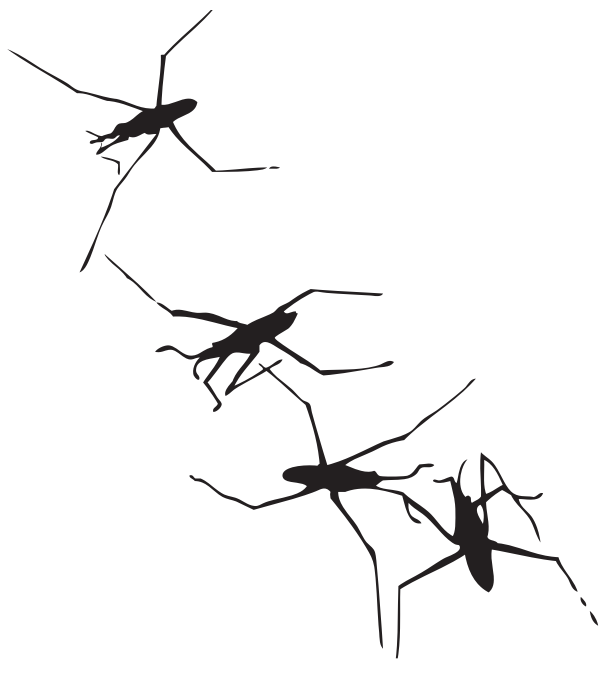
A GUIDE TO STREAMWALKING



A GUIDE TO STREAMWALKING

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Dear Stream Watcher,

Are you ready for the time of your life? Would you like to go wading, maybe splash and play in the water? How do you feel about peering closely at rocks, logs and leaves? If you are moderately (or even extremely) interested in these ideas, this booklet is for you! This is a publication designed to provide you, the "Walker," with exciting and informative methods of exploring your adopted stream or lake. You can wade right out into the water and generally assess the healthiness of your stream!

In order to acquaint (or reacquaint) the "Walker" with aquatic environments, Chapter One of the manual provides background information on general stream and river characteristics. Chapter Two presents a brief description of the small creatures and aquatic plants that you may encounter in these environments. Chapter Three addresses selected methods that are used to study aquatic environments. This will include descriptions of equipment and sampling techniques. Finally, in the Appendix, you will find informative tables, a key, and a vocabulary list. It is hoped that the information and experience provided in this guide will make your explorations successful. We hope you will have a wonderful time!

ECOLOGY
Chapter I

A wide variety of streams, lakes, and rivers are located in the different physiographic regions of North Carolina. They range from the swift trout streams of our mountains to the sluggish swamps that characterize the coastal plain. Although each stream, river or lake possesses distinct characteristics, general features can be recognized.

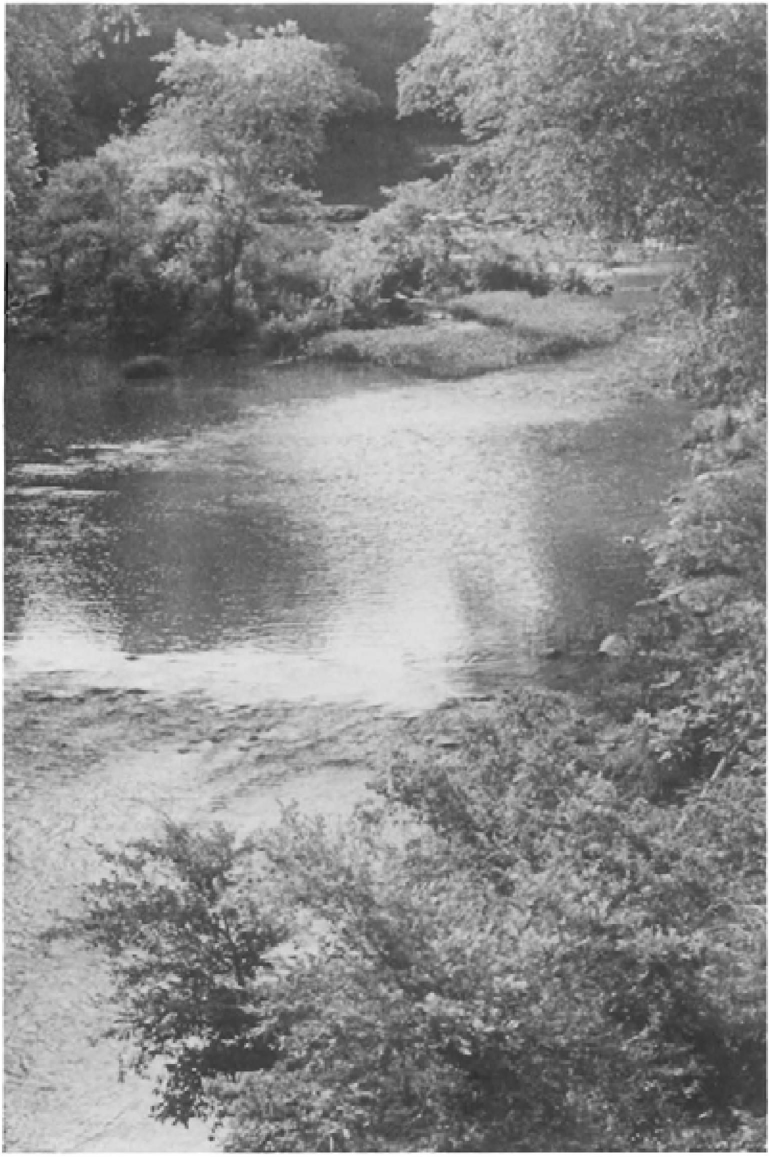
Cascading mountain stream

The cold, clear waters of the mountains are characterized by low temperatures (20° C or less), rapid water velocities, and a high dissolved oxygen content. The high dissolved oxygen concentrations are the result of both low temperature and turbulent flow. Temperature affects the amount of oxygen which can be dissolved in water; turbulent flow affects aeration rates. Shallow areas of turbulent flow, called riffles, are usually spaced at more or less regular intervals of five to seven stream widths. Between these riffle areas are slower and deeper pools. The alternating of shallow and deep areas is a riffle-pool sequence. Because of their overall high velocities, these streams are called eroding systems; the current is swift enough to carry away sand and gravel, maintaining a "clean" river bed. The rocky substrate is a critical habitat for fishes and other stream creatures.

The Piedmont region of North Carolina falls between the mountains and the coast. This region is characterized by a decline in the gradient of the terrain, resulting in decreased stream velocities and turbulence. Piedmont streams characteristically have higher concentrations of suspended sediments, sometimes giving streams a brown, cloudy appearance. Decreased stream velocities allow these sediments to deposit along the stream bed.

The coastal plain is influenced by its very flat topography. The rivers and streams become sluggish and meander more. Water velocities and turbulence decline, dissolved oxygen concentrations are lower, and water temperatures are higher. Because of these slower flows, there is often an accumulation of silt, sand, and organic matter in the stream. The number of riffle areas diminishes. Organisms in coastal streams are usually found associated with the bank areas or "snags" (woody debris projecting from the substrate). Coastal streams and rivers are often acidic. Acidic waters are virtually clear, with a "tea-colored" appearance.

Coastal blackwater stream



Piedmont stream showing riffles and pools

In all regions of the state, natural stream flows vary seasonally in response to precipitation patterns. The flows of most streams and rivers are higher in the winter and taper off towards September and October. This trend is not as evident in areas controlled by impoundments.

Stream Pollutants

Most natural systems, whether in the mountains, piedmont or coastal zone, possess a great diversity of plants and animals. A decline in the diversity of organisms occurs when the system is stressed in some way. For this reason, you can generally assess the health of a stream by looking for and counting the variety of organisms in an area. Although there are some natural pollutants that can create problems for streams, rivers, or lakes, most problems result from human activities.

Water pollutants generally can be grouped into the followingcategories: sediment, organic wastes, nutrients, and toxic substances. Pollution sources are defined as either "point" or "non-point" sources. Point sources are the type that you see pouring out of a pipe into a river. They include wastewater effluent from municipal treatment plants and from industry. Non-point sources are just about everything else, including sediment washing from construction sites in rainwater, nutrients and pesticides washed from agricultural lands, acid rain, and runoff from streets, lawns, and golf courses.

Bank erosion resulting from improperly protected land left void of vegetation.

Sediment

Throughout North Carolina erosion of soil is creating water quality problems. This erosion introduces sediment into the streams, producing sediment loads which exceed natural conditions. Any poorly managed land-disturbing activity will cause soil to be washed into the water. Unprotected lands left void of vegetation by agriculture, unpaved roads, eroding roadsides, construction operations, urban areas, forestry and mining activities contribute sediment to North Carolina's creeks and rivers. Agricultural practices contribute most of the sediment, but the highest erosion rates are associated with construction activities and mining. Only a small percentage of the cropland in the state is estimated to be adequately protected against soil erosion. Excessive amounts of sediment may cause many problems in the stream system. As an example, it may fill in the spaces between boulders, rocks, and other obstacles, producing poor riffle habitats. In addition, filter feeding mechanisms used by some aquatic creatures will be clogged with sediment, and bottom-dwelling creatures may be smothered by the deluge of sediment covering their habitats. Because many of these animals are a prime food supply for many game fish such as trout and bass, the reduction could be detrimental to these fish. Game fish may give way to non-game fish or fish whose existence does not rely on these small aquatic organisms.

An overloading of sediment also contributes to a reduction of channel capacity, producing excessive flooding -- a profusion of sediment fills in the stream bed --reducing the volume in which the stream may travel. Therefore, during high flows, the stream bed is no longer confined to its banks and flooding occurs.

Flooding of urban or agricultural land often has been addressed by channelization. In the past, the most commonly employed methods of channelization were to straighten the channel (eliminating the meanders) or dredge the stream and remove the vegetation from the stream banks. These practices affect both the immediate stream area and the downstream areas. Locally, the loss of vegetation results in the reduction of protective covering and a loss of available habitat for both fish and other aquatic animals. An increase in temperature also occurs in the now unshaded portions of the stream. These increases can reduce the diversity of creatures in the stream. With a straightened channel, the water velocity increases, the banks are undercut and erosion occurs. This sediment, in turn, is washed downstream and sometimes causes sedimentation problems.

A stream attempting to naturalize itself. It is reforming meanders or bends. The original meanders had been eliminated by channelization.

Organic Wastes

Oxygen is as essential to aquatic life as it is to terrestrial life. However, the amount of oxygen in water is in limited supply and may be depleted naturally or by pollution introduced into the water. Many organic substances found in wastewater break down in the streams. This decomposition requires oxygen. The amount of oxygen used to decompose a particular waste is called its biochemical oxygen demand or BOD. Sometimes, the BOD requirement of the wastes exceeds the amount of available oxygen in the stream. When this happens, oxygen is depleted from the system and is not available to fish, aquatic insects and other aquatic organisms. Slow moving waters (on the coastal plain for example) are particularly vulnerable. Here, because of high water temperatures and low amounts of turbulence, dissolved oxygen is naturally low. However, organisms in coastal streams are usually more tolerant of low dissolved oxygen levels, and they may be abundant in streams with unnaturally low dissolved oxygen values. Such organisms may include redblood worms (midge larvae) or worms (Oligochaeta).

Nutrients

Like terrestrial plants, the flora of streams, rivers and lakes naturally require phosphorus and nitrogen to survive. However, excessive quantities of these nutrients can overstimulate plant production. For example, algae, a type of aquatic plant, can respond to this excess with an explosion of productivity--an algal bloom. At times, an algal bloom can literally blanket a water body's entire surface. These algal blooms can damage the food chain, create unsightly patches of scum on the water surface, produce odor and taste problems in drinking water supplies and in some instances, can be toxic to both aquatic and terrestrial animals. As the algae masses die and decompose, foul odors may be released and the decomposition process may deplete the available concentrations of oxygen.

