Michigan Lake and Stream Association Stream Monitoring Program

Information in this booklet was modified from the following sources:

An Introduction to the Aquatic Insects of North America, Second Ed., Edited by R.W. Merritt and K.W. Cummins *Aquatic Entomology*, Patrick McCafferty Clinton River Watershed Council *Teacher Training Manual*, Michigan, Meg Larson *Field Manual for Water Quality Monitoring*, 10th Ed., Mark K. Mitchell and William B. Stapp Macroinvertebrate Identification Flash Cards, GREEN/Earth Force, Ann M. Faulds, et al. *Save Our Streams Monitor's Guide to Aquatic Macroinvetebrates*, Loren Larkin Kellogg, and primarily from Indiana Riverwatch Association Volunteer Monitoring Booklet and MDNR/MDEQ Stream Crossing Watershed Survey Procedure Manual.

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Introduction:

About 8 years ago I was teaching a course in environmental chemistry and became interested in expanding my knowledge of “water chemistry” and the environmental consequences of man’s impact on our environment. Over the years this developed into a more holistic vision of rivers and lakes from both a chemical and biology viewpoint. Finally, within the last three or four years I have educated myself about using aquatic macroinvertebrates (“bugs”) as water quality indicators. Simply stated, kids love collecting, identifying, and learning about these little critters. They are amazed at the abundance and diversity of aquatic insects and love the “field trips” we take to find them.

SEE-North, a regional math and science center, used to have an organized river water quality program where students from seven or eight local high schools would gather water quality data and then meet at a “student congress” to share their data and learn more about the environmental aspects of exotic species, environmental concerns, conservation, algae, lake nutrients, and many other water quality issues. This program stopped operating about 3 years ago and I have missed participating in it.

Over the last few years I kept my ears open for alternatives. About 2 years ago Pearl Bonnell with ML&SA contacted me about participating in Randy Cook’s *chemical* water quality program with 10 other schools from around the state. In doing our research, students would use state of the art digital monitoring equipment. I jumped right in and said “YES !”

Since starting in with that program I thought a river biomonitoring program would fit nicely side by side with the lake program and embarked on writing grants to fund it. This last spring the Irwin Andrew Porter Foundation, based in Minnesota, funded the initial portion of the program. I hope you enjoy it.

Jeff Kalember

1. Why are we doing this? Why study benthic macroinvertebrates?

Stream-bottom macroinvertebrates are an important part of the community of life found in and around a stream.

Stream-bottom macroinvertebrates are a link in the aquatic food chain. In most streams, the energy stored by plants is available to animal life either in the form of leaves that fall in the water or in the form of algae that grows on the stream bottom. The algae and leaves are eaten by macroinvertebrates. The macroinvertebrates are a source of energy for larger animals such as fish, which in turn, are a source of energy for birds, raccoons, water snakes, and even fishermen.

Stream-bottom macroinvertebrates differ in their sensitivity to water pollution.

Some stream-bottom macroinvertebrates cannot survive in polluted water. Others can survive or even thrive in polluted water. In a healthy stream, the stream-bottom community will include a variety of pollution-sensitive macroinvertebrates. In an unhealthy stream, there may be only a few types of nonsensitve macroinvertebrates present.

Stream-bottom macroinvertebrates provide information about the quality of a stream over long periods of time.

It may be difficult to identify stream pollution with water analysis, which can only provide information for the time of sampling. Even the presence of fish may not provide information about a pollution problem because fish can move away to avoid polluted water and then return when conditions improve. However, most stream-bottom macroinvertebrates cannot move to avoid pollution. A macroinvertebrate sample may thus provide information about pollution that is not present at the time of sample collection.

Stream-bottom macroinvertebrates are relatively easy to collect.

Useful stream-bottom macroinvertebrate data are easy to collect without expensive equipment. The data obtained by macroinvertebrate sampling can serve to indicate the need for additional data collection, possibly including water analysis and fish sampling.

Copied from http://www.people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/WhyStudyMacro.HTML

Why Do We Monitor Them? (continued)

Biological monitoring focuses on the aquatic organisms that live in streams and rivers. Scientists observe changes that occur in the number of types of organisms present in a stream system to determine the richness of the biological community. They also observe the total number of organisms in an area, or the density of the community. If community richness and community density change over time, it may indicate the effects of human activity on the stream.
Biological stream monitoring is based on the fact that different species react to pollution in different ways. Pollution-sensitive organisms such as mayflies, stoneflies, and caddisflies are more susceptible to the effects of physical or chemical changes in a stream than other organisms. These organisms act as indicators of the absence of pollutants. Pollution-tolerant organisms such as midges and worms are less susceptible to changes in physical and chemical parameters in a stream. The presence or absence of such indicator organisms is an indirect measure of pollution. When a stream becomes polluted, pollution-sensitive organisms decrease in number or disappear; pollution-tolerant organisms increase in variety and number.

In addition to being sensitive to changes in the stream's overall ecological integrity, benthic macroinvertebrates offer other advantages to scientists looking for indications of stream pollution. Benthic macroinvertebrates are relatively easy to sample. They are abundant and can be easily collected and identified by trained volunteers. They are relatively immobile. Fish can escape toxic spills or degraded habitats by swimming away. Migratory animals may spend only a small portion of their life cycles in a particular stream before moving to larger rivers, wetlands, or other streams. However, most macroinvertebrates spend a large part of their life cycle in the same part of a stream, clinging to objects so they are not swept away with the water's current.

Benthic macroinvertebrates are continuous indicators of environmental quality. The composition of a macroinvertebrate community in a stream reflects that stream's physical and chemical conditions over time. Monitoring for certain water quality parameters (such as the amount of dissolved oxygen) only describes the condition of the water at the moment in time the samples were taken. Benthic macroinvertebrates are a critical part of the aquatic food web. They form a vital link in the food chain connecting aquatic plants, algae, and leaf litter to the fish species in streams. The condition of the benthic macroinvertebrate community reflects the stability and diversity of the larger aquatic food web.

BIOLOGICAL MONITORING

1. Benthic macroinvertebrates are animals that are big enough to be seen with the naked eye.
2. They lack backbones (invertebrate) and live at least part of their lives in or on the bottom (benthos) of a body of water.
3. Macroinvertebrates include aquatic insects (such as mayflies, stoneflies, caddisflies, midges, beetles), snails, worms, freshwater clams, mussels, and crayfish. Some benthic macroinvertebrates, such as midges, are small and grow no larger than 1/2 inch in length. Others, like the three ridge mussel, can be over ten inches long.

2. How Do We Collect Them?

A. Kick Seine Sampling Method

The kick seine method is a simple procedure for collecting stream-dwelling macroinvertebrates. It is used in riffle areas where the majority of the organisms live. This technique can be quite effective in determining relative stream health; **however, it is only as good as the sampling technique.** Two to three people work together to perform the technique properly. Follow the procedures as closely as possible.

1. Locate a "typical riffle." Such a riffle is a more shallow, faster moving mud-free section of stream with a streambed composed of material ranging in size from ten-inch cobbles to one-quarter inch gravel or sand. The water ranges in depth from approximately two inches to a foot, with a moderately swift flow. Avoid riffles located in an area of a stream that has been recently disturbed by anything, including construction of a pipeline crossing or roadway.

2. Once the riffle has been located, select an area measuring 3 feet by 3 feet that is typical of the riffle as a whole. Avoid disturbing the streambed upstream from this area.

3. Examine the net closely and remove any organisms remaining from the last time it was used.

4. **Approach the sampling area from downstream!**

5. Have one person place the net at the downstream edge of the sampling area. (It may take two people to hold it in place.) The net should be held perpendicular to the flow, but at a slight downstream angle. Stretch the net approximately three feet, being certain that the bottom edge is lying firmly against the bed. If water washes beneath or over the net you will lose organisms.

6. Another person comes upstream of the net. **Stand beside, not within the sampling area.** Remove all stones and other objects two inches or more in diameter from the sampling area. Hold each one below the water as you brush all organisms from the rock into the net. You can also place rocks on the bottom of the net to help hold it down.

