net, follow the process in the core method above to get the bugs from that net to the bucket, swirl and use the sieve to process the bugs into ice cube trays.
2. Place the net in the water riffle, not a pool habitat. Depending on flow, start about 3-4 feet upstream from the net, kick and disturb the substrate (bottom of the river) moving downstream to the net. If debris is floating past net, start closer. The kicking should last one minute for consistency. **DO NOT sample if the river is deeper than 24 inches for safety reasons**. You can repeat this in other habitat locations or have multiple nets and teams, taking care to not disturb habitats before they are sampled.
3. Pull the net out of the water in such a manner that the bugs on the net are not swept downstream from the current.
4. Place the net on the bank over white trash bags or rinse the material on the net into a large white enamel pan or plastic tray or both.
5. With the tweezers find all sizes and colors of bugs from the net for 30 person minutes—two people picking for 15 minutes equals 30 person minutes, four people picking for 7.5 minutes equals 30 person minutes. This is provides consistency and data comparability across index scores. You can chose to pick all of the bugs regardless of time as well.

   a. Place river water in the ice cube trays. Every bug you find on the net, place in an ice cube tray, placing “like” bugs with “like” bugs. If a bug looks different than all the other bugs in the tray, it gets its own slot in the tray. The more precise you can place similar mayflies, stoneflies, caddisflies, black flies, beetle larvae, worms into like categories the more precise your index will be. Once all bugs are picked and placed in ice cube trays or time is up, calculate the Sequential Index and/or complete the remaining physical habitat assessments (micro-substrate composition, depth profile, macro stream reach assessment).

9. Calculate the sequential diversity index, use the provided data sheet or make your own. The index divides the number of different species sets collected or ice cube trays with bugs by the total number of individuals collected in all ice cube tray(s), for example 7/50 = 0.14. The closer to one the more diverse the bug community and the closer to 0 the less diverse.

   a. As a rule of thumb, you should complete at least three “kicks” or “nets” per station (transect) in riffle habitat to collect a representative sample. The more you do the more representative your sample will be. If the stream is wide enough you can do three kicks across the river. If the river is not wide enough, do your kicks in an upstream fashion: kick one, move upstream; kick two, move upstream; and kick the third.

b. You can repeat this at different sites, year to year (at the same relative time) and compare diversity indexes over space and time. This along with species lists and if identity the bugs can also look at the functional feeding composition, see below.

c. Macroinvertebrates vary with season. They emerge at different times of the year filling unique niches. Because of seasonal variation and the influence on bug life cycles, ideally you sample three times a year, spring, summer and fall. Sampling one station different seasons will produce different species list and diversity index, and could be a study itself.

10. If you are making a reference collection, store the bugs in 70 percent ethyl alcohol (ethanol) or Everclear alcohol diluted with river water. Try not to use isopropyl alcohol, the bugs become rubbery over time.

11. Identification can be taken a step further by completing the trophic level (functional feeding analysis). If the bugs are identified past the family level the trophic level (functional feeding group) can be determined and species composition.

    a. Functional feeding group or trophic level refers to how a bug "captures" its food, for example shredding detritus, filtering the water, gathering detritus, or preying on other bugs. This information can be related to the River Continuum Concept, physical habitat, and the riparian zone. There is a percent functional feeding group summary table included for you on page 354. Higher up in a watershed you would expect bugs that can capture and eat coarse organic material like leaves and twigs, items you can see.

    b. As you move further downstream to midsized streams that composition changes to bugs who have evolved to capture and eat fine organic material produced by primary producers, decomposition, etc. that is sourced from the adjacent landscape and tributaries. This is where rivers in Colorado transition from cold to warm and different species composition. Further downstream in larger rivers stream size seven and larger the composition are strategies to consume fine particulate organic matter that is sourced from the upstream sections of river primarily. Every stream order has a percentage of predators. Predator species changes from upstream to downstream in bugs, fish and zooplankton. Because food sources are tied to the land, when the land is altered often so is the bug community and this can serve as an indicator of degradation or impairment as well as a successful restoration or remediation.

    c. The percent composition of each species / family can also be computed and provide valuable information. Does one family dominate? Are the three cold water pollution sensitive families (mayfly, stonefly, and caddisfly) well represented? If not, why?

    d. It is suggested that you use An Introduction to the Aquatic Insects of North America by Merritt and Cummins [1] for insect identification. It teaches the students how to use a key and has interesting information about bugs (life cycles, habitats, unique features, etc.).