A river experiencing a fish kill

Studies have indicated that streams draining agricultural areas generally have about 10 times the concentrations of total phosphorus and five times the concentration of total nitrogen than those streams draining forested watersheds (Omernik, 1976). Nitrogen levels have also been found to be abnormally high in channelized streams (USGS, 1982).

Other sources of nutrient loading include wastewater discharges, septic tank leakages, and runoff from residential lands.

Toxic Substances

Toxic substances have found their way into the waters of North Carolina through industrial and mun... - l wastewater discharges and runoff from agricultural and urban lands. In 1979 the number of chemicals used in commercial production exceeded 3,000 and about 1,000 new compounds were being added yearly (Water Quality Management Plan, 1979). Many of these compounds may be toxic and their combined and cumulative effects on stream life are little known.

These substances may be divided into many categories. The four most common divisions are substances causing acute toxicity and chronic toxicity, substances which bioaccumulate, and materials which produce behavioral modifications. Acute toxicity causes immediate danger or death to organisms. Chronic toxicity is more subtle, producing long-term effects that may alter appetite, growth, metabolism and reproduction; possibly leading to death or mutations.

Bioaccumulation is the concentration of a particular substance in an organism by means of a biological process. The substance may not be toxic to that particular organism, but it may reach toxic levels as it "travels" up the food chain. For example, a toxicant may enter the lower food chain absorbed by a plant or eaten by an animal. Then the chemical compound may accumulate and increase in concentration within this organism's tissue over time. Many of these organisms are, in turn, consumed in vast quantities by other animals and the toxicants are concentrated in their bodies. As you proceed higher in the food chain, successively higher concentrations of toxins will be found. Ultimately, they may become concentrated in humans as well as other animals high on the food chain. Behavioral modification in response to a toxicant means that the organism either departs from the affected area or in some way alters its normal behavior. Examples of this latter behavior might be a disorientation of the creature or increase or decrease in aggression towards other creatures.

Effluent from this "point source" may be harmful to aquatic life.

AQUATIC LIFE
Chapter II

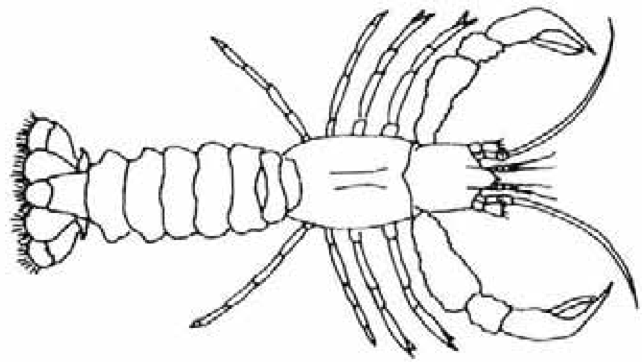
Benthic Macroinvertebrates

A Glimpse Into Their World

This section will introduce you to freshwater benthic macroinvertebrates. Benthic means that the animals live on or in the sediments (substrate) of the water. Macro refers to the fact they are big enough to be seen without using instrumentation, such as a microscope. Invertebrate means that the animal lacks a backbone.

Each type of benthic macroinvertebrate has a preference for certain living conditions--"some like it cold, some like it hot!" It is by looking at these conditions that you will be able to obtain information on the health of your adopted area. (Methods used to find these creatures are discussed later in the kicknet survey section.) Again, this is only a brief "tour" of benthic macroinvertebrates--just an exposure to some general characteristics of the varieties you may encounter in your watershed. Use the pictures in this chapter, and if you feel ambitious or you just want to confirm your identification, try the simple key in the Appendix. You can use the centimeter ruler on the back cover to help with metric size ranges listed for each animal. Non-insect groups will be addressed first, then insects will follow. If you desire additional information, extra references are listed in the Additional Readings in the back of the manual.

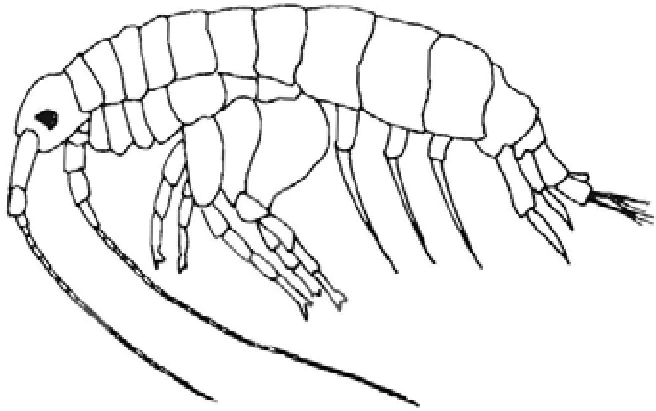
- Crayfish and freshwater shrimp (order Decapoda) are among the largest of the invertebrates you will collect. Crayfish, resembling tiny lobsters, hide within the stream banks or under rocks and logs. Their coloration includes brown, orange, black and sometimes blue. Freshwater shrimp, on the other hand, are almost transparent. They may be found in slow areas of most rivers and large streams.



Crayfish *(order Decapoda)*
(size 1.5 to 13 cm)

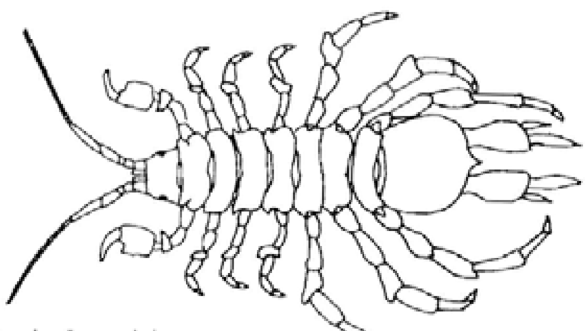
- Most of you are familiar with terrestrial snails. But did you know that they have cousins inhabiting the water? You will find them in almost every freshwater environment. Snails and limpets comprise the order Gastropoda. Gastropoda literally means "belly-footed," and, in fact, there is a muscular portion of the body protruding from the coiled or cone shell which contains some of the animal's digestive tract and reproductive system. These are animals of the substrates, found creeping on all types of submerged surfaces.

- Clams and mussels (order Pelecypoda) burrow in soft sediments. They are most abundant and diverse in large rivers. You'll be able to retrieve some clams with a kicknet (described later). However, if you are looking for mussels you may need to poke around in the softer sediments. Because mollusks require calcium carbonate (lime) to build their shells, the generally "soft" waters (low in lime) in North Carolina limit the diversity of this group. There is definitely a knack to finding these interesting creatures, so persevere!



Scud *(order Amphipoda)*
(Size .5 to 2 cm)

- Scuds or sideswimmers (order Amphipoda) are mainly marine, but a few types have adapted to freshwater environments. Their laterally compressed bodies resemble those of tiny shrimp. When a scud swims, it often does so on its side or back, hence the nickname sideswimmer. Scuds react negatively to light, so during daytime collecting trips you will find them hidden in vegetation such as root masses hanging from trees, in very small streams or in swamps.



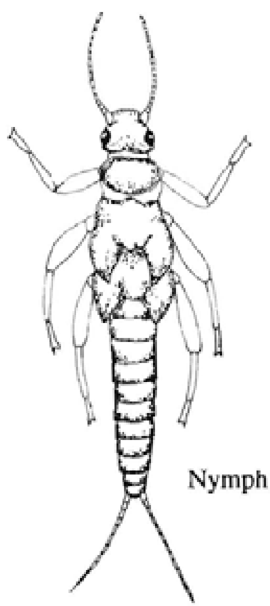
Isopod *(order Isopoda)*
(size .5 to 2 cm)

- Isopods (order Isopoda), commonly called pill bugs or roly-polies on land, have some relatives that inhabit freshwater. Aquatic isopods are flatter and have longer legs than their land counterparts. They seldom inhabit open waters, but instead remain hidden under rocks, vegetation, and debris. Isopods are typical inhabitants of very small streams or swamps.

There are a great numbers of insects inhabiting the aquatic environment. Some insects spend their entire lifespan in the water, while others may inhabit the area only when they are young (pupa and nymph stages). The insects contain some groups that are very sensitive to pollutants. Members of the next three orders can be especially sensitive and are good indicators of water quality.

- Stoneflies (order Plecoptera) are one such group. If you are an angler, you may already be familiar with these insects. They spend the earlier nymph stage of their life in the water and provide a good food source for trout. Their bodies possess two tails extending from the rear area and each leg ends with a double hook. Their coloration ranges from white, tan, yellow or brown to a glossy black. Some even appear to be clad in an armor exquisitely decorated in yellows and deep browns. Generally, these insects are slow moving, living in protected areas of debris, leaves or under stones. Many species are voracious predators. They prefer clean, cool waters where there is a good supply of oxygen. The group as a whole is extremely sensitive to pollutants.

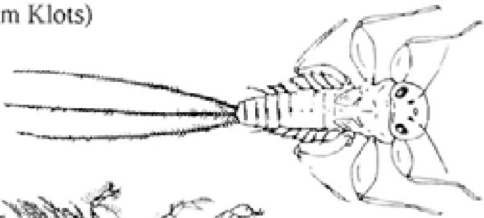
Stoneflies *(order Plecoptera)*
(size .5 to 5 cm)

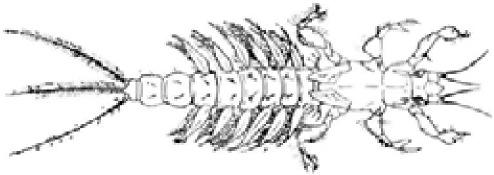


Stonefly nymph (photo by Jim Page)

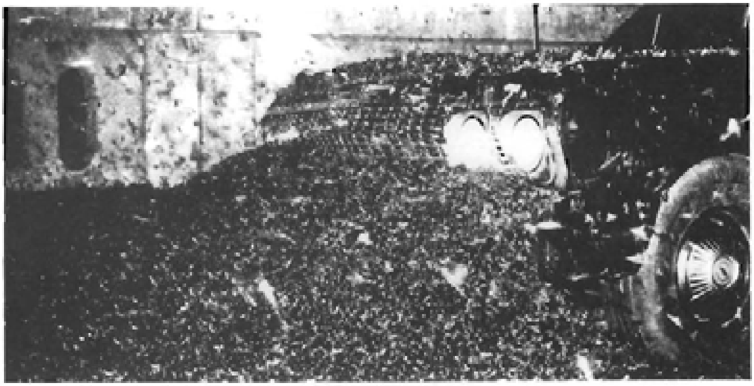
Mayflies *(order Ephemeroptera)*
(size .5 to 3 cm) (from Klots)

Stenonema nymph





Hexagenia nymph



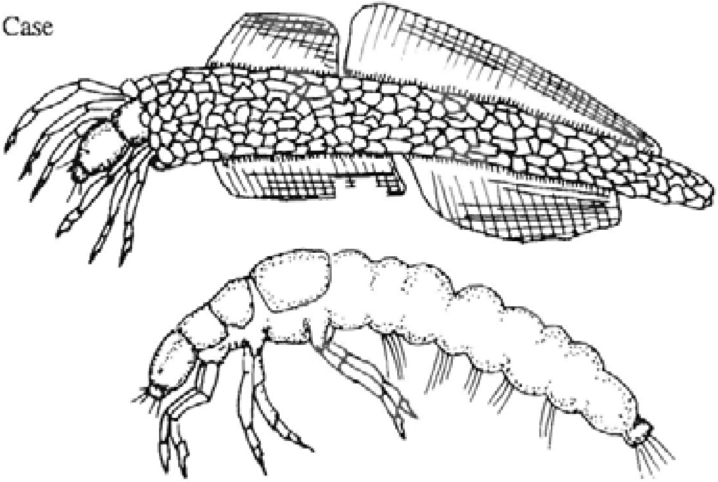
Mayflies were attracted to the headlights of this car found near the Mississippi River in 1966.