7. When all materials two inches or larger have been brushed, step into the upstream edge of the sampling area and kick the stream bed vigorously until you have disturbed the entire sampling area. Kick from the upstream edge toward the net. Try to disturb the bed to a depth of at least two inches. You can also use a small shovel to disturb the bed. Kick for at least 2-3 minutes.

8. Carefully remove the net with a forward upstream scooping motion. DO NOT allow water to flow over the top of the net or you may lose organisms.

9. Carry the seine to a flat area on the stream bank. Remove leaves, rocks, and other debris. Examine them for any attached organisms. Using fingers or forceps, remove organisms from the net and place in a plastic container for later identification. If nothing appears to be on the net, leave it alone for a few minutes. The insects will begin to move around because they are out of the water.

10. Perform steps 1-9 a total of three times in the same riffle or different riffles within your site.

11. Sort all the organisms collected from the three samples according to body shape using ice cube trays or petri dishes. Record the presence of each type of organism and estimate the number of each type.

B. Dip Net Sampling Method

If there are no riffles at your stream site to perform the kick seine sampling method, then you should use the dip net to perform your biological monitoring. Dip nets are useful for sampling aquatic habitats other than riffles. One dip net "jab" involves forcing the dip net against the stream bottom repeatedly, starting close to your body and finishing with arms fully outstretched. However, sampling technique differs depending on specific habitat conditions. The following is a list of habitat-specific sampling hints *(modified from the Clinton River Watershed Teacher Training Manual)*.

Leaf Pack: Look for leaves that are brown and slightly decomposed (only a handful of leaves is necessary). Place the bottom of the net immediately downstream from the leaf pack with handle perpendicular to stream flow. Gently shake the leaf pack in the water to release organisms, and then quickly scoop up the net, capturing both the organisms and the leaves.

Tree Roots, Snags (accumulations of debris), and Submerged Logs: Select an area approximately 3 by 3 feet in size. Begin working downstream, scraping the surface of roots, logs, or debris with the net. You may also disturb such surfaces with a large stick, your foot, or by removing some of the bark to expose hidden organisms. In all cases, be sure that the net is positioned downstream from the snag, root, or log, so that dislodged material floats into it.

Undercut Banks: Place the net below the surface under the overhanging vegetation. Move the net in a bottom-up motion, jabbing at the bank several times in a row to loosen organisms.

Sediments: (Sampling technique useful in areas of mostly sand and/or mud). The person holding the net stands downstream of sediment area with dip net resting on the bottom. Another person begins upstream, kicking and disturbing sediments to a depth of about two inches as they approach the net. The "netter" sweeps the net upward to collect organisms as the kicker approaches. Finally, keeping the opening of the net at least an inch or two above the surface of the water, wash sediment out of the net by moving the net back and forth in the stream water. Take a total of twenty jabs in a variety of habitats. After two or three jabs are performed with one net, dump the collected materials from the net into a shallow white container or bin - a dish pan works well. The materials in the bin may be quite muddy and turbid (depending upon your stream habitat). If this is the case, once you find macroinvertebrates in your sample, you may want to place them into another clean container with a small amount of clear water for easier identification.

C. Combination Sampling Method

If your 200-foot sampling site has a variety of habitats, including riffles, then you may perform a combination of sampling methods. Record the types of equipment used and the types of habitats sampled on the Biological Monitoring Data Sheet.

3. How Do They Develop?

Most of the benthic macroinvertebrates you will encounter are aquatic insects. Aquatic insects have complex life cycles and live in the water only during certain stages of their lives.

Complete Metamorphosis (true flies, beetles, caddisfly)

Egg to larvae to pupa to adult

Aquatic insects may go through one of two kinds of development or metamorphosis. Those that go through complete metamorphosis undergo four stages of development: egg, larva, pupa, and adult. They lay their eggs in water; eggs then hatch into larvae that feed and grow in the water. (These larval insects do not resemble the adult insects; many appear wormlike.) The fully-grown larvae develop into pupae and then into adults. The fully-formed adults of some species (midges and flies, for example) emerge from the water and live in the habitat surrounding the stream. Others, such as riffle beetles, continue to live in the stream as adults. After mating, adults of all aquatic insect species lay eggs in the water, beginning the life-cycle all over again.

Incomplete Metamorphosis (mayfly, dragonfly, stonefly, true bugs)

Egg to nymph to adult

Aquatic insects that go through incomplete metamorphosis undergo only three stages of development; eggs, nymphs and adult. The eggs hatch into nymphs (also called larvae). Nymphs feed and grow in the water while they develop adult structures and organs. The life cycle begins again when adults lay eggs in the water.

4. What and How Do They Eat?

Macroinvertebrates may be categorized by their feeding groups - the type of food they eat and the manner in which food is obtained/collected.

Shredder: feeds on coarse, dead organic matter (leaves, grasses, algae, and rooted aquatic plants), breaking it into finer material that is released in their feces. Shredders include stonefly nymphs, caddisfly larvae, cranefly larvae.

Collector: feeds on fine, dead organic matter, including that produced by the shredders.

Filtering collector: filters particles out of flowing current. Examples include blackfly larvae and net-building caddisflies.

Gathering collector: gathers matter while crawling along the river bottom. Gatherers include mayfly nymphs, adult beetles, midge larvae.

Grazer: grazes on algae growing on rocks in the substrate or on vegetation. Grazers include snails and water pennies.

Predator: feeds on other invertebrates or small fish. Mouth parts are specially adapted to feed on prey. Dragonflies and damselflies have scoop-like lower jaws, the jaws of hellgrammites (dobsonflies) are pincer-like, and water strider's mouth parts are spear-like. Also includes beetle adults and larvae.

5. General Benthic Macroinvertebrates Collection Information

The sampling effort expended to collect benthic macroinvertebrates at each site should be sufficient to ensure that all types of benthic invertebrate habitats are sampled in the stream reach. This generally will be about 30 minutes of total sampling time per station.

Sample collection should begin at the downstream end of the stream reach and work upstream.

Macroinvertebrate samples should be collected from all available habitats within the stream reach using a dip net with a one millimeter (mm) mesh, a kick screen made from doweling and window screening, or by hand picking. Habitat types can include gravel, cobble, silt, sand, submerged wood, leaf packs, algal mats, and aquatic plants. Habitat and substrate types from which macroinvertebrates were collected (or collections were attempted) should be recorded on the form.

All organisms collected should be placed into a jar or bucket to form one composite sample. The composite sample should be rinsed and all large pieces of debris removed. The remaining sample contents should be emptied into an enamel pan with a light-colored bottom.

The organisms in the pan should be identified to order using the taxonomic keys provided, and the abundance of each taxon in the stream segment should be estimated and recorded on the survey form (R=Rare [1-10 organisms], C=Common [11 or more organisms]).

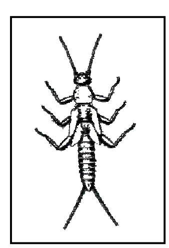
The total stream quality score should be calculated as indicated on the survey form. This score is then used to rank the site as excellent, good, fair, or poor.

During the macroinvertebrate survey, volunteers should take note of any fish or wildlife (frogs, turtles, ducks, etc.) that may be visible in/on the stream and document any observations on the survey form.