[1] Merritt R.W. and K.W. Cummins, 1984. *An Introduction to the Aquatic Insects of North America*, Second Edition. Kendall/Hunt Pub. Comp. Dubuque, Iowa. (Available in soft or hard back).

Sugaring for Burrowing Aquatic Organisms

Swirling a large bucket 20 times or so as demonstrated in the RW macroinvertebrate method brings bugs to top. If you use a method that employs a different net that you need to empty into a bucket, sugaring can help find the organisms. To determine the concentration and distribution of aquatic organisms in stream sediments, a technique that could be used is called, “sugaring”.

Samples of stream sediments are placed in separate pans and water is added to cover the material by several inches. Saturating the water with sugar changes the density of the water and the lighter aquatic organisms will float to the surface. The organisms can then be identified into general categories and returned to the stream.

If specific identification is needed, a preservation technique is to add formalin to the water covering the sediments in the pan (10 percent formalin solution) to replace the body fluids of the aquatic organisms with formalin. After several hours pour off all liquids in the pan and replace with water. The lighter preserved organisms will float to the surface of the water as the sediments are stirred and can be removed and identified.

Sequential Comparison Index

"The Sequential Comparison Index" is a simple method for non-biologists to estimate relative differences in biological diversity (Cairns, et al. 1968)." This Index, like other diversity measures, assumes that reduced diversity is an indication of pollution. Reduced diversity may also be related to land uses such as impoundments and urbanization, or to stream order. When estimating relative differences in benthic diversity, it is important to match approximately such physical variables as flow, bottom substrate, and amount of shading.

a. Empty the bugs from the net, or pick from a net and place in a white pan. Ice cube trays help a lot here, but are not necessary; a demarcated white trash bag will work. Randomly pick an organism, place it in the first ice cube tray or delineated square. Pick the next organism and compare each organism with the preceding one. If the second organism is like the first organism, place it with it, if it is different place it in another cube or square. Pick the third organism and compare with the previous two, if it is like either of them, place it there or place it in a different cube or square, repeat until all organisms are placed.

b. Calculate the Sequential Diversity Index (SDI):

DI = number of runs (number of ice cube squares) = 8 = 0.25
number of organisms (total individuals) 32

Ind Org	x	x	x	y	z	z	a	b	f	f	h	h	r	r
Run			4	2		3	4	2		6		3		8

c. The closer this calculated index is to 1, the greater the diversity of that bug community (which implies supporting or better water quality than a site that has an index closer to 0). The SDI runs from 0 to 1.0, with a value of 1 representing the greatest diversity. General Water Quality Rating:

0-0.30= Poor
0.31-0.60= Fair
0.61-1.0 = Good

d. Each group in class can calculate a diversity index and these may be averaged for a particular station. The higher the ability to identify species to family visually, the more sophisticated the lumping should be. For example HS students can lump species of mayflies, stoneflies, caddisflies whereas elementary students might just lump major families. The index will reflect the diversity of the stream if you sampled a representative habitat, collection and process time is consistent and process looks for all types of bugs present, small and large, alone and embedded in debris. The index is bias to what can be seen with the naked eye.

Macroinvertebrate Sequential Comparison Index

Station Name_____ Date of survey ___/___/___ Time: _____

River_____School_____

Station Description _____

Total number of samples_____ Page _____ of _____

1. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____	2. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____
3. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____	4. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____
5. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____	6. Sample____ of____ A. Number of runs____ B. Number of organisms____ Diversity Index (DI) = A/B DI=____/____=_____

Station Average DI = Sum of DIs divided by number of DIs = _____
(This average is for pages _____ of _____, Samples _____ through _____)'

Data recorded by_____ Date recorded _____

Optional Macroinvertebrate Data Sheets

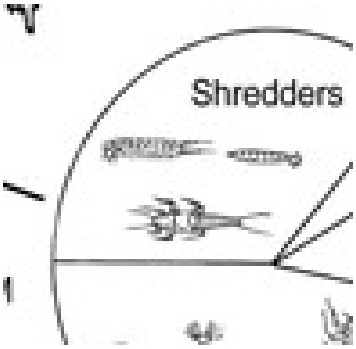
Introduction

Macroinvertebrate data collected from the required RW method (modified D kit net) can be further analyzed using these data sheets. The optional RW macroinvertebrate collection method (3 x 3 foot screen door net) can also use the following data sheets. Comparison from following datasheets require the same collection and laboratory procedures. These datasheets provide additional means of displaying, viewing and analyzing your bug data. The following is an overview of what is offered.