- Mayflies (order Ephemeroptera) are very similar in shape to the stoneflies. However, they usually have three "tails" coming from their abdomens and possess one hook at the end of their legs. Mayflies can be brightly striped, and they dart, crawl, cling, sprawl, and burrow. Mayflies inhabit all types of freshwaters wherever there is a good oxygen supply. Most species prefer clean water. After three months to a year in the nymph stage, they emerge from the water. One group, the genus *Hexagenia*, can emerge in hugh numbers as the following passage illustrates.

"*Hexagenia* mayflies tend to emerge en masse, and the river residents are accustomed to nuisance problems caused by the insects during periods of maximum emergence. Tree limbs droop under their weight...Shoppers desert downtown areas as the large clumsy insects fly in their faces, cover windows, and blanket sidewalks. In extreme cases, snowplows are called out to reopen bridges which have become impassable" (Fremling, 1970).

Caddisflies *(order Trichoptera)*
(size .5 to 5 cm)

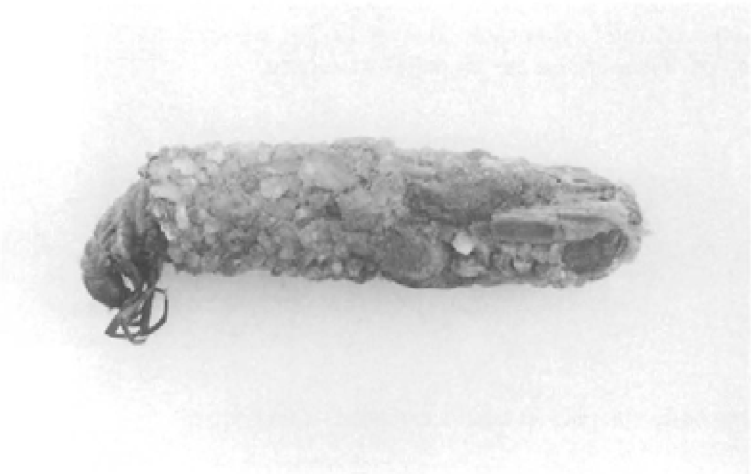
Case



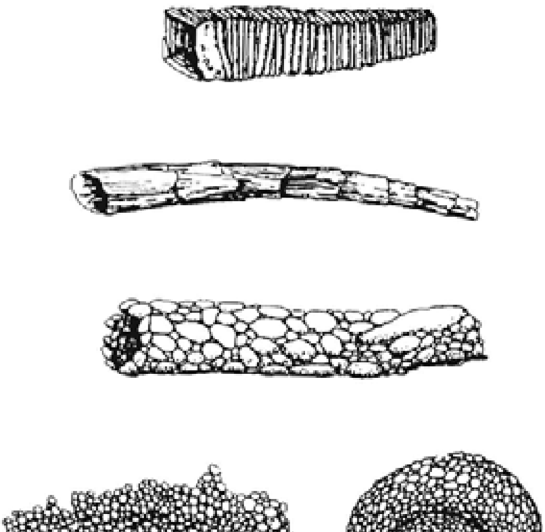
Larva

- Another group sensitive to pollution is the caddisflies (order Trichoptera). Caddisflies are soft and often delicately colored insects that inhabit all varieties of habitats. Many build beautiful, intricate cases of stone, leaves and sticks. Do not be alarmed to find a stick apparently scurrying among your sample. Peer closely at the twig (or twigs) you'll see the dark head of a caddisfly poking out the end. Some caddisflies with large leaf or twig cases are restricted to calm waters while those cased in heavy stones live in swifter environments. A number of streams or river species (those living in flowing waters) actually construct complex nets for the purpose of trapping food from the moving water. The uncased caddisflies will be found clinging to leaves, rocks, and logs. Overall, they are quite a talented group!

  A delightful theory on the origin of the name "cadis" is presented in Norman Hickin's book, Caddis Larvae. He thinks that this name originated from the peddlers of "bits of stuff, braid and ribbons who traveled the countryside calling at isolated cottages and hamlets..." "They pinned or stuck their wares on their coats as an advertisement for their business, and they were called cadice men." He concludes, "is it not very likely that the Cadice worm in the streams and pools received its name from the cadice man who stuck all sorts of cloth and worsted braid (or caddis) on his coat?"

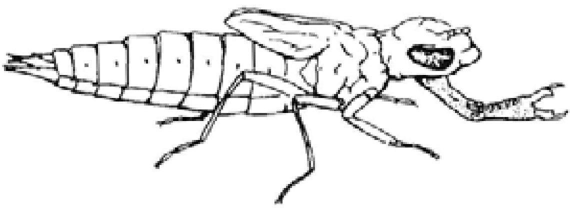


Caddisfly larva in case (photo by Jim Page)



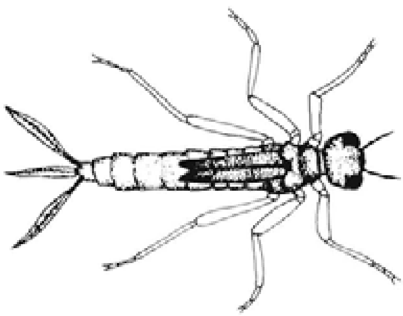
Various types of caddisfly cases (from Klots, not to scale)

The remainder of the aquatic insect groups are less sensitive to the quality of their environment. There are individual species within these groups, however, that are not pollution tolerant.



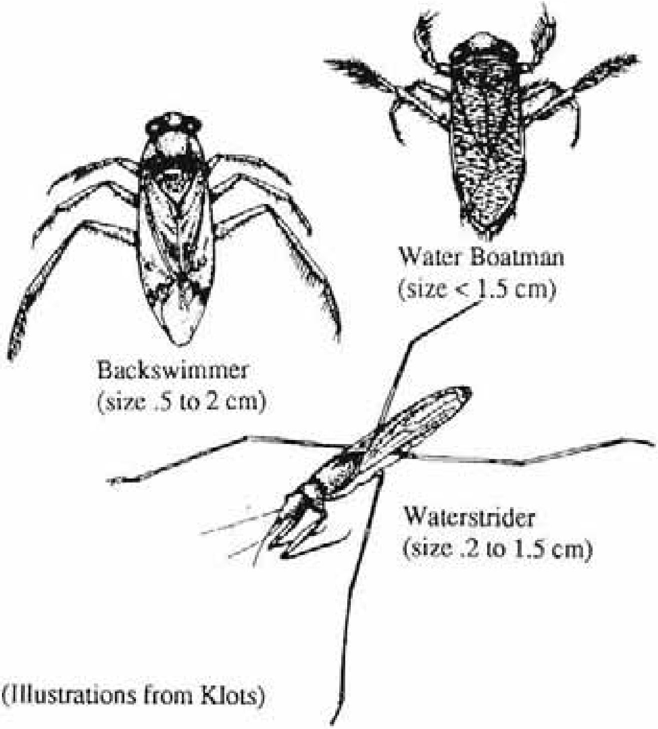
Dragonfly nymph with labium extended (from Klots)
(size .5 to 4.5 cm)

Nymph



Damselfly nymph *(order Odonata)*

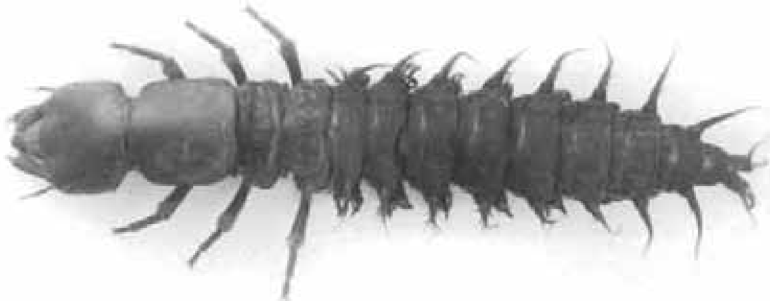
- Dragonflies and damselflies compose the order Odonata. Their aquatic larvae metamorphose into those elegant winged creatures you've encountered near streams, rivers and lakes. The larva, itself, can be a rather bizarre looking creature. It is elongated, and gray, black, brown, orange, or green in color. All possess a structure called a labium. The labium, a food gathering device, is normally found folded backward upon itself underneath the head. It is flat and hinged, and can be extended out from the body. The labium can be as long as one fourth the size of the body. All species are predatory. You'll locate the insects in submerged vegetation or in the bank regions of streams and ponds. Large logs are also good collection sites. Burrowing forms sometimes make trails in the sandy backwater areas. You might sight the trails along the stream bank in the shallow areas.



(Illustrations from Klots)

- Water boatmen, backswimmers, and waterstriders, found in the order Hemiptera, are interesting bugs to watch. They have long, flattened hind legs, similar to oars, used to dart about on and within the water. Be careful in handling hemipterans as they can produce a painful bite. Water boatmen are somewhat flattened and usually are dark gray, brown, or black. They occur in shallow, slow-moving sections of streams, rivers, or ponds. The adults are strong fliers and may migrate to other water bodies. Backswimmers, as the name implies, swim on their backs. They are powerful swimmers using rapid oar-like strokes. They have unusually large eyes and show considerable color variation. Some have patterns of color adorning the head and body. They are abundant in the backwaters of streams, ponds, and small lakes resting on the surface upside down or clinging to submerged objects. The semiaquatic waterstrider will be found "striding" on the surface of streams and rivers. Mostly you will see them from early spring to late autumn under overhanging banks or in other shaded areas. They have long legs which are specially modified to allow them to skate over water without piercing the surface tension.

- Alderflies, dobsonflies and fishflies (order Megaloptera) are very striking in appearance. Mature larvae possess lateral cylindrical projections and have elongated, stout bodies bearing dull colors of yellow, brown and tan (often they are mottled). The fierce appearance of some species are in fact indicative of the predatory behavior they possess. You will locate them in quiet waters and banks or on large logs and rocks. People who fish find this insect to be one of the finest of all live baits. Be careful in handling large megalopterans as they can bite.

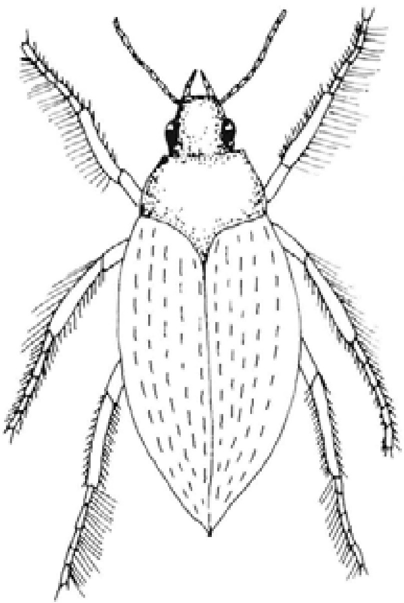


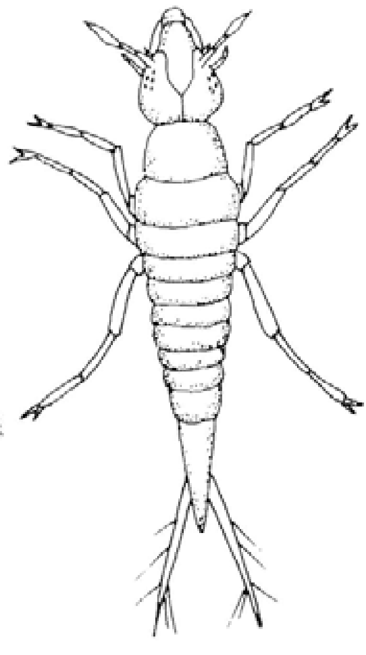
Dobsonfly larva or hellgrammite (order Megaloptera)
(size to 9 cm) (photo by Jim Page)

- Some beetle species (order Coleoptera) live their entire lifespans in the water. The adults have the ability to crawl, swim, or fly. Some rely on atmospheric oxygen in air bubbles. Found on its stomach, the bubbles are held in place by fine hairs. One such beetle, the "silver beetle" derived its name from its bubble--the film of air gives off a silver-like appearance. The adults are often located in shallow areas on vegetation or debris. Many will be found clinging to sticks or logs. One type of beetle, the whirley-gig beetle (Gyrinidae), is an amusing animal. It literally twirls about on the water surface. If you can catch one, smell it; it has an apple-like odor.