6. What Do They Look Like?

Stonefly nymph

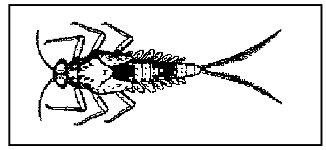
Class: Insecta **Order** Plecoptera



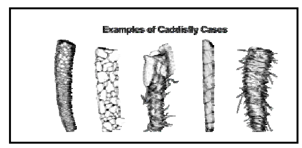
Where to find Underside of rocks, in debris, in algal mats
Body shape Elongated, resembles adult **Size** 5 - 35 mm
Feeding Group Predator or shredder
Lifecycle Incomplete metamorphosis
Larval development: 3 months to 3 years, involves 12-22 molts
Distinguishing Characteristics Abdomen ends in two hair-like tails No gills visible on abdomen 2 tarsal claws Antennae long (longer than head) Only found crawling on surfaces, not swimming
**Distinguished from mayfly by two tails and lack of feathery gills*

Mayfly nymph

Class: Insecta Order Ephemeroptera



Where to find Underside of rocks and logs, some species free-swimming
Body shape Elongated and flattened, resemble adults **Size** 3 - 20 mm
Feeding Group Gathering collector
Lifecycle Incomplete metamorphosis, with additional sub-adult stage unique to mayflies. Larval development lasts 3 months to 3 years
Adults often form large mating swarms over water following emergence
Distinguishing Characteristics Abdomen usually ends in three filamentous, hair-like tails (some species have two); tails may appear webbed Tails are fragile and may break off during collection, examine carefully Feathery gills line sides of abdomen 1 tarsal claw
**Distinguished from stoneflies by presence of three tails and feathery gills*

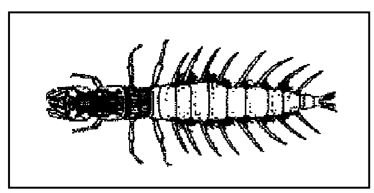


Caddisfly larva

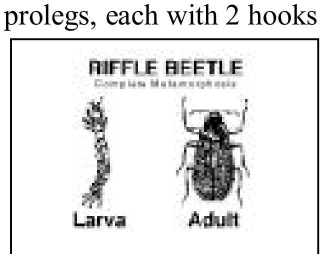
Class: Insecta Order Trichoptera
Where to find Underside of rocks, on plant materials
Body shape Usually cylindrical and "C"-shaped, 6 legs near head **Size** 2 - 40 mm
Feeding Group Shredder (net-spinning caddisfly is a filtering collector)
Lifecycle Complete metamorphosis, which occurs while sealed in "cases" or "houses"
Distinguishing Characteristics Usually found in "houses" made of pebbles, wood, sticks, leaves, or shells; cases constructed using glue-like secretion from end of abdomen Caddisflies leave holes in ends of "houses" to serve as breathing tubes prior to metamorphosis Abdomen ends in 2 prolegs, each with a claw May have darker, harder plates on top of thorax Some form nets at end of house to collect food (net-spinning caddisfly) Move with characteristic wiggling – back and forth then up and down through the water

Dobsonfly larva (Hellgrammite)

Class: Insecta Order Megaloptera **Family** Coryalidae



Where to find Soft substrate; soft, rotting logs and stumps;
Or between rocks
Body shape Large, long and slightly flattened **Size** 10 - 90 mm
Feeding Group Predator **Lifecycle** 2 – 5 years
Distinguishing Characteristics Large pinchers on head Three pairs of legs on middle portion of body with tiny pinchers at the end of each 7 - 8 pairs of lateral filaments on abdomen 3 pair of well-developed legs on thorax Abdomen ends in pair of short, spiny prolegs, each with 2 hooks



Riffle Beetle (adult)

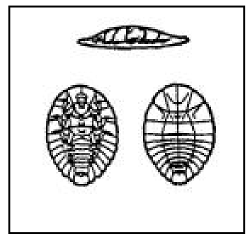
Order Coleoptera **Family** Elmidae
Where to find Crawling on stream bottom; often

collected with kick seine in riffles
Body shape Oblong, oval, hard **Size** 1 – 6 mm
Feeding Group Gatherer collector **Lifecycle** Complete metamorphosis Both adults and larvae are aquatic
Distinguishing Characteristics Tiny Walks very slowly underwater Black in color Hardened, stiff appearance of entire body True "beetle" appearance with 6 legs Adult found more often than larvae

Riffle Beetle (larva)

Order Coleoptera **Family** Elmidae
Where to find Crawling on stream bottom
Shape Elongate, hard-bodied
Size Usually < 1.25cm
Feeding Group Gatherer collector or grazer **Lifecycle** Complete metamorphosis Both adults and larvae are aquatic **Distinguishing Characteristics** Resemble tiny torpedoes with circular rings around body Body hard and stiff Grey or brown in color

Water penny beetle larva

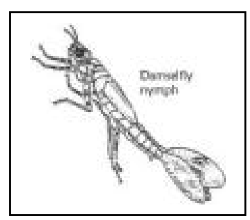


Order Coleoptera **Family** Psephenidae
Where to find Stones and other substrate
Body shape Disk (flat)
Size 3 - 5 mm **Feeding group** Grazer
Lifecycle Complete metamorphosis; Lifecycle from 21 to 24 months
Distinguishing Characteristics Brown, black, or tan colored Round – resemble pennies Often difficult to remove – resemble suction cups 3 pairs of tiny legs on underside of body

Right-Handed (Gilled) snail

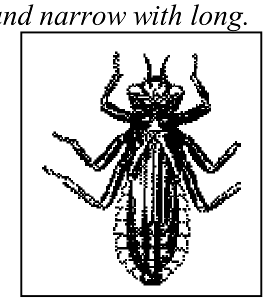
Phylum Mollusca **Class** Gastropoda **Order** Mesogastropoda
Where to find Grazing on a variety of substrates **Body shape** Hard, spiraled shell
Size 2 - 70 mm **Feeding group** Grazer
Distinguishing Characteristics With point held up, opening (aperture) is on your right and faces you (right = good = gilled) Respire via gills, so require oxygenated water Plate-like covering over shell opening Shells coiling in one plane are counted as Left-Handed (Pouch) Snails (Group 4) Only **live** snails may be counted in determining water quality

Damselfly nymph



Class: Insecta Order Odonata **Suborder** Zygoptera
Where to find Overhanging/emergent aquatic vegetation
Body shape Elongated, narrow, tapering rearward, resemble adults
Size 15 - 30 mm **Feeding group** Predator
Lifecycle Incomplete metamorphosis, maturation in 1 to 4 years
Distinguishing Characteristics Abdomen ends in 3 wide, oar-shaped gill-plates resembling tails Large eyes and long legs No gills present on sides of abdomen Grey, green, or brown in color
**May be confused with mayflies, but damselflies have no abdominal gills and tails are more paddle-shaped *May be confused with dragonflies, but bodies are thin and narrow with long.*

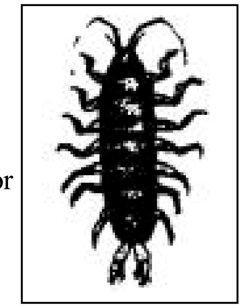
Dragonfly nymph



Class: Insecta Order Odonata **Suborder** Anisoptera
Where to find Bottom substrate, mud, vegetation
Body shape Wide abdomen, oval, flattened, robust,

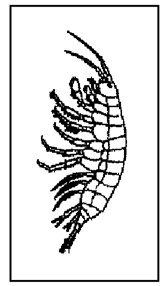
resemble adults **Size** 20 - 50 mm **Feeding group** Predator
Lifecycle Incomplete metamorphosis, maturation in 1 – 4 years
Distinguishing Characteristics Large eyes No visible external gills Distinct mouthparts that extend to catch prey Grey, green, or brown in color Body is generally rough Rectal respiratory chambers (though no tails)
**May be confused with damselflies, but distinguishable by wide, oval abdomen and no tails*

Aquatic sowbug



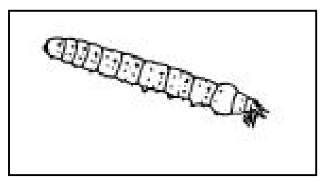
Class Crustacea **Order** Isopoda
Where to find Crawling on substrate, vegetation, and debris
Body shape Hard bodied and flattened dorso-ventrally (top to bottom)
Size 5 – 20 mm**Feeding group** Collector
Distinguishing Characteristics 7 pairs of legs Dark brown to gray in color Two pair of antennae, one usually much longer Similar in appearance to terrestrial "roly-poly" or pillbug**May be confused with scuds, but sowbugs are wider than they are high, and they walk slowly along surfaces*