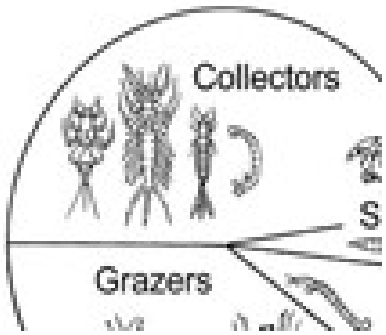
Macroinvertebrate Summary Data Sheet

Once a species list is completed, the **functional feeding group (trophic level)** of each species or taxa (depending on how far you identified your collection) can be recorded on the Functional Feeding Group Analysis datasheet. This trophic level is as informative as what species and total taxa are present. Since bugs occupy so many different habitat niches they evolve different eating strategies. The size of the stream where bugs reside and the primary food source is will also influence the feeding strategies and thus what species thrive. Go back to Chapter 2, Stream Ecology and the River Continuum concept to review that small streams are heterotrophic and allochthones, getting their primary food from the surround flood plan and landscape. Here that food is **coarse particulate matter** like leaves and limbs. As streams flow downstream into medium size streams these systems are autotrophic and produce most of their food from within as **fine particulate matter**, breaking down organic material. Further downstream systems become heterotrophic again, depending upon the nutrients and food upstream and these rivers are often anaerobic at the bottom layers. This continuum effects what species live in them but also type of feeding strategies (refer to one of the River Continuum Illustrations). **If this composition is not present it could indicate stressors or impairment.**

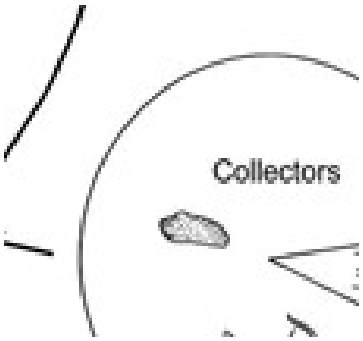
Small Rivers CPOM



Medium Rivers FPOM



Large Rivers FPOM



You can download taxa per station from the River Watch database for this information. You can determine each species functional feeding group from Merritt and Cummins (1984) identification book. This book is recommended but others may work as well. If you do not have this book and identify your collection further than order, notify CPW River Watch Program Manager to send you the functional feeding descriptions from Merritt and Cummins. This book is available from CPW to “check out.”

The Functional Feeding Group Datasheet provides a visual summary of the functional feeding group analysis. It is a table you complete based on your identification and research. Do the functional feeding groups you found, fit the River Continuum Concept for the stream reach they were collected? Do you have a dominance of predators? Are you in stream order 1-3 and have no shredders?

Species Composition Summary Datasheet This datasheet is a table that records percent composition for the major taxonomic groups. The more taxa, the more diverse, the healthier a stream is. Calculate your EPT index: the percent of mayfly, stonefly and caddisflies.

Macroinvertebrate Functional Feeding Group Analysis

Station Name _____ Station Number _____

River _____ Date of survey ___/___/___ Time: _____

School _____

Station Description _____

Functional Feeding Group	Sample				
	1	2	3	4	5
Shredder					
Collector Gatherer					
Collector Filterer					
Scraper					
Predator					

Comments:_____

_____

_____

Data recorded by_____ Date recorded _____

Shredders: have mouth parts and other features that allow them to tear apart leaves, twigs, etc.

Collectors: have mouth parts, features and behaviors that they can trap either coarse or fine material

Filterers: have mouth parts or features that act like a filter for fine organic material or food

Scrapers: have mouth parts, features and behaviors that allow them to graze on substrate for food

Predators: have mouth parts and features to eat other bugs or living organisms

What is your stream order and what should be the functional feeding group composition?

Percent Composition by Major Taxonomic Groups

Station Name_____ Station Number _____

River_____ Date of survey ___/___/___

Station Description_____

Taxa	Sample				
	1	2	3	4	5
Ephemeroptera (Mayfly)					
Plecoptera (Stone fly)					
Trichoptera (Caddisfly)					
Coleoptera (Beetles)					
Diptera (Craneflies)					
Chironomidae (Midges)					
Odonata (Dragonflies)					
Hemiptera (True bugs)					
Arachnida (Water mites)					
Turbellaria (Flatworm)					
Oligochaeta (Earthworm)					
Hirudinea (Leeches)					
Gastropoda (Snails)					
Total Taxa					

Comments_____

_____

Data recorded by_____ Date recorded _____