Beetle larvae are completely different from the adults in their appearance. Similar in shape to the megalopterans, they are elongated, slender and sometimes flattened. Some are able to swim; others crawl or walk. Beetle larvae will usually be found in the same habitats as the adults.

Beetles (order Coleoptera)

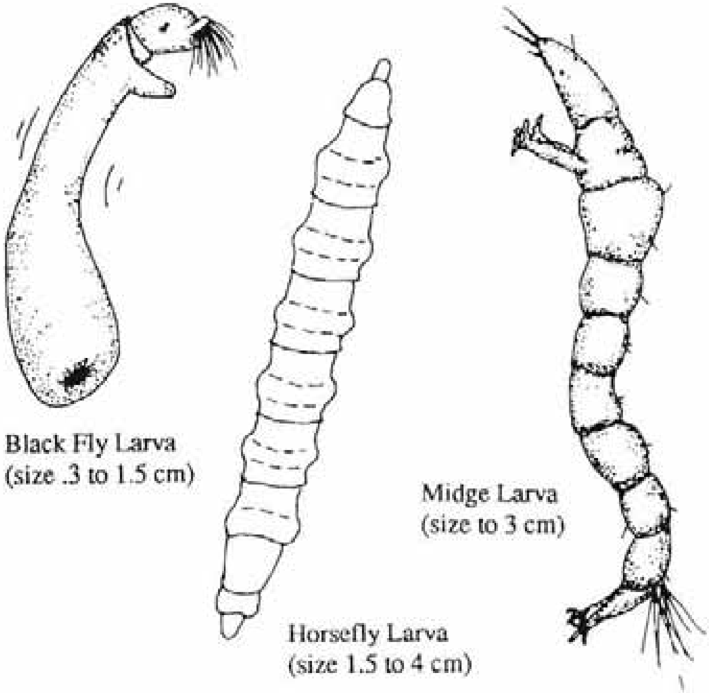




Adult (size 2 to 4 cm) Larva (size to 7 cm)

- Flies and midges partially comprise the order Diptera. The adults are not aquatic; however, many have immature stages living in water. Three of the most frequently found groups are blackflies (Simuliidae), craneflies (Tipulidae) and midges (Chironomidae). Larvae occur in every type of freshwater environment. Aquatic diptera larvae have greater morphological variability than any other group of aquatic insects. However, their general distinguishing features include an elongated, worm-like body and an absence of true legs. Colors frequently observed are black, brown, red, yellow and white. Wiggling and creeping body movements are their means of locomotion.

Flies (order Diptera)



- Aquatic worms (Oligochaeta) possess the same fundamental shape as the terrestrial earthworm, however, most have a more delicate morphology. Many crawl, although there are a few swimmers. You'll find them in all areas, especially burrowing in mud and sand.

- Last, in this section, we come to a discussion of the dreaded Leech! (Hirudinea). Tradition has endowed the leech with an evil and mysterious aura stemming mainly from medicinal folklore (and their often slimy appearance). One prime example was the common use of leeches by the medical profession to bleed their patients. Sometimes, this practice resulted in the patient's demise! Contrary to our wild imaginations, only a minority of these creatures will take blood from a warm blooded animal. Most are nonparasitic, finding their food by scavanging and predation. Oftentimes, they are quite beautiful --brightly colored and patterned. Worm-like but flattened, they possess suction disks on either end of their bodies. Leeches occur in shallow warm waters under objects of concealment.

AQUATIC PLANTS

Aquatic vegetation can be found in all streams, rivers and lakes of North Carolina. Plants provide oxygen, food, and shelter for aquatic organisms. Aquatic plants stabilize the bottom sediments. Some aquatic plants are referred to as "weeds," growing so profusely that they crowd out the more desirable plants. This in turn may detract from the usefulness and the appearance of the water and possibly decrease diversity of habitats and organisms in streams and rivers. The following list contains seven groups of North Carolina's most problem weeds.

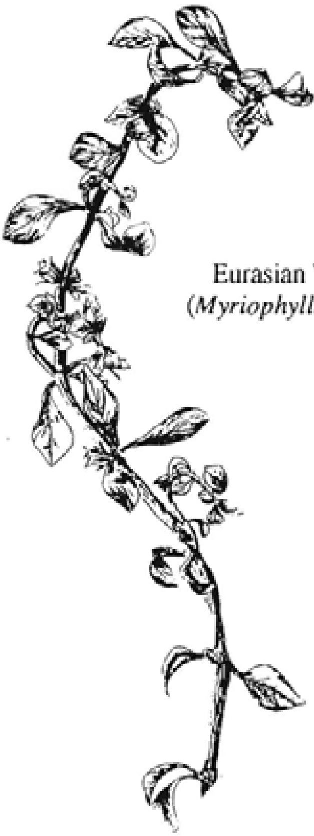
- Green and bluegreen algae are microscopic plants suspended in the waters of ponds, lakes or slow-moving rivers. Mentioned earlier in the ecology section, some species may become so abundant that they may impart a "pea-soup" green or brownish color to the water. A few types form a scum-film on the surface. Some filimentous types may become dense enough to form mats covering the entire water surface. Such mats may interfere with irrigation, livestock watering, boat navigation, swimming and fishing. Natural dieoff of the plants may deplete the dissolved oxygen in the water causing fish kills. Some species will release toxins into the water.

- Alligator weed *(Alternanthera philoxeroides)* is a semi-terrestrial plant. It occasionally takes root on the land. In water, it forms a mat which is loosely attached or free floating. Its hollow stems grow to one meter in height. Its fleshy leaves are glossy green, oval in shape, and 5-13 cm long. The leaf axils may have a few hairs. Alligator weed mats can block boat traffic and impede water flow.

- Water primrose *(Ludwigia repens)* occurs in the shallow waters of ditches, ponds, streams, and freshwater marshes. It may grow up to 50 cm tall. The leaves are elliptical in shape and are opposite each other on the stem. Leaf coloration is either dark red or dark green. This plant is commonly sold as an aquarium plant.

- Eurasion watermilfoil *(Myriophyllum spicatum)* is a submerged aquatic plant rooting in the bottom mud of fresh to brackish waters. Its red or brown stems grow 2-3 m (about 6-9 ft.) in length and contain olive green leaves in whorls of six.

Eurasian Watermilfoil
(Myriophyllum spicatum)



Water Primrose
(Ludwigia repens)

Alligator Weed
(Alternanthera philoxeroides)

(Illustrations from Godfrey and Wooten, by permission)

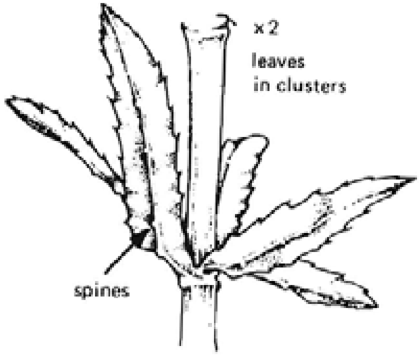
They appear feather-like. The thick growth of the weed can negatively affect shellfish and fish. It can destroy the overall appearance of the water, detracting from boating and other recreational uses.

- Hydrilla *(Hydrilla verticillata* Royle*)* is an introduced species of aquatic plant which, though rooted in the spring and summer, has long, branching stems that break off in the fall to create a mat of floating vegetation. It has short, pointed leaves arranged in multiple whorls of three to five around the stem. The leaves have sharply toothed margins, and tiny spines on the edges give the leaves a slightly crinkled appearance. The plant is coarse in texture. It also produces a characteristic tuber in the soil. The tubers are about the size of a pea, white to brown or mottled black, and shaped like a bent tear drop. Hydrilla is one of the most threatening aquatic plants found in our streams and lakes. It was brought into the country for use in aquariums and sold under the name of "star vine" and "oxygen plant." Hydrilla has been replacing other aquatic plants in our waterways. Large populations have developed in some southeastern states. This has created extensive problems for the sport fishing enthusiast, and it has reduced overall waterflow in many areas producing boat traffic problems. Its spread is facilitated by fragments attached to boat trailers. If you spot hydrilla in North Carolina waters, please notify the Aquatic Plant Control Coordinator, Division of Water Resources, P.O. Box 27687, Raleigh, NC (919) 733-4064.

- Brazilian elodea *(Egeria densa)* is another submersed aquatic plant that has been introduced into this country. It is found rooted, or drifting when broken loose. Its stem is slender, and the leaves are 1-3 cm long. It closely resembles hydrilla, but the leaves of Brazilian elodea have numerous tiny spines on the margins that are too small to be seen with the naked eye. Unlike hydrilla, they have a smooth texture. The leaves are in whorls of four to eight. Brazilian elodea can produce large mats of vegetation in slow-moving waters.

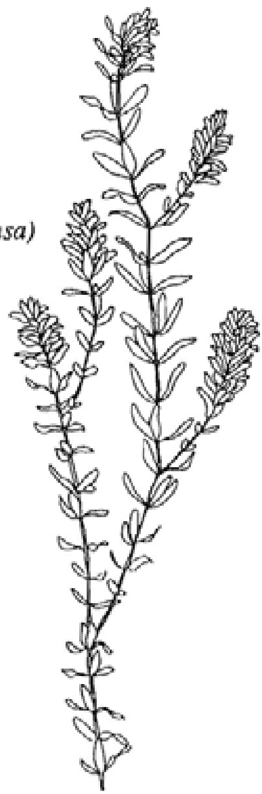
- Slender naiad *(Najas minor)* will be found in large freshwater lakes, reservoirs, and streams in clean waters 1 to 5 m deep. It has slender, branching stems up to 3 m long with narrow, ribbon-like leaves. The spiny leaves are curved away from the stem and frequently grow in clusters. The stems are very brittle and break with almost no resistance. The plant's coloration varies from a reddish hue to an olive green. If severe infestations of this introduced species occur, navigational problems can arise.

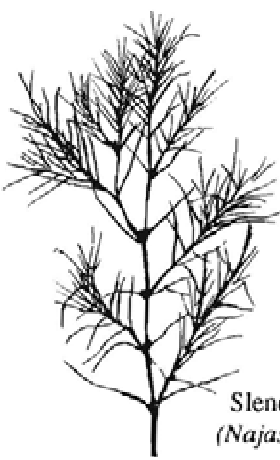
Hydrilla (*Hydrilla verticillata* Royle)



Hydrilla: close-up of leaves

Brazilian Elodea (*Egeria densa*)

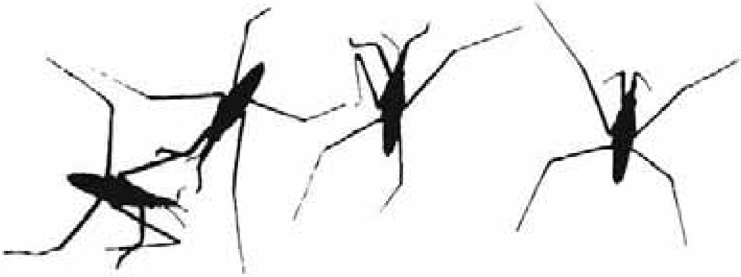




Slender Naid
(*Najas minor*)

SELECTING A STUDY TYPE

Chapter III



BEFORE YOU GET YOUR FEET WET

The first step in developing a study program is to familiarize yourself with your adopted area. Begin by gathering maps of your watershed. United States Geological Survey topographic maps are best for learning the characteristics of the watershed (see Appendix F). They will probably be the most accurate maps you will find. County maps are vital in finding the locations of possible study areas in relation to road crossings. Further, it will be helpful if you use the maps to explore the watershed. Try to get a feel for land use characteristics, including agricultural areas, mining and natural forests. Knowing the surrounding lands leads to a better understanding of your adopted area.