Scud



Class Crustacea **Order** Amphipoda
Where to find Aquatic vegetation
Body shape Flattened laterally (side to side)
Size 5 – 20 mm **Feeding group** Filtering collector
Distinguishing Characteristics 7 pairs of legs Shrimp-like Swims on side White to clear to pink in color Distinct black eyes**May be confused with sowbugs, but are higher than they are wide and swim rapidly on their side*

Cranefly larvae



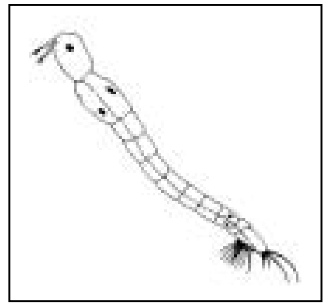
Order Diptera (True Flies) **Family** Tipulidae
Where to find Under rocks, on aquatic vegetation, in leaf-packs
Body shape Caterpillar-like and segmented **Size** 10 – 100 mm
Feeding group Shredder
Lifecycle Complete metamorphosis, spends 6 weeks – 5 years in aquatic stage
Distinguishing Characteristics No true legs or wing buds
Prolegs may be visible as small lobes
Milky, light brown, or greenish in color with digestive tract often visible
**Distinguished from other fly larvae by finger-like appendages that extend from posterior end (if no appendages on hind end, probably a deer or horse fly larvae)*

Clams and Mussels

Class Bivalvia **Where to find** Substrate **Body shape** Two shells attached by a hinge
Size Varies
Feeding group Filtering collector

Distinguishing Characteristics Only **live** clams and mussels may be counted in determining water quality

Midge larvae

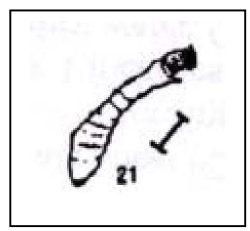


Order Diptera (True Flies) **Family** Chironomidae
Where to find Sediment, vegetation, leaf pack
Body shape Cylindrical, thin, soft, and often curled
Size 2 - 20 mm **Feeding group** Gathering collector or grazer
Lifecycle Complete metamorphosis
Distinguishing Characteristics Hardened head capsule
No true legs
Anterior and posterior prolegs
**Often confused with aquatic worms, but midge has visible head and prolegs*
**Bloodworms (Very Tolerant to Pollution – Group 4) are a group of midges that are red in color – they are discussed separately*

Leech

Phylum Annelida **Class** Hirudinea
Where to find Sediment, leaf pack, vegetation, attached to host animal
Body shape Flattened dorso-ventrally (top to bottom), many segments **Size** 5 – 100 mm
Feeding group Predaceous, collector
Distinguishing Characteristics Anterior and posterior suckers Usually much wider than aquatic worm
Usually tan to brown in color, though can be patterned and brightly colored
**May be confused with planarians but are usually larger, with segments and suckers*

Blackfly larvae



Order Diptera (True Flies) **Family** Simuliidae
Where to find In swift current on rocks, and submerged vegetation Often attached by disk on end of abdomen
Body shape Bowling pin shaped with sucker on wide end
Size 3 - 12 mm
Feeding group Filtering collector
Lifecycle Incomplete metamorphosis
Distinguishing Characteristics Soft body Single proleg directly under head - no true legs Fan-like mouth bristles may be present Head usually black, less often brown, tan, or green. Move downstream by drifting on silken threads extended from abdomen
**Distinguished from other fly larvae by swollen back end*

Planaria (Flatworm)

Class Turbellaria **Order** Platyhelminthes
Where to find Bottom of rocks, leaf litter
Body shape Soft, flattened dorso-ventrally (top to bottom), arrow-shaped head **Size** Usually <1mm, range to 30mm **Feeding groups** Gathering collector, predator
Distinguishing Characteristics Flat body Arrow-shaped head with eyespots Body slides smoothly along surfaces
**May be confused with aquatic worms or leeches, but slides along surfaces rather than moving end to end (leeches) or by stretching part of body and pulling the rest (worms) also, planarians are unsegmented*

Aquatic worms

Phylum Annelida **Class** Oligochaeta
Where to find Silty sediment, organic debris **Body shape** Long, thin, cylindrical, segmented
Size 1 – 30 mm **Feeding groups** Shredder, collector, grazer
Distinguishing Characteristics Often similar to earthworm in appearance Red, tan, black, or brown in color
**Distinguished from leeches, midges, and planarians by long, thin body and worm-like movement (stretching and pulling body along)*

Blood Midge larva

Order Diptera (True Flies) **Family** Chironomidae
Where to find Substrate, often in organically polluted water **Body shape** Cylindrical, thin, soft, and often curled **Size** 2 - 20 mm **Feeding group** Collector gatherer **Lifecycle** Complete metamorphosis
Distinguishing Characteristics Red in color Hardened head capsule No true legs Anterior and posterior prolegs

Left-Handed (Pouch) snail

Phylum Mollusca **Class** Gastropoda **Order** Prosobranchia
Where to find Grazing on a variety of substrates
Body shape Hard shell usually spiral, but may be flattened **Size** 2 - 70 mm **Food source** Grazer
Distinguishing Characteristics With point held up and shell opening facing you, opening is on your left Snails with shells coiling in one plane (orb snail) are also counted as Left-Handed No plate-like covering over shell opening Respire via lung-like structures, so not dependent on dissolved oxygen in the water Only **live** snails may be counted in determining water quality

Rat-tailed Maggot

Order Diptera (True Flies) **Family** Syrphidae
Where to find Silty sediments of organically enriched water
(ex. sewage lagoons)
Body shape Soft, worm-like with long tail **Size** Usually 4 - 14mm, may exceed 70mm
Feeding group Collector **Lifecycle** Complete metamorphosis
Distinguishing Characteristics Maggot-like, wrinkled body Long tail (can be 3 – 4x body length)
Tail is extended above surface of the water, allowing rat-tailed maggot to obtain oxygen from the air

NOTE !!! READ !!

** There is a possibility that you will discover the following insects and other organisms that are not listed on the Pollution Tolerance Index (e.g., crawfish, adult dragonflies, water striders, water bugs). ***They are not counted in the PTI***. These organisms are not as useful as indicators of water quality because they are less dependent on local stream conditions for habitat requirements.

True bugs
(Backswimmer, Giant water bug, Water boatmen, Water strider)

Order Hemiptera **Where to find** Often seen skimming or walking along water Surface **Body shape** Hard, oval, and somewhat flattened **Size** 1 – 65 mm

Waterboatman - swims right side up, back is black
Backswimmer - swims on back, back is white or creamy
Water Strider - lives on surface
Giant Water Bug - grasping front legs, up to three inches in length

7. Dissolved Oxygen Testing and Results

Although this program is focusing mainly on "bioassessment" protocols, the chemical nature of lakes and streams is also a good indicator of water quality. Dissolved oxygen levels are usually considered the most important chemical test for lakes and streams and are essential for the maintenance of healthy water.

Most aquatic plants and animals need oxygen to survive. Fish and some aquatic insects have gills to extract life-giving oxygen from the water. Some aquatic organisms, like pike and trout, require medium to high levels of D.O. Other animals, like carp and catfish, flourish in waters of low D.O. Waters of consistently high D.O. levels are usually considered healthy and stable ecosystems capable of supporting many different kids of aquatic organisms.

Sources of Dissolved Oxygen

A. Most of the dissolved oxygen in lakes/rivers comes from directly dissolving in the body of water from the atmosphere.
B. Waves on lakes and waterfalls in rivers create "aeration" which helps oxygen dissolve into the water.
C. Aquatic plants, both macro and microscopic, produce large amounts of oxygen which can dissolve directly into the water.

Physical Influences on Dissolved Oxygen

As with other gases, oxygen will dissolve best in COLD water. During the summer months as lake temperatures rise, the dissolved oxygen levels may fall. In rivers, the water temperature usually stays fairly constant throughout the year (compared to lakes) so the dissolved oxygen levels will not fluctuate as much. If a river is dammed or contains large amounts of suspended sediment, the water temperature may, in turn, increase causing a decrease in temperature.