Once you have a general understanding of the watershed, choose a section of the stream or river to be monitored. Just remember not to take on too much. Try and maintain a sense of enjoyment and ease when developing your study section.

In choosing a study area, locate one that is accessible. Consider the land you must cross, the descent to the stream and the water depth. If you must traverse private lands, get in touch with the owners for permission. It is very possible that you may arouse their curiosity and they may wish to help. However, if trouble arises, try and find another site. Remember, the area of exploration should be simple to get into and out of, and it must be wadeable. If the area is too deep, there are sampling techniques that can be carried out in a boat. However, these won't be included in this manual.

Now that you've gathered your information together, proceed to the next section for discussions on sampling techniques.

As a suggestion, before any decision is made regarding the type of techniques you may use to monitor your segment, introduce your group to the stream or river by conducting a loosely structured hike along its banks. Present the background information such that everyone is aware of your goals. Encourage city planners, wildlife biologists, naturalists, teachers and students from local schools and universities, or anyone else who might have any interest in or expertise on your adopted segment to make the first walk. They have much information to share. This is an opportunity to address the segment's historical importance, its ecology, possible problems, and the individual interest each person has in the adopted portion. Walk along the banks pointing out attributes, past usages and problems. Upon returning, exchange ideas on what you've seen. Now, you're probably ready to make realistic decisions on the path you want to take in monitoring your adopted stream. The next portion of this manual will concern a few possible methods of monitoring.

Your next decision will be to choose a survey. The two methods described here are a visual survey and a kicknet survey. The visual survey involves walking a stream segment and noting physical characteristics. The kicknet survey allows the walker the use of a tool, the kicknet, to obtain samples of some of the invertebrate animals inhabiting the stream. The samples will be used to help analyze the water quality. You will gain a much broader base of information and a better understanding of the area if you are able to perform both types of surveys. However, remember to consider the group's enthusiasm towards the project in making the decision. It is better to take on a little less if you feel this would result in the accomplishment of your goals. You can always add to the survey later.

SURVEY SELECTION

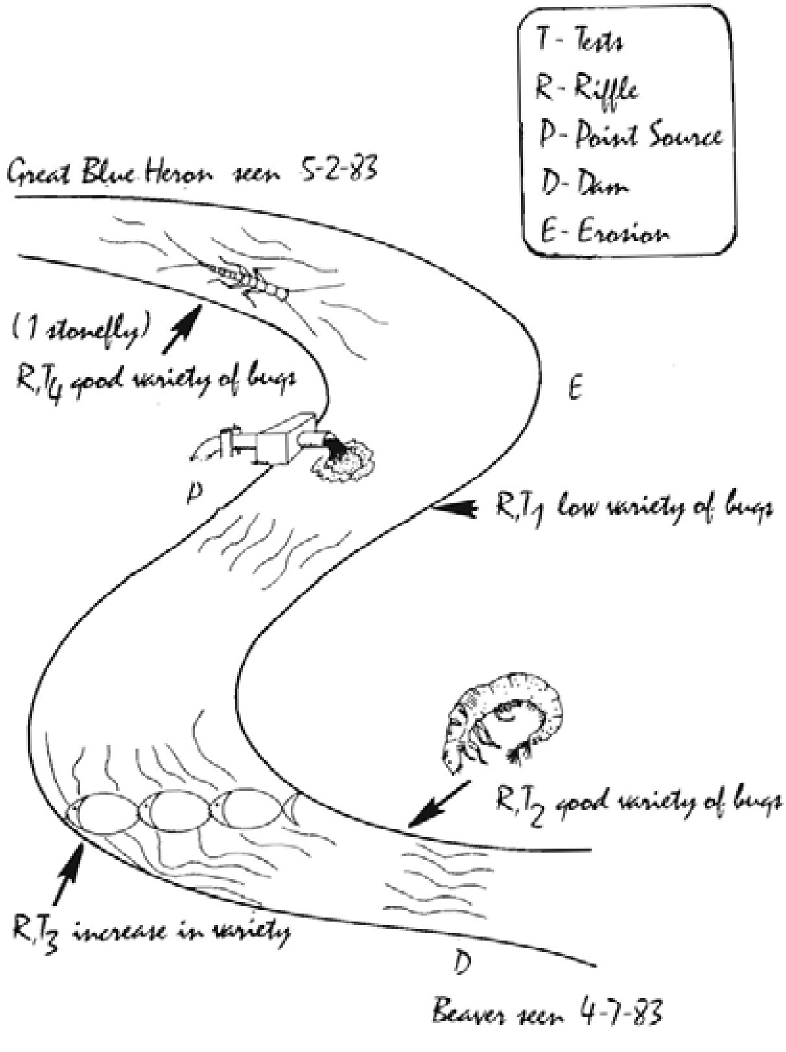
VISUAL SURVEY:

The visual survey requires little equipment. Basically, you'll need pencils, paper, stream map, and (if possible) hip boots and a camera. Depending on your goals, additional equipment could include a walking stick, (for balance, probing, and depth measurement), thermometer, data sheets, pH paper, and problem recognition tables (Appendix B, provided by the Izaak Walton League of America).

The visual inspection is a great excuse for a hike, observing the nature of your habitat. Participants should initially map their segment. This process may be as primitive or as complicated as desired. The important thing is that the map is both legible and understandable. Your first walk should be used to map your segment.

Gather your gear and simply walk the segment recording the stream's characteristics. You may want to sketch the segment as you go along or note details and draw it later. For your map, note the meanders, width of the stream or river, and depth. Again, try to obtain a general picture of morphology. Once the segment is walked, retrace your steps to assure correct information. A sample map is located on the following page. For your convenience, make copies of your map(s), put the original in the handbook and take a copy along during your walk. You can conduct your first survey during this "map walk" if you wish. However, you may wish to wait for the overall view provided by the finished stream map before conducting your survey. A camera can be a great way to document any unnatural or natural characteristics in your stream. Remember to note the date, time, location, and photographer's name on your record sheet or map.

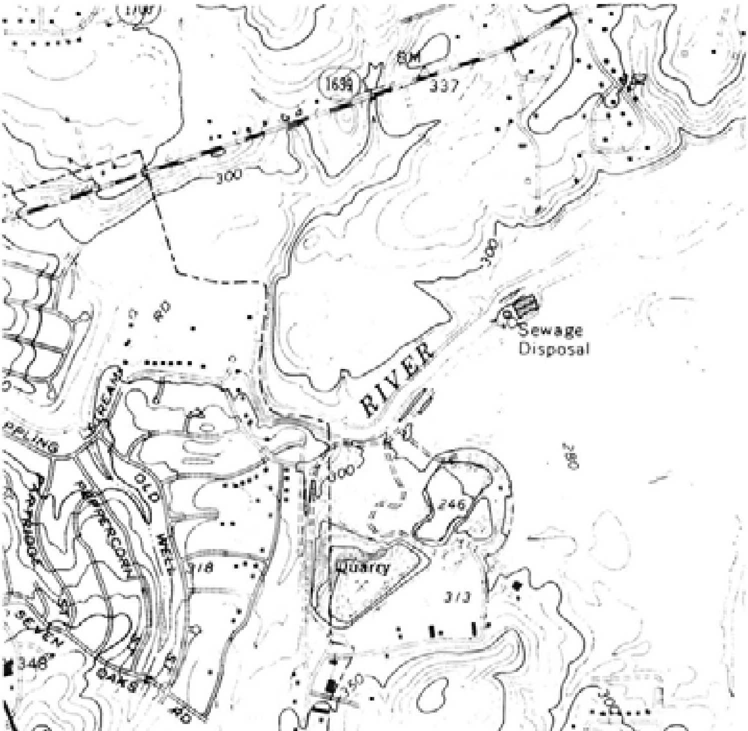
During your walk, remember the general traits inherent in streams and rivers. However, don't forget that each stream will have some individual characteristics. The purpose of the walk will be to probe past the generalities and into the detailed character of your adopted segment. Observe the bottom--is it rocky or sandy? Is there an abundance of vegetation? Do you smell any unusual odors? What is the color, is the water tinted? Are there point source dischargers? Did you see any trash dumps? Is there anything obstructing the flow of water in your stream? Are there any fishing or swimming holes? Who uses the stream, and what are their needs and concerns? All of these traits, and many more, make up the character of an individual water body.



Sample of some of the things you might like to include on your homemade maps.

Look for them and record what you find on both the maps you've made and the data sheets found in Appendix D. Take along the tables found in Appendix B. They will be a great help to you in recognizing potential problems.

Homemade maps can be fun to create and add to, and they will be useful in communicating with your group about the stream's attributes and problems. They will also be a good personal record of the things you find. On the other hand, topographic maps may be best when you want to share your findings with state or local officials, since they will be able to look at the same maps in their offices. Recent topographic maps will also help you by showing you what kinds of land uses are in your stream's watershed. Look for where industry, wastewater treatment plants, mining, agriculture, urban areas, and other land uses may drain or discharge water into your stream. Think about how these uses might affect water quality. If you would like to know more about using or getting topographic maps, see the Appendix.



Topographic map--use this type of map to help locate different land use types and potiential problems in your watershed.

KICKNET SURVEY:

An analysis of aquatic organisms provides valuable water quality information. These organisms are sensitive to water pollution. Chemical and physical measurements generally reflect only one moment of a stream's history, while biological measurements integrate its past over time. Small invertebrates have proven to be excellent organisms for water quality analysis. Many are pollution sensitive and respond quickly to habitat changes. Basically, they are stationary residents traveling only short distances. For these reasons and the fact that they have life spans of at least a year, the investigator observing the numbers and types of aquatic invertebrates may be able to obtain a general chronicle of the past year's events and deduce environmental impacts.

The macroinvertebrates that you'll find will generally be smaller than a half dollar. They will have an incredible array of colors and intriguing shapes. You'll find yourselves comparing the creatures, examining their respective habitats, and wondering about the purposes of their contrasting features.

At this point, you may be wondering how to locate these creatures. This is where the kicknet survey comes into action. You'll be utilizing the same equipment as that used in the visual survey, plus you'll need a kicknet, a shallow white pan and tweezers. Drawings of a kicknet and directions for its construction are found in Appendix C. The drawings illustrate an ideal net. However, feel free to be imaginative with the materials that you use. The cost of construction will fit into any budget. With a little scavenging for the materials, you can make it for next to nothing.

Now that your equipment is ready, all you'll need to do is find these exquisite creatures. Then by counting the number of different kinds, you'll be able to determine the general health of your stream or river. (See Appendix E for gross water quality assessment. This table describes how to interpret your kicknet data. This was also provided by the Izaak Walton League.)

Using the kicknet is simple. Be sure to protect your feet from sharp objects in the stream. Put on hip boots or old sneakers for wading. The following directions on the kicknet method are from an article published by the Izaak Walton League of America.

1. Select a riffle area, that is, a shallow fast-moving area.

2. Place the kicknet at the downstream edge of the riffle. Be sure that the bottom of the net fits tightly against the stream bed so no creatures can escape along this point. Also, try not to allow any water to flow over the screen top.

3. Disturb the stream bed for a distance of three feet upstream of the net. Brush your hands over all the rock surfaces to dislodge any attached insects. Stir up the bed with hands and feet until the foot area has been worked over. (Remember to be careful of your hands. Watch for objects that might cut.) All detached creatures will be c_rried into the net.

4. When step 3 is completed, remove the net with a forward scooping motion. The idea is to remove the net or screen without allowing any of the critters to be washed from its surface.

5. Place the net on a flat, light-colored area. Using tweezers, pick all of the creatures from the net and place them in a pan. Or, just wash the creatures int(. light-colored bucket where they may be easily seen. Any creature moving, even if it looks like a worm, is part of the sample. (Do not miss snails and clams.) Look closely since most of these organisms are only a fraction of an inch long.

6. Once all animals have been removed from the net (excluding any fish or other vertebrates--throw these back quickly so they might survive the stress of being out of their habitat), count the total number. Then separate them into look-alike groups. Use body shape and number of legs and tails primarily since the same family can vary some in size and color.

7. If the stream seems to have a problem, for example, no bugs are found, take a quick second sample from another spot, preferably a riffle. If your results are similar, you might want to check another spot about a quarter mile upstream. When you find a place where the variety of benthic creatures is greater and the numbers are more balanced, then you know the problem occurs between that spot and where you last tested downstream. The general key in Appenix A is provided to be used in identifying the creatures to order.

8. Sometimes, it can be difficult to locate a riffle. For example, in an area where there is excessive sand, boulders and rocks are often completely covered. In these cases remember that a riffle is an area of turbulence. It may be composed of rocks, logs or even an old car! Look for large stationary objects. Things which have "weathered" in the stream for a while. (The critters need time to make these objects home.) Then kick around them much as you would rocks. However, if the substrate is covered with sand or composed entirely of bedrock and a "kickable" riffle does not exist, you can use the bank habitats. For example, place your net downstream of submerged tree or grass roots and kick in and around them. Make sure that this is an area where water is flowing or there is current.

ADDITIONAL SURVEYS:

1. Sweep Net Survey:

Most people are familiar with the dip nets used for fishing. A sweep net is similar in construction, but the mesh of the net is smaller. In fact, the net mesh found on a sweep net is smaller than the mesh used on most kicknets.

If your group has the money, you can order sweep nets from scientific supply houses. However, a very adequate net can be simply and inexpensively constructed by arranging screen mesh over an old dip net frame. This net will not be ideally correct, but will be useful for collecting a wide variety of creatures.

To perform a sweep net survey, take your net and sweep around the banks of your stream. Sweep in and around tree roots and other vegetation. Then, stir the sediment near the stream bank with your foot and use the sweep net to scoop up the creatures jarred loose. Dragonflies, damselflies, mayflies and snails will often be found in a sweep net sample.

2. Diversity Survey:

The object of this type of survey is to increase the variety of bugs collected. You will be searching for those creatures that are difficult to obtain with the previously described methods. This is one of the most enjoyable of the surveys. Simply, it is a nature hike. The investigator walks along the stream carefully examining the tiny habitats found on logs, leaves, boulders, rocks and any other substrates encountered (this includes man-made materials such as cans, tires, stoves, etc., don't limit yourselves). Often, beetles and limpets will be nestled into the crevices of an old rotting log. Mayflies too are found on these habitats. Every so often a megalopteran will be found clinging to the underside of a rock or inside a tin can. You'll discover the habitats of many of the bugs you found in your kicknet samples.

3. Pristine Survey:

Before you try out your kicknets on a segment of river where you suspect water quality problems, you may want to take your group for a practice run on a known pristine segment. Here you can try out your sampling techniques and get a feel for where the critters like to hide. Encourage participants to take turns picking out the invertebrates, and begin to get an idea of what naturally occurs in a relatively clean and undisturbed environment.

4. Other Kinds of Activities:

Remember that biomonitoring is not the only type of activity Stream Watch groups can do. Consult the 1989 Stream Watch Action Guide for information on chemical monitoring, sediment monitoring, working with water quality permits and designation , clean-ups, education and recreation, and historical and cultural activities. Contact the Stream Watch Coordinator at the address on page ii for information on these topics and on receiving the Action Guide; or you can find it on the web at : www.dwr.ehnr.state.nc.us/wrps/swactive.htm.

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APPENDICES

APPENDIX A Key to Benthic Macroinvertebrates

APPENDIX B Stream Diagnosis Tables

APPENDIX C Kicknet Creation

APPENDIX D Stream Survey Data Sheet

APPENDIX E Gross Water Quality Assessment

APPENDIX F Topographic Maps

Vocabulary List

APPENDIX A -- Key to Benthic Macroinvertebrates

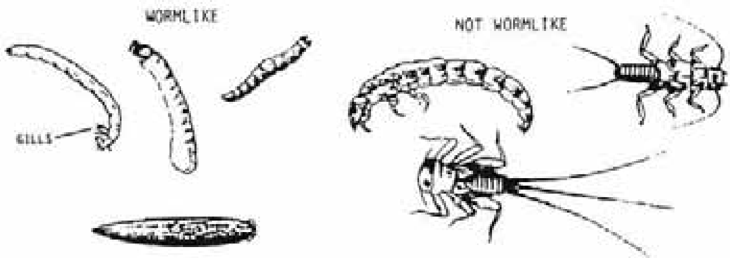
Adapted from a key by John Kopec and Stuart Lewis, Ohio Scenic Rivers Program

The following key is a general guide to the orders of benthic macroinvertebrates found in North Carolina's streams and rivers. To some, the key may appear complicated, however, when you understand how it works, it is quite simple. When reading the key, you will make a series of choices that will correctly match the observable traits of the invertebrate. You will be given two alternatives and will choose one that applies to the particular animal. You will then proceed as directed by the numbers at the end of the sentences to the next set of alternatives or until an end point is reached. At the end point, you will come to the order of the animal in question.

GO BELOW TO

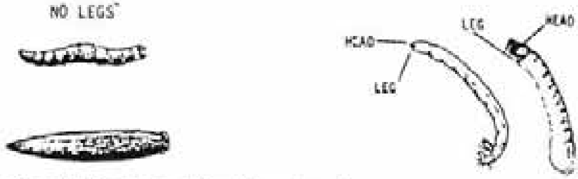
(1) Body wormlike, may or may not have legs; if legs present, they are not distinct 2

(1) Body not wormlike, of if wormlike has distinct legs 6



(2) Body with no legs, without distinct head region 3

(2) Body with very small, indistinct legs, with no distinct head region 5



(3) Body with large suction disc at each end; body segmented: LEECHES (Hirudinea)

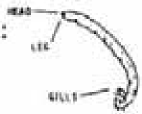
(3) Body without a suction disc at either end 4

(4) Body black or brown; more than 1 cm long; plump and caterpiller-like: CRANE FLY LARVAE (Tipulidae)

(4) Body thin and earthworm-like; usually less than one inch long: AQUATIC WORMS (Oligochaeta)

(5) One end of body wider than other end: BLACK FLY LARVAE (Simuliidae)

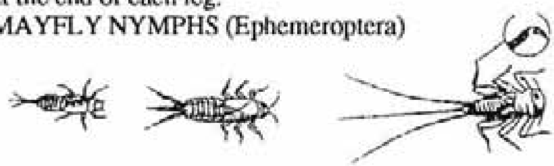
(5) Both ends of body almost same width: MIDGE LARVAE (Chironomidae)



(6) Thin, hair-like tails present; if tiny hairs on the tails, hairs not joined by oar-like membrane 7

(6) Tails absent, or if present, broad and oar-like 8

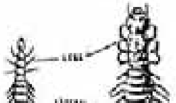
(7) With three tails (occasionally two) and one hook at the end of each leg: MAYFLY NYMPHS (Ephemeroptera)



(7) With two tails and two hooks at the end of each leg: STONEFLY NYMPHS (Plecoptera)

(8) Body beetle-like; with legs: ADULT RIFFLE BEETLE (Elmidae)

(8) Body not beetle-like; with or without legs 9



(9) Body generally long and cylindrical, or short and rounded with six legs (DO NOT CONFUSE LATERAL APPENDAGES WITH LEGS) 10

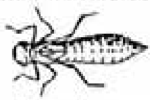
(9) Body not as above; or if cylindrical, with more than six legs 15

(10) With a hinged, plate-like lower jaw (labium) 11

(10) Not as above 12

(11) With three broad, oar-like tails (tails break off easily): DAMSELFLY NYMPHS (Odonata: Zygoptera)

(11) Without broad, oar-like tail: DRAGONFLY NYMPHS (Odonata: Anisoptera)



(12) Hair-like or tentacle-like lateral appendages extending from side of body (usually longer than body with) 13

(12) No such appendages 14

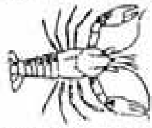
(13) Body dark colored, usually more than 1.5 cm long, two pairs of hooks at end of abdomen: DOBSONFLY LARVAE (Hellgrammites) (Corydalidae)

(13) Body light brown, white or other light colors; less than 2 cm long: BEETLE LARVAE

(14) One or two hooks or claws at or near end of abdomen: CADDISFLY LARVAE (Trichoptera)

(14) Not as above (no hook): BEETLE LARVAE (Coleoptera)

(15) With two large claws and eight legs: CRAYFISH (Cambaridae)

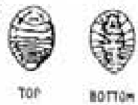


(15) Without claws; legs variable or absent 16

(16) With six or more legs 17

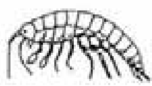
(16) Legs absent; body covered by a shell 19

(17) Body saucer-shaped; about the diameter of a pencil eraser (these have very small legs under the shell): WATER PENNY BEETLE LARVAE (Psephenidae)



(17) Not as above; with more than six legs 18

(18) Body much higher than wide: SCUDS (Amphipoda)



(18) Body much wider than high: ISOPODS (Isopoda)

(19) Body shell composed of two hinged parts: CLAMS (Pelecypoda)

(19) Body shell singular or coiled: SNAILS (Gastropoda); see 20

(20) Shell opening on left: POUCH SNAILS (Physidae)

(20) Shell opening on right or in center: OTHER SNAILS

APPENDIX B

STREAM DIAGNOSIS TABLES

"How can I tell what is wrong with my stream?" Just like diagnosing a person or pet who is sick, you take all the symptoms and signs together and try to hazard a guess. These tables are to help you know what kinds of problems you might have in your area and the obvious signs of those problems. Read each table several times allowing yourself to get a feel for threats to streams. You may even want to take these tables with you when you next visit your stream.

Table 1. Characteristics of Surrounding Area Draining Into Stream

Forests	Check for sedimentation (cloudy or muddy water) from erosion caused by logging, road building or any clearcutting.
Farmland (crops, pasture and feedlots)	Check for excessive algae growth caused by fertilizers or manure draining into stream. Also watch for sedimentation caused by poor farming practices and posible pesticides.
Urban Setting	Urban run-off can carry with it all sorts of pollution including metals, salts, chemicals and oil. Insect counts may indicate the presence of one of the above, but chemical analysis may be needed to pinpoint it.
Industries	Because of the variety of by-products of industry, the stream should be tested for both organic and toxic substances. Keep an eye out for excessive algae and absence of animal life, such as insects and fish.
Sewage(treatment plants or pipelines)	Look for organic pollution indicated by absence of some aquatic organisms and/or extreme abundance of others.
Mining	Check for sedimentation and acid drainage. Acid drainage can be detected by a low pH. A yellowish-orange deposit may be present on bottom.
Construction	Land disturbing activities such as development and road building are the leading cause of erosion and sedimentation, so watch for cloudy or dirty water.