Atmospheric air pressure can also play a role in regulating or changing the amount of oxygen which will dissolve in a lake/stream. At high pressure more oxygen dissolves directly from the atmosphere at low pressure (high elevations- mountains) less oxygen dissolves directly from the atmosphere.

Percent Saturation

Since dissolved oxygen levels are so closely linked with water temperature, the percent saturation of the water is usually a better measure of water quality than just the level of D.O. To calculate the percent saturation use the chart below. Percent saturation levels from 90-110% are usually considered "good." Supersaturation, levels well above what would be expected at a certain temperature, can occur downstream from waterfalls or in areas of cultural eutrophication (extremely large amounts of plant growth, weeds, or algae blooms.)

Results

The dissolved oxygen values which should occur in rivers and streams ranges from a low of 6 ppm to a high of 13 ppm. Values below 6 ppm are usually indicative of water, which will not support river fish. High levels of bacteria or large amounts of rotting organic material can consume oxygen very rapidly and cause the percent saturation to decrease. Conversely, water may become supersaturated for short periods of time, holding more than 100% of the oxygen it would hold under normal conditions.

Low levels of dissolved oxygen can have many causes. Rapid decomposition of organic materials, including dead algae, shoreline vegetation, manure or wastewater decreases dissolved oxygen levels. High ammonia concentrations in the stream use up oxygen in the process of oxidizing ammonia ions to nitrate ions.

Calculating the DISSOLVED OXYGEN LEVEL - Follow instructions in the box!!!!

Calculating % Saturation

Use the chart on the following page ______ to calculate % SATURATION. Remember, you must have both a DISSOLVED OXYGEN value and a TEMPERATURE.

Calculating a "Q-value"

A Q-value is a scale form 0-100 which ranks the test. Many non-scientist people will not understand what the values of dissolved oxygen and percent saturation mean. They may not realize what values are good and what values are bad. Use the chart on page _______ to calculate your "Q-value."

8. Temperature

One of the most serious ways that humans can change the temperature of a river is through thermal pollution. Thermal pollution is an increase in water temperature caused by adding relatively warm water to a stream or river. Industries, such as nuclear power plants, manufacturing plants, electric generating plants all use water to cool machinery. It may also come from stormwater runoff from warmed urban surfaces such as streets, sidewalks, and parking lots. Erosion can also cause the river water to warm because the dark, turbid water can absorb more of the sun's thermal energy.

In this portion of the test you will measure the temperature change of the river between two points: the test site and a site one mile upstream or downstream. By detecting significant temperature changes along a section of the river, we can begin to uncover the sources of thermal pollution. The temperature test is significant because temperature is so closely linked to dissolved oxygen levels.

Calculate the temperature change by subtracting your two temperatures and use the chart on page _________ to calculate a Q-value.

9. Site Selection

The association and the high school involved should work together to select a site, which is crucial to the health of their lake and/or watershed. Road crossings make a good site to select because they are easy to reach and because they are often sites of contamination, erosion, construction, etc.

If you do select a site at a road crossing be sure to sample 100 feet upstream and downstream of the bridge/culvert. Sample all riffle, pool, mucky, silty, sandy areas using different nets. In addition, be sure to sample under stream banks if they overhang and in all rocky, cobble, and gravel areas. Leaf mats and areas with bunches of organic matter will also often contain different species of macroinvertebrates.

NOTE !!

The following pages contain the forms you will use when performing your stream assessment. **The forms contained here are NOT to be used in your survey.** Please fill out the EXTRA forms attached at the end of this booklet.

10. Completing Survey Forms

Time of Year

The time of year in which a survey is conducted is important. Surveys should not be conducted when there is snow on the ground or ice on the water because sources and impacts may be hidden from view. The best time for getting an unobstructed view of the landscape is in the early spring before leaf-out, followed next by late fall after leaf drop. However, if potential nutrient enrichment of the watershed to be surveyed is a major consideration, then summer is often the best time to conduct the survey because there may be more aquatic plant or algae growth visible as a potential manifestation of nutrient enrichment. Surveys conducted during or shortly after storm runoff events may help to identify sources of pollutants, but increased stream turbidity during that time may make assessment of instream conditions difficult.

INSTRUCTIONS FOR COMPLETING DATA SHEETS

1. Stream Survey Data Sheets

Photographs: Taking Pictures

Take one photo looking upstream from the road crossing and one photo looking downstream. The photos should be composed (framed) to best represent site conditions. Take the photos in the same sequence at each station to help in later assigning the photos to the proper upstream/downstream designation at the sites. The photos should include at least some of the riparian corridor—how much depends on which areas are significant to include in the photo. Additional photos may be taken to highlight a particular item of concern in the river or upland landscape. Photos may also be taken between stations to record a specific river concern or source area, but these photos should be assigned to the pertinent upstream or downstream station to keep them organized.

A copy of the photos should be kept and sent in with data forms. In addition, any photos of your students in action can be sent in with the data. If possible use digital photography and forward pictures to kalemberj@gaylord.k12.mi.us so that we can place them on our dedicated web page.

Date: Record the month, day and year.

Time: Use 24-hr time (e.g. 1:00 PM should be recorded as 1300).

Waterbody Name: The waterbody name should be the name of the river or river branch, as given on local and state maps. In addition, note where the river/stream empties. (lake name)

County: Record county name.

Location: Record the name of the road crossing the stream crossing. To avoid confusion use milages to nearest landmark. Some streams cross the same road more than once, if this is the case, note which location you are testing at.
Township: Record the township name.

Section: Record the township section number, town number, range number, and section ¼ ¼ designations (e.g. SW ¼ of the NW ¼).

Investigator: Record the name of the person conducting the survey (doing the assessment and filling out the form) at this particular site. A last name is generally sufficient.

<u>Latitude</u>: Record the latitude coordinates of the road crossing location.

<u>Longitude</u>: Record the longitude coordinates of the road crossing location.

Background Information

<u>Event Conditions Noted at Site</u>: A stream "event" occurs when water runoff from a significant weather event, such as a major rainstorm or fast snowmelt, causes an increase in river flow. Note that high water flow conditions can exist (particularly in the spring) that are not related to storm events. Also, rainstorms can occur that result in no increase in stream flow and therefore there is no stream event.

Circle the appropriate description of event conditions exhibited ***in the stream***. Event conditions are <u>increased river flow</u> above what would be considered typical or normal for the stream for the time of year. The surveyor needs to determine this based on the following:

- Their knowledge of recent weather conditions (e.g. how much it has rained recently).
- Visual stream observations (look for event related conditions such as a rising or recently elevated water level, water running off the land into the stream, fast stream water velocity, increased water turbidity, an increase in the amount of debris being carried by the stream, etc.).
- The surveyor's knowledge (or best guess) of what is typical flow for that (or a similar) stream, in that geographic area, for that season of the year.

None	-No event conditions are evident. Stream flow conditions exist that are typical for the season of the year. Note that it is possible to have "high" flow conditions that are not due to a recent storm event.
Light	-Stream exhibits increased turbidity from normal and/or the water level of the stream (stage height) is somewhat elevated above what would be considered typical for the season of the year.
Moderate	- Stream stage height is elevated substantially above typical flow conditions for the stream, for that time of year.
Heavy	- Bank full or flooding conditions exist.

<u>Days Since Rain</u>: Circle the appropriate number of days that have passed since the last significant rain ended. This information is based on what you know about recent weather in the vicinity of the site. If you do not know, circle "unknown".

<u>Water Temperature:</u> Record the water temperature to the nearest degree centigrade, making sure to include the scale units. If possible, determine the water temperature one mile downstream or upstream from the testing site. Subtract the two measurements to determine the temperature change and calculate a Q- value.

Water D.O The person coordinating a particular watershed survey will determine the dissolved oxygen (DO) level, % saturation, and Q value for DO. Record the DO level in the river.

Water pH: This is an optional data item. The person coordinating a particular watershed survey will determine if pH measurements will be made. If measured, record the pH of the stream to the nearest tenth. PH paper and/or a pH meter have not been furnished for you to use. Your school science teachers can help you with this.

Water Color: Circle the choice that best represents the color of the water.