Residential (homes)	Lawn fertilizer, detergents used for washing clothes or cars, oils drained from autos and grass clippings are common forms of residential pollution. Keep an eye open for excessive algae growth, white foam greater than 3 inches high, color sheen on surface or absence of organisms in insect counts.

Table 2. Physical Indicators of Water Pollution

A. Color of Stream:

Green	If the stream is excessively green, this could be an indication of nutrients being released into the stream, feeding algae. What To Do: Check watershed for possible fertilizer or manure run-off areas.
Orange-Red	Orange to red deposits could be caused by acid drainage. What To Do: Check watershed for mining and watch for industrial waste draining into the stream.
Light Brown (muddy or cloudy)	Sediment deposition caused by erosion. What To Do: Search upstream for disturbed ground left open to rainfall. Remember, if the source is a drainpipe, don't stop there.
Yellow Coating on Stream Bed	Indication of sulfur entering the stream What To Do: Check upstream for industrial waste or coal-using operation.
Multi-color reflection	Indicates oil floating in stream.

What to do:

Chemical analysis is needed to find the source, but check upstream to see where it begins.

Absence of fish.	This is a good indication of a badly stressed stream. The cause could be urban run-off, sewage seepage or toxics entering the stream.

What to do:

Chemical analysis is needed to find the source. But, again, check upstream to find where it begins.

	What To Do: Check closely upstream for source--waste oil may have been dumped along the stream
Yellow brown to dark brown water	Acids released from decaying plants. What To Do: Naturally occurs each fall when dead leaves collect in the stream. Also common in streams draining marsh or swampland.
White Cottony masses on stream bed	Could be "sewage fungus." What To Do: The presence of this growth indicates sewage or other organic pollution.

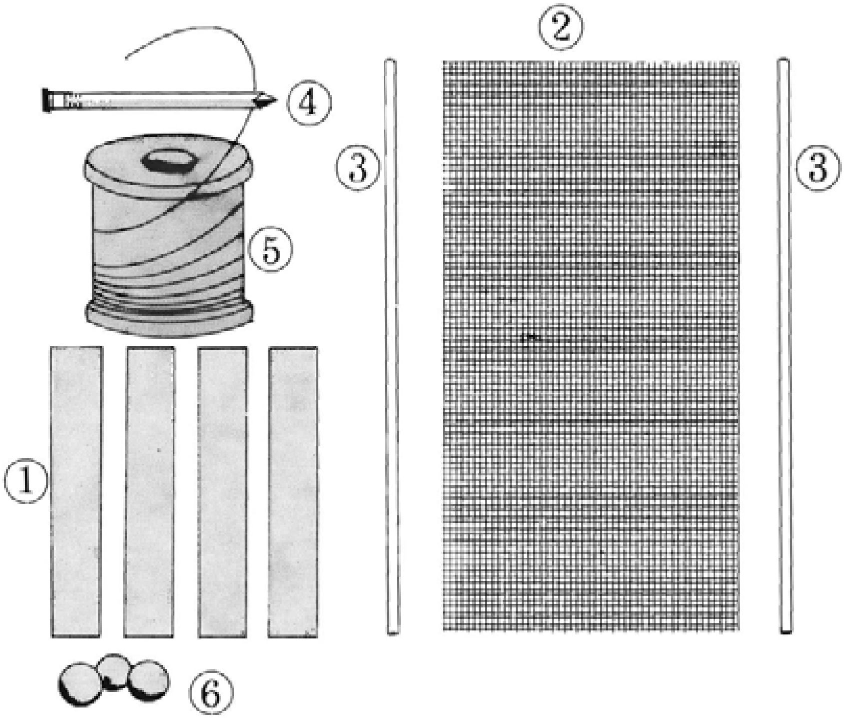
B. Stream Odor:

Rotton egg odor	Indicates sewage pollution. Odor may also be present in marsh or swampy land.
Musky odor	May indicate presence of untreated sewage, live-stock waste, algae or other conditions.
Chlorine	This may mean that a sewage treatment plant is over chlorinating their effluent.
Chemical	May indicate the presence of an industrial plant or the spraying of nearby agricultural land.
C. Foaming:	When white, and greater than 3 inches high, it may be due to detergents. What To Do: Check upstream for industrial or residential waste entering the stream.

Table 3. Fish as Biological Indicators of Water Quality

Odd Behavior	Jumping out or non-responsive action of fish may indicate toxic substance in the stream.

APPENDIX C - KICKNET CREATION



Materials:

1 4 strips of strong fabric each 6" x 36"

2 Nylon door screen (one piece 3' x 6')

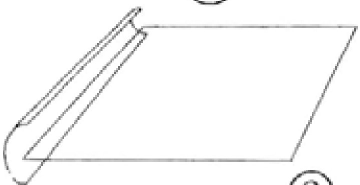
3 4 half round 2" x 6' dowel poles

4 Finishing Nails

5 Heavy-weight thread

6 Approximately eight 4-ounce weights (for instance sinkers or hardware slugs)

①



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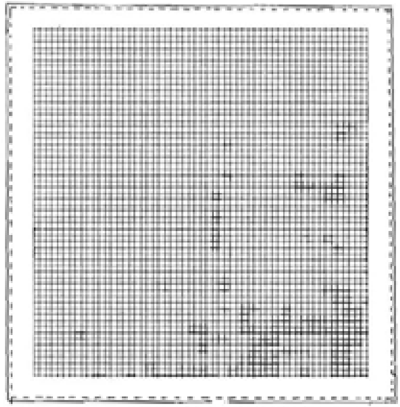


③

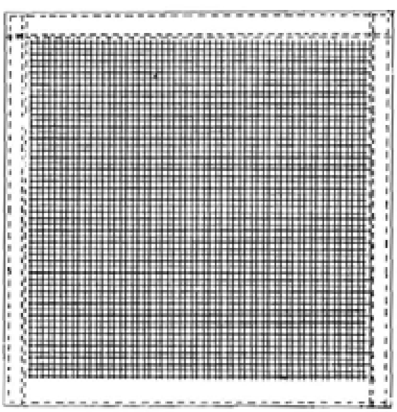
Kicknet Construction:

1) Overlap the screen forming a 3' x 3' double-mesh square.

2) Wrap a strip of fabric over each edge of the screen and pin into place.

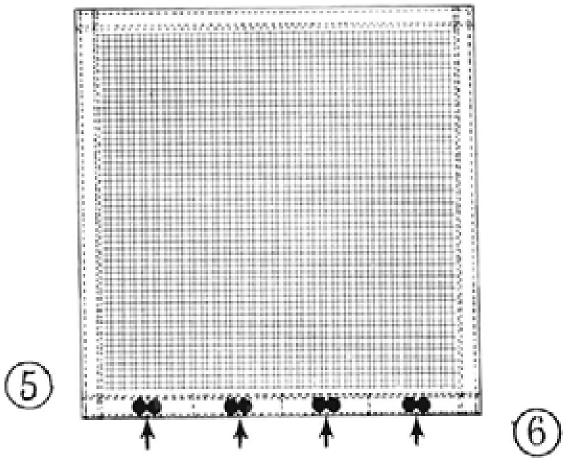
3) Single stitch the fabric to the screen along the outside perimeter of the screen.

4) Double stitch the inside of the fabric to the screen on three of the four strips.* Do not stitch the fourth fabric strip.



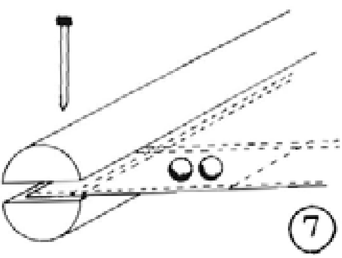
④

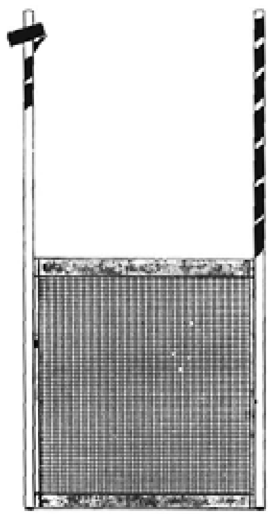
5) One side of the screen has not been double stitched along the inside edge. Sew across the fabric as indicated forming four pockets.



6) Insert weights into the pockets (approximately 8 oz. per pocket), then double stitch the fabric enclosing the weights.

(finishing nail)





7) Sandwich the screen between the dowels, and nail into place. Be careful to nail the screen into place so that the weighted edge is flush with the bottom of the dowels. Now that your kicknet is assembled, you may also want to wrap water resistant tape around the handles for greater comfort.

APPENDIX D - STREAM SURVEY DATA SHEET

Water appearance:	Stream bed coating:	Odor:
scum ____	orange to red ____	rotten egg ____
foam ____	yellowish ____	musky ____
muddy ____	black ____	other ____
clear ____	brown ____	none ____
tea ____	none ____	
milky ____		
colored sheen (oily) ____		
brownish ____		
other ____		

good cover ____
(70% - 100% of bank soil covered by plants, rocks and logs)

poor cover ____
(less than 30% of bank soil covered by plants, rocks, and logs)

fair cover ____
(30% - 70% of bank soil covered by plants, rocks and logs)

Stability of stream bed:

Did the bed sink beneath your feet in:
____ ☐ no spots ____ ☐ a few spots ____ ☐ many spots?

Width of study area:
pool section____________ riffle section____________

Depth of study area:
pool section____________ riffle section____________

Speed of stream's flow____________

Land use in watershed:

____ homes ____ stores ____ factories ____ farming
____ woods ____ fields

Litter:

Average number of small and large items ___

paper, small trash	cans and bottles	tires, carts, etc.
___☐0-5	___☐0-5	___☐0-5
___☐5-10	___☐5-10	___☐5-10
___☐10-50	___☐10-50	___☐10-50
___☐more than 50	___☐more than 50	___☐more than 50

Barriers to fish movement:

________waterfalls ________dams ________beaver dams

_______none _______other

Structure causing a water level difference of one foot or more:

________waterfalls ________dams ________beaver dams

_______none _______other

Are there any discharging pipes? _____☐yes ____☐no

If so, how many discharging pipes are there?________________

Algae:	Is the algae located:	Is the algae:
light green ☐_____	everywhere ☐_____	matted on the stream bed ☐_____
dark green ☐_____	in spots _____☐____	hairy☐_____
brown coated ☐___		other☐_____
other☐_________		

What is the average bottom coverage of algae in the stream?____%

Aquatic life:

fish___☐scattered individuals

___☐scattered schools

crayfish ___☐scarce

___☐abundant

Macroinvertebrates:

Number of insects__________________

Number of kinds____________________

Additional comments which describe the stream:

APPENDIX E
GROSS WATER QUALITY ASSESSMENT

Table 1. Gross Stream Quality Assessment from Kicknet Samples

1. The stream is rated DEAD if:

   a. the number of organisms/square foot sampled is less than 1, and

   b. no fish are observed along a walk of 100 feet of the stream channel.

   Suspect a severe toxicity problem.

2. Stream quality is POOR if:

   a. the number of organism/square foot sampled is more than 1 (i.e., 20 insects/3 ft. x 3 ft. = 20/9 =approximately 2 or 3 insects),

   b. 90% or more of the organisms (excluding the head) are red, white or gray in color; they resemble the midge or blackfly larvae, or

   c. you can pick out only 1-2 kinds of organisms with the unaided eye,

   d. one kind makes up 90% or more of the sample, and

   e. no fish are observed during a walk of 100 feet of the stream channel.

   Suspect a moderate toxicity or severe physical problem.