Waterbody Type-u/s: Characterize the waterbody upstream of the road crossing and circle the appropriate category. Impd=impoundment.

Waterbody Type-d/s: Characterize the waterbody downstream of the road crossing and circle the appropriate category. Impd=impoundment.

Stream Width (ft): Circle the range that represents the average stream width in feet. Make this observation using best professional judgment of the distance. This can be done by pacing off the distance (counting the number of steps taken) on the road crossing from one edge of the stream to the other. There is no need to measure the distance with a tape measure or similar device, however, it is best to have previously paced off distances of 10, 25 and 50 feet so that the number of strides is known to these category endpoints.

Avg. Stream Depth (ft): Circle the appropriate depth range in feet. If the water is turbid and the depth cannot be determined, circle "Unknown". This observation is for the average depth of the stream that is consistently observed. In other words, if the stream is mostly shallow, but is 5ft deep in the channel, the >3ft category should be circled. However, if the stream is generally shallow (<1ft), but has a pool that is 3ft deep, circle the <1ft category since a pool is not representative of the average depth of <1ft observed over most of the stream. Remember that water often looks shallower than it is. The primary purpose of this data observation is to identify sites that would be suitable for wading for potential future instream assessments.

Water Velocity (ft/sec): This is an optional data item. The person coordinating a particular watershed survey will determine if water velocity measurements will be made. If measured, record the approximate surface water velocity in feet per second, observed at the surface in the area of fastest river flow that is not impacted by the road crossing. The preferred method is to observe how far downstream surface bubbles, foam, leaves, or other floating objects, travel in one second (or observe for 10 seconds and divide the distance by 10). Another method is to step off the width of the road, time how long it takes a particular object (e.g. leaf, stick, grass blade) to float from the upstream side of the bridge to the downstream side, and divide the number of seconds into the distance to get feet per second. In some cases, the water velocity measured at the road crossing will not accurately represent actual stream velocity. This may occur at road crossings where the river width is abnormally restricted by the size of passage beneath the road (such is often the case with culverts), which can cause faster flow through the culvert than is observed in the stream. In such a case, it is better to measure water velocity further upstream or downstream (by looking further upstream or downstream from the bridge, not by going to a different location), if possible.

Stream Flow Type: Circle the category that best represents general flow volume in the stream. Note that in this case, "average" flow refers to the annual average flow. If a river flow is reduced in the summer, due to dry and hot conditions, circle "L" because it is below average, even though low flow may be typical for that stream in the summer.

Dry	=	No standing or flowing water, sediments may be wet.
Stagnant	=	Water present but not flowing, can be shallow or deep.
L (low)	=	Flowing water present, but flow volume would be considered to be below average for the stream.
M (medium)	=	Water flow is in average range for the stream.
H (high)	=	Water flow is above average for the stream.

Physical Appearance

Starting with this section of the form and continuing to the end, the person conducting the survey should evaluate each category twice—once for the upstream (U/S) side of the road crossing, and a second time for the downstream (D/S) side. From this point on, the surveyor is assessing two distinct sites. The conditions observed at one site should not bias the surveyor's assessment of conditions at the other. Usually it is easiest to complete the rest of the form for either the upstream or downstream site first, and then move to the other side of the road crossing and complete the remainder of the form for the remaining site. Most people do the upstream site first since it is listed on the form first.

Check the stream upstream and downstream, for as far as can be seen from the road stream crossing, for the presence of any of the following characteristics. If a category type (e.g. aquatic plants) is not present in the stream, do not record anything. If a category type can be seen, in any amount, circle "present". If a category type is present in a large portion of the stream, circle "abundant".

Aquatic Plants: This category refers to aquatic macrophytes only, not terrestrial species. By definition, macrophytes are any plant species that can be readily seen without the use of optical magnification. However, the usage here is directed primarily toward aquatic vascular plants—plants with a vascular system that typically includes roots, stems and/or leaves. This includes duckweed, as it is a floating vascular plant. Certain large algae species that superficially look like vascular plants, such as Chara, can be recorded here as well. If the person conducting the survey is knowledgeable about aquatic plants, the particular type or species of plant(s) can be noted in the comment section at the end of the form. Floating, suspended, or filamentous algae species should be recorded in one of the algae categories and not here.

Floating Algae: The presence of suspended algae (single celled organisms that may or may not form colonies) or floating algae mats/bundles should be recorded here. This includes blue green algae mats/bundles, whether floating on the surface, suspended in the water column, or present at the bottom.

Filamentous Algae: Algae that appear in stringy or ropy strands, such as Cladophora. The strands may or may not be attached to other objects in the waterbody.

Bacterial Sheen/Slimes: -Bacterial sheens occur as oily appearing sheens on the water surface, often with a silverish cast to them. The sheens are produced from bacterial decomposition activity, and occur most often in still water areas of lake edges and coves, as well as wetland areas. The sheen can be distinguished from petroleum products by breaking into distinct platelets when poked with a stick or otherwise physically disturbed, whereas petroleum products remain viscous.
-Bacterial slimes are bacterial growths that are visible as a slimy-appearing coating of stream or lake substrates. They can be various colors, including black and orange.

Turbidity: Water appears cloudy—it is not transparent. Turbidity is caused by suspended particulates such as silt, sand, algae, or fine organic matter. Turbid water is opaque to varying degrees, preventing the observer from seeing very far into it. Note that water can have a color to it that is not turbidity, such as the brown transparent water often associated with swampy areas. If the water is slightly turbid, circle "present". If it is moderately turbid to very turbid, circle "abundant".

Oil Sheen: An oily appearing sheen on the water surface caused by petroleum products. A thin sheen will often have a rainbow of hues visible. The sheen can be distinguished from bacterial sheens by remaining viscous when poked with a stick or otherwise physically disturbed, whereas bacterial sheens break into distinct platelets.

Foam: Naturally occurring foam often looks like soap suds on the water surface and can be white, grayish or brownish. Foam is produced when water with dissolved organic material is aerated and can range in extent from individual bubbles to mats several feet high. Foam is typically produced in streams when water flows through rapids or past surface obstructions such as logs, sticks and rocks. Simple wave action can produce foam in lakes. This naturally occurring foam is quite common. Natural foam can be distinguished from soap suds by rubbing it between ones fingers. If the suds disintegrate and leave only wet fingers or a gritty residue, the foam is natural. If the suds feel slippery and soapy, it is not natural foam.

Trash: Use this category to record the presence of general litter, such as paper, bottles, cans, etc., either in the waterbody or along the riparian banks. Use some reasonable discretion when completing this category. A single piece of gum wrapper on one bank would not be sufficient cause for checking "present".

Substrate

Substrate is the material that makes up the bottom of the stream or lake. In general, good quality substrates (from an aquatic habitat perspective) contain a large amount of course aggregate material—such as gravels and cobbles—with a minimal amount of fine particles surrounding or covering the interstitial pore spaces. These stable materials provide the solid surfaces necessary for the colonization of attached algae and the development of diverse macroinvertebrate communities.

Using the particle size and composition guidance provided below, identify the percent area extent of each substrate type present. Round off to the nearest 10% increment. For example, do not record 25%, use either 20% or 30%. The composition estimate should include the entire area of the stream bottom that is visible from the road stream crossing, including substrates near or under the bridge. Sometimes it is not possible to determine the substrate type all the way across a river because it is too deep or the water is turbid. In these cases, assign the appropriate percentage amount to the "unknown" category.

Substrate Type		Composition and Size
Boulder	-	Rocks 10 inches in diameter or larger.
Gravel-Cobble	-	Rocks 1/12 inch to 10 inches in diameter.
Sand	-	Rocks 0.06 to 2 millimeters in diameter.
Silt-Muck-Detritus	-	Silt is usually clay, very fine sands, or organic soils, 0.004 to 0.06 millimeters in diameter. Muck is decomposing organic material of very fine diameter. Detritus is small particles of organic material such as pieces of leaves, sticks, and plants.
Hardpan-Bedrock		-Solid surface. Hardpan is usually packed clay, <0.004 millimeters in diameter. Bedrock is a solid rock surface (the tops of buried boulders are not bedrock).
Artificial		-Human made, such as concrete piers, sheet piling or rock riprap (that portion of shoreline erosion protection structures that extends below the water surface is considered substrate).
Unknown		-The portion of the stream bottom for which a substrate type determination can not be made because the bottom can not be seen due to water depth or turbidity.

Instream Cover

Instream cover generally refers to habitat cover that is available to fish to: (1) protect them from predators, or (2) avoid certain stream conditions such as fast flow velocities or direct sunlight. Check all the instream cover types on the data form that are present in the stream reach for as far as can be seen—except, only check those cover types that are in areas of sufficient water depth (usually greater than 6 inches). Types of cover include the following:

Undercut Banks	-Stream banks that overhang the stream because water has eroded some of the material beneath them.
Overhanging Veg	-Terrestrial vegetation that extends out from shore over the surface of the stream within a foot or two of the water surface (includes trees, shrubs, grasses, etc.). This category also includes sweeping vegetation, which is terrestrial shoreline vegetation that extends into the water itself (such as low hanging branches on shrubs) and is therefore often "swept" in a downstream direction by the current .
Deep Pools	-A depression or "hole" in the bottom of the stream where the water is substantially deeper than the average water depth of the stream.
Boulders	-Rocks 10 inches in diameter or larger.
Aquatic Plants	-Aquatic macrophytes.
Logs/woody Debris	-Logs, branches and roots.

River Morphology

Riffle

Riffles are areas of naturally occurring, short, relatively shallow, zones of fast moving water followed by a pool. The water surface is visibly broken (often by small standing waves) and the river bottom is normally made up of gravel, rubble and/or boulders. Riffles are not normally visible at high water and may be difficult to identify in large rivers. The size of, and distance between, riffles is related to stream size. In large mainstream reaches, such as the Manistee or Muskegon rivers, riffles may be present in the form of rapids.

Present - A riffle can be positively identified.
Abundant - A series of riffles and pools are visible.

Pool

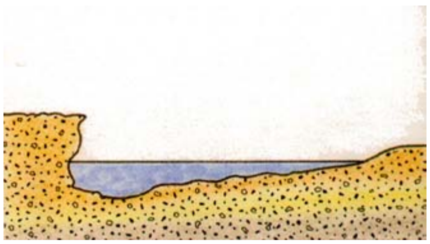
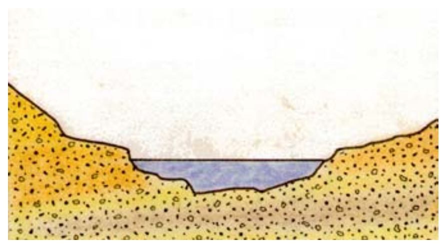
Pools are areas of relatively deep, slow moving water. The key word here is "relatively". Water depth sufficient to classify an area as a pool can vary from around 8 inches in small streams, to several feet in wadable streams, to tens of feet in large rivers. Pools are often located on the outside bend of a river channel and downstream of a riffle zone or obstruction. The water surface of a pool is relatively flat and unbroken. The presence of pools in large rivers may be difficult to identify because of an increase in relative scale, and an often limited ability to see to the bottom of deep or turbid stream reaches.

Present - At least one pool can be identified.
Abundant - A series of pools in a riffle pool sequence are visible.

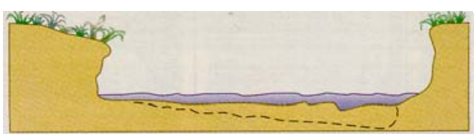
Channel

The channel condition, for the purposes of this assessment, is classified as Natural, Recovering, or Maintained.

Natural Stream - A natural stream has not been altered from its defined pattern, dimension and profile by artificial means, which includes straightening and widening. It is not necessarily stable, however. The stream has a non-uniform cross section with distinct pool and riffle sequences, although in large rivers the pool/riffle sequences may be difficult to identify. Mild to extreme meanders are often visible. The banks are vegetated and there are no signs of spoil piles or dikes along sides. The stream is not channelized or artificially controlled.

Recovering - A recovering stream is one that has been straightened or otherwise controlled, and is evolving back to a stable pattern, dimension and profile. The stream channel is relatively straight, or is overly wide with a channel within the wider channel. Meanders may be beginning to form as evidenced by bank erosion and pool formation. Pools and riffles should be forming but may be sparse. Point bars may be forming. Vegetation may be sparse or very young. Defined dikes or spoil piles along the stream bank can be identified.




Maintained - A maintained stream channel is one that is actively controlled through dredging, widening, straightening, or the formation of dikes along the stream channel. The stream channel is straight, wide and shallow at low flow, and has a uniform cross section. Bank vegetation is typically sparse or very young. Pools and Riffles are not existent or very sparse.

Designated Drain

If the surveyor knows whether or not the stream segment being assessed is a legally designated drain under the Michigan Drain Code, circle "Y" (yes) or "N" (no). If the surveyor does not know, circle the "?".

Highest Water Mark

The highest water mark is the maximum height to which the stream water level rises at the site, as determined by the visible evidence present. This level is typically reached during floods or high flow conditions. The highest water mark is determined as the distance in feet **above the present water level** at the site. If the surveyor cannot visibly determine how far the stream rises at the site, circle the "?" on the form.

The highest water mark may be visible as discoloration on bridge pilings or abutments, stream debris (trash, leaves, weeds) left along the stream banks or in tree/shrub branches, ice scour marks on trees or streambanks, or muddy residues left in floodplains or on streamside vegetation.

Stream Cross Section

Draw a rough cross section of the stream profile. This should be just a general approximation. Do not spend more than a few seconds on this.

Stream Corridor

The questions in this section are used to characterize terrestrial land cover and land use in the vicinity of the stream, often referred to as the stream corridor.

Riparian Vegetative Width

The riparian vegetative width is the width of the streamside natural vegetation zone along the stream banks. The width is measured from the edge of the stream to the end of the contiguous block of natural vegetation. Natural vegetation is defined as including trees, shrubs, old fields, wetlands, or planted vegetative buffer strips (often used in agricultural areas and stormwater runoff control). Agricultural crop land and lawns are **not** considered natural vegetation for the purposes of this question. Circle the appropriate distance (in feet) that represents the **average, or most representative** (>50% of the lineal bank distance) width of the vegetation zone for each side of the river. Left and right banks are determined from the perspective of facing downstream.

Bank Erosion

Bank erosion may occur as a result of natural flow conditions, or may be caused by human activities. Determine the severity of erosion that has taken place and circle the appropriate category. Record the most severe magnitude of erosion observed on either bank.

0 -The banks appear stable and there is no evidence of erosion. These banks have stable toes and sidewalls, are most likely well vegetated or structurally stabilized, and have no evidence of exposed tree roots or leaning trees due to eroded soil. They are not being altered by water flows, livestock access, or recreational access.

L - Low evidence of erosion. Streambanks are stable but are being lightly altered. <u>Less than 10%</u> of the streambank is receiving any kind of stress. Stress that is noted is very light. Less than 10% of the bank is sloughing, broken down, or actively eroding.

M -Moderate evidence of erosion. At least 75% of the streambank is in stable condition. <u>Between 10% and 25%</u> of the streambank is sloughing, broken down, or actively eroding.

H -High evidence of erosion. Less than 75% of the streambank is in stable condition. <u>Over 25%</u> of the streambank is sloughing, broken down, or actively eroding. Streambank sidewalls may have been scraped by machinery or scouring flows, banks may be slumped, bank toe may be severely undercut. Tree roots may be exposed or fallen/leaning trees may be present.

Streamside Land Cover

Circle the letter of the dominant type of cover that exists at the streambank "edge" (within the first 20 feet or so of the stream edge) along the reach of river that can be seen from the road stream crossing.

B - Bare ground. No, or almost no, streamside vegetation.
G - Grasses, wildflowers, ferns, sedges (non-woody vegetation).
S - Shrubs and small trees. Woody vegetation less than 15 feet high.
T - Trees (15 feet tall or higher).

Stream Canopy

The stream canopy is the amount of leafy vegetation that extends out over a stream (at any height) and shades the water from direct sunlight. The amount of stream canopy should be recorded as the amount of water shading that would be present if the sun were directly over the stream.

0 - None. No shading of stream when sun is directly overhead.
L - Low. Less than 25% of the stream would be shaded.
M - Moderate. 25-50% of the stream is shaded.

H - High. Over 50% of the stream is shaded.

Adjacent Land Uses

In this area make comments about the land use surrounding your stretch of river. Some examples are given below.

Wetlands -Wetland vegetation is present. May or may not include standing water. Could include shrubs and trees.

Shrub or Old Field -Meadow or field that has not been recently cultivated or grazed. Often represented by tall grasses and shrubs.

Forest -Trees present in forested setting (includes small woodlots). Trees may be cultivated or natural.

Pasture -Field showing signs of being recently or actively grazed by livestock (vegetation is cropped close to the ground).

Crop Residue -An agricultural crop residue remains, after harvest and/or tillage, which covers 30% or more of the field surface.

Rowcrop -Agricultural cropland planted in rows and cultivated.

Res. Lawns, Parks -An expanse of maintained grass, often found in residential lawns and parks.

Impervious -Impervious surfaces (water can not penetrate them) are present near the water. Includes paved surfaces and roofs.

Disturbed Ground -Soil has been disturbed (plowed, cleared, bulldozed, excavated) for construction or agriculture. Vegetation is not present on disturbed ground but may be present in adjacent areas.

No Vegetation -Bare ground. No vegetation is present on the soil, but it is not disturbed ground.

Comments

Any observations about the site that were not covered elsewhere on the survey form should be recorded in this section. If certain survey responses require clarification or elaboration, those should be described here as well. The comment section can also be used to add detail to the site characterization, such as listing the types of aquatic plants or algae present, if known.

Sometimes while traveling to or from a site, significant factors that could potentially affect water quality (e.g. land use, habitat, and pollutant sources) are observed. If these conditions were observed between this site and the next upstream site, they should be recorded here, with a notation that the conditions cannot be seen from the site. These "between site" observations are often important for characterizing conditions in a watershed and should be recorded whenever possible.

ALL of the following go in the comments section

Potential Sources of Pollutants and River Disturbances-

Goes in COMMENTS SECTION !!!!!!

The intent of this section is to evaluate the relative importance of potential sources in terms of pollutant contribution to the waterbody at a given site in the watershed. The evaluation assesses the potential for pollutant inputs at the site, NOT pollutant impacts, or the potential for pollutant impacts

(1) Source Identification

Visually evaluate the various land use/land change activities at the site for potential sources of pollution. Note all potential sources for the area that can be seen (choosing from among the list of sources on page two of the survey data sheet). For example, is there evidence of soil disturbance at the site, or land uses such as residential lawns, agricultural fields, parking lots, urban areas, etc., near the waterbody. Use the source definitions provided to help identify what potential sources may exist. If it is known that a significant source exists upstream between the road crossing and the next road crossing, such as a wastewater treatment plant, it may be important to note the presence of that source, but it should be recorded in the comments section since it was not visible at the site.

(2) Pollutant Pathway

Next, for each potential source that has been identified, evaluate how pollutants could get from the source to the water. An evaluation of likely pathways for pollutants to enter the water body provides information regarding the potential for the identified sources to contribute pollutants. The following provides a quick outline of some visual observations to consider in evaluating pollutant pathways. Pay particular attention to likely water runoff patterns at the site that may occur during rainfall or snowmelt events.

- Gully/rill erosion provides a direct pathway for pollutants to enter the stream in a concentrated flow when the land slopes toward the stream. Pollutants associated with eroding soils will vary depending on the type of land use activity.
- Tile/pipe discharges are potential direct pathways for pollutants.
- Bare soils near the edge of a water body provide a likely pathway for sediment to get to the water body.
- Maintained lawns to the edge of a water body provide a likely pathway for nutrients and pesticides to the water body.
- Land disturbance/use activities to the edge of a water body provide a likely pathway for various pollutants to the water body.
- Open areas of disturbed soils and/or bare soils devoid of vegetation provide a potential pathway for pollutants via wind erosion.
- Steep stream banks (steeper than a 2:1 slope) devoid of vegetation are likely pathways for sediment.
- No canopy over the water body is a pathway for dramatic thermal increase in water temperature during the day.
- Impervious surfaces (parking lots, roads, roof tops, etc.) provide a likely pathway for various pollutants, and may increase flows in the watershed causing flashiness.
- Culverts/bridges may not be aligned with the stream, or may be undersized, and could provide a likely pathway for flow to create stream bank erosion both upstream and downstream of the culvert or bridge.

(3) Severity Ranking

Finally, for each source for which a pathway has been identified, evaluate how severe the pollutant loading is. Rank each source identified as Slight, Moderate or High severity for the contribution of pollutants, based on the magnitude or quantity of pollutants likely to be delivered to the stream. At present, the surveyor must use their judgment on assigning a slight, moderate or high rating. Eventually, it is expected that there will be a reference photo collection that will provide an example for each rating level in each of the subject categories.

The severity ranking is based only on *pollutant inputs* from the specific source *at the site*, not on visible stream impacts or impacts the pollutant may cause downstream. The pollutant loads from the identified source(s) may or may not have an impact at the site. Assessment of the impact on the water body at this site should have been evaluated on the first page of the survey form.

Evaluation of the source, location and pathways can provide a reasonable assessment of the severity of the pollutant loading. The following provides a quick outline of some visual observations to consider in evaluating the severity of pollutant loading.

- Proximity to water body – generally the closer the use, or land disturbance activity, is to the water body, the greater the likelihood for pollutant delivery.
- Slope to water body – generally the steeper the slope/topography to the water body, the greater the likelihood of overland pollutant delivery.
- Conveyance to water body (ditch, pipe, etc.) – generally a conveyance from the use, or land disturbance activity, increases the likelihood of pollutant delivery.

- Imperviousness – impermeable surfaces reduce the amount of land area available for water infiltration and increase the potential for overland runoff. Additionally, if a watershed is greater than 10% impervious, it will start to show some systemic problems due to impacts from flow. If a watershed is greater than 25% impervious, the natural hydrology is generally heavily impaired.
- Intensity and type of use, or land disturbance activity – generally the more intensive the activity the greater the likelihood for the generation of pollutants. Certain activities may have specific types of pollutants associated with them.
- Size of erosion area – generally the larger the erosion area the greater the likelihood for sediment delivery.
- Soil type – clay is less permeable than sand, and therefore would create a greater potential for overland runoff of pollutants.
- Presence and type of vegetation – the greater the vegetative buffer around a water body, the better the filtration of pollutants from nearby land disturbance and use activities. Certain types of vegetative buffers work better than others and should be evaluated on a case-by-case basis.

Note: It is usually most time efficient to go through this three-step process individually for each source as it is identified, and then go on to the next source identified (if more than one exists), rather than to evaluate all sources at the same time.

Overall Site Ranking

Using your macroinvertebrate survey form and general observations at the site give an overall site ranking. On a scale from 0-10, rate the river. For example if you found ALL macroinvertebrate species on the survey form and the riparian corridor is very well established and undeveloped give the site a 10. If you find very few macroinvertebrates, erosion, few plants, bare stream banks and obvious river pollution give the site a 0. This overall ranking is slightly subjective.

Siltation

Some siltation along stream margins is normal. However, silt that settles on gravel, cobble, and woody debris in the main stream channel can have a negative impact on the benthic invertebrates that colonize these substrates and also can affect fish reproduction. Note on the data form whether there is obvious siltation on the dominant substrate types in the main stream channel.

Embeddedness

Embeddedness refers to the extent to which gravel, cobble, or boulders are surrounded or covered by fine material (such as silt or sand). The more the substrate is embedded, the less its surface area is exposed to the water and available for colonization by invertebrates. Record the appropriate level of embeddedness observed in the stream reach. This is measured as the percentage of an **individual** substrate piece, such as a rock, that is covered on average.