3. Stream quality is FAIR if:

   a. the number of organisms/square foot sampled is more than 1,

   b. 22%-30% of the organisms (excluding the head) are tan, brown, black or green in color; they resemble the caddisfly or mayfly larvae,

c. you can pick out only 3-6 kinds of organisms with the unaided eye,

d. no one kind makes up 90% or more of the sample, and

e. fish are observed during a walk of 100 feet of the stream channel.

Suspect a mild toxicity or moderate physical problem or excessive organic enrichment.

4. Stream quality is GOOD if:

a. the number of organisms/square foot sampled is more than 1, and

b. 30% or more of the organisms (excluding the head) are tan, brown, black or green in color; they resemble the caddisfly, mayfly or stonefly larvae, or

c. you can pick out six or more kinds of organisms with the unaided eye,

d. no one kind makes up more than 50% of the sample, and

e. fish are observed during a walk of 100 feet of the stream channel.

No significant stream quality problems present.

Table 2. Insect Count and Water Quality

In the case of:	Look for:
Great variety of insects with a few of each kind.	Clean water
Less variety of insects, with great abundance of each kind.	Water overly enriched with organic matter
Only one or two kinds of insects, with great abundance.	Severe organic pollution

No insects, but the stream appears clean	Toxic pollution

Stream Problems and Their Impact on Insect Life:

a. PHYSICAL PROBLEMS -- may include excessive sediment from erosion or a pipe discharge. The sediment may create poor riffle characteristics and contribute to excessive flooding, reduced water in stream, extreme temperatures, smothering of insects. The results will usually be a reduction in the number of all animals in the study area.

b. ORGANIC POLLUTION -- is from excessive human or livestock wastes or high algae populations. The result is usually a reduction in the number of kinds of insects, and it seems to favor collectors/scrapers (such as the caddisflies) with a large increase in the number of organisms per study area.

c. TOXICITY -- chemical polluntants such as chlorine, acids, metals, pesticides, oil. The result is usually a reduction of the number of insects. Usually a toxic problem is the only condition which will render a stream totally devoid of all insects.

APPENDIX F - TOPOGRAPHIC MAPS

As you become familiar with the land uses in your watershed, you may wish to use topographic maps to help identify potential problems and to accurately locate the course of your stream and any tributaries it might have. Topographic maps are important tools for planning, and most professionals you might deal with, such as those at local, state, or federal agencies, will understand you best if you can indicate where problems lie on "topo" maps.

Although topo maps come in various scales, the most useful for looking at your watershed will probably be in the "7-1/2 minute quadrangle series." These maps have a scale of 1:24,000, which means that one inch equals 24,000 inches or one meter equals 24,000 meters, etc.

Topo maps are made using aerial photographic methods with some field checking. The colors and symbols on the maps will tell you a great deal about the area covered. Black is used for man-made objects other than major roads and urban areas. Houses and other buildings will appear as small, black rectangles or squares. Blue is used for all water-related features such as streams, lakes, and marshes. Contour lines are brown, and vegetation is green. Red is used for major roads and land survey lines. Pink indicates urban areas, and purple shows up on interim maps where changes have occurred since the previous edition.

If you would like a free copy of all the symbols used on topographic maps, or if you need to purchase topo maps, you can write to or call the U.S. Geological Survey (USGS). Local maps may also be available from local outdoor stores, blueprint shops, or your city or town offices. If not, you can buy a 7-1/2 minute series map directly from USGS for about $2.50. You can figure out which map you need by looking at a "state index" which you can find at places that sell them or use them or by contacting USGS. The Stream Watch Coordinator may also be able to help.

North Carolina Geological Survey
Division of Land Resources
NCDENR
1612 Mail Service Center
Raleigh, NC 27699-1612

VOCABULARY LIST

A

acute toxicity: Any poisonous effect produced by a single short-term exposure, that results in severe biological harm or death.

adaptation: A change in structure or habit of an organism that produces better adjustment to its surroundings.

acclimation: The physiological and behavioral adjustments of an organism to changes in the environment.

aerobic: Life or processes that depend on the presence of oxygen.

algae: Simple plants which do not grow true roots, stems, and leaves and which live mainly in water providing food for the food chain.

anaerobic: Life or processes that can occur without free oxygen.

aquifer: An underground bed or layer of earth, gravel, or porous stone that contains water.

assimilation: The ability of a body of water to purify itself of pollutants.

autotrophic: An organism that produces food from inorganic substances.

B

bacteria: single-celled microorganisms that lack chlorophyll.

bed material: The unconsolidated material of which a stream bed, lake or pond is composed.

benthic region: The bottom layer of a body of water.

benthos: The animals and plants that inhabit the bottom of a water body.

bioassay: Using sibling organisms to measure the effect of asubstance, factor or condition.

biochemical oxygen demand (BOD): The dissolved oxygen required to decompose organic matter in water. It is a measure of pollution since heavy waste loads have a high demand for oxygen.

biodegradable: Any substance that decomposes quickly through the action of microorganisms.

biological control: Using means other than chemicals to control pests, such as predatory organisms, sterilization, or inhibiting hormones.

biological magnification: The concentration of certain substances up a food chain. A very important mechanism in concentrating pesticides and heavy metals in organisms such as fish.

biomass: Amount of living matter in a given unit of environment.

biomonitoring: Use of living organisms to test water quality at a discharge site or downstream.

biota: All living organisms that exist in an area.

bloom: A proliferation of algae and/or higher aquatic plants in a body of water, often related to pollution.

BOD: The amount of dissolved oxygen consumed in 5 days by biological processes breaking down organic matter in an effluent.

bog: Wet, spongy land usually poorly drained, highly acid and rich in plant residue; the result of lake eutrophication.

buffer strips: strips of grass or other erosion-resisting vegetation between disturbed soils and a stream or lake.

C

carbon dioxide (C02): A colorless, odorless, nonpoisonous gas normally part of ambient air, a result of fossil fuel combustion, aerobic respiration, and decomposition.

cfs: Cubic feet per second, a measure of the volume of water passing a given point; refers to an amount of flow or discharge.

channelization: The modification of a stream including the straightening of stream meanders for the use in controlling floods, improving navigation, relocating streams for highway construction, and draining wetlands to increase agricultural productivity.

chemical oxygen demand (COD): A measure of the oxygen required to oxidize all compounds in water, organic and inorganic.

chlorinated hydrocarbons: A class of persistent, broad-spectrum chemicals, including insecticides, notably DDT, that linger in the environment and accumulate in the food chain.

chronic toxicity: Long-term effects that may be related to changes in appetite, growth, metabolism, reproduction, and even death or mutations.

clear cut: A forest management technique that involves harvesting all the trees in one area at one time. Under certain soil and slope conditions it can contribute sediment to water pollution.

combined sewers: A system that carries both sewage and storm water runoff. In dry weather all flow goes to the waste treatment plant. During a storm only part of the flow is intercepted due to overloading. The remaining mixture of sewage and storm water overflows untreated into the receiving stream.

conservation: The protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

contour plowing: Farming methods that break ground following the shape of the land in a way that discourages erosion.

cover: Vegetation or other material providing protection.

culvert: A closed passageway (such as a pipe) under roadways and embankments which drains surface waters.

D

decomposition: The breakdown of matter by bacteria and fungi.

degrading: Progressive deterioration of physical characteristics.

depositional zone: An area of a stream in which one current is relatively slow and small particles fall out of suspension and become deposited as silt on the stream bottom.

dissolved oxygen (DO): A measure of the amount of oxygen available for biochemical activity in a given amount of water. Adequate levels of DO are needed to support aquatic life. Low DO concentrations can result from inadequate waste treatment.

dredging: To remove earth from the bottom of water bodies using a scooping machine.

dump: A site used to dispose of solid wastes without environmental controls.

E

ecology: The relationship of living things to one another and to their environments, or the study of such relationships.

ecosystem: The interacting system of a biological community and its nonliving surroundings.

effluent: An outflowing branch of a main stream or lake; waste material (i.e., liquid industrial refuse, sewage) discharged into the environment.

enrichment: Sewage effluent or agricultural runoff adding nutrients (nitrogen, phosphorus, carbon compounds) to a water body, greatly increasing the growth potential for algae and aquatic plants.

environment: The sum of all external conditions affecting the life, development and survival of an organism.

erosion: The wearing away of land by wind or water.

erosional zone: An area of a stream in which the water velocity is fast enough to carry small particles in suspension.

estuaries: Areas where fresh water meets salt water (bays, mouths of rivers, salt marshes, lagoons). These brackish water ecosystems shelter and feed marine life, birds and wildlife.

eutrophication: The slow aging process of a lake evolving into a marsh and eventually disappearing.

F

fecal coliform bacteria: A group of organisms found in the intestinal tracts of animals. Their presence in water indicates pollution and possible dangerous bacterial contamination.

fen: Low-lying land partly covered with water.

filter feeder: An organism that obtains food by passing water through a filtering mechanism.

floodplain: Low area of land, surrounding streams or rivers, which holds the overflow of water during a flood.

flow: The direction or amount of movement of water in a stream or river.

food chain: The transfer of food energy from the primary source, plants, through a series of organisms with repeated eating and being eaten. For example, algae to aquatic insects to small fish to larger fish to fish-eating birds to mammals.

G

game fish: Species like trout, salmon, bass, etc. caught for sport. They show more sensitivity to environmental changes than "rough" fish.

groundwater: A supply of freshwater under the earth's surface which forms a natural reservoir.

H

habitat: The sum of environmental conditions in a specific place that is occupied by an organism, population or community.

half-life: The time taken by certain materials to lose half their strength. For example, the half life of DDT is 15 years; of radium, [illegible]0.

hardness of water: A physical-chemical characteristic that is commonly recognized by the increased quantity of soap required to produce lather. Mainly, it comes from the presence of calcium and magnesium.

hazardous waste: Waste materials that are inherently dangerous to handle or dispose of including old explosives, radioactive materials, some chemicals, and some biological wastes.

heavy metals: Metallic elements like mercury, chromium, cadmium, arsenic, and lead, with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.

herbivore: An animal that feeds on plants.

holding pond: A pond or reservoir usually made from earth built to store polluted runoff.

humus: Decomposed organic material.

hydrogen sulfide (H_2S): The gas emitted during organic decomposition that smells like rotten eggs. It is also a byproduct of oil refining and burning and can cause illness in heavy concentrations. It is toxic to fish and other aquatic organisms.

I

infiltration: The action of water moving through small openings in the earth as it seeps down into the groundwater.

impoundment: A body of water confined by a dam, dike, floodgate or other barrier.

indicator: In biology, an organism, species, or community that shows the presence of certain environmental conditions.

L

leachate: Materials that pollute water as it seeps through solid waste.

leaching: The process by which nutrients, chemicals or contaminants are dissolved and carried away by water, or are moved into a lower layer of soil.

lead: A heavy metal that may be hazardous to health if breathed or swallowed.

M

marsh: Wet, soft, low-lying area dominated by herbaceous plants that provides a habitat for many plants and animals. It can be destroyed by dredging and filling. (Contrast with swamp).

membranous: Of, pertaining to, consisting of, originating in, or resembling a membrane.

microhabitat: Local conditions which immediately surround an organism.

monitoring: To watch and care for a stream on a regular basis.

muck soils: Earth made from decaying plant materials.

N

non-point source pollution: A type of pollution whose source is not readily identifiable--such as, pollution caused by car exhaust carried off of city streets by rainwater.

nutrient: Substance which is necessary for growth of all living things (i.e., oxygen, nitrogen and carbon).

nymph: The young of an insect which undergoes simple metamorphosis; loosely applied to the young of all aquatic insects.

O

oil spill: Accidental discharge into bodies of water; can becontrolled by chemical dispersion, combustion, mechanical containment, and absorption.

organic: Referring to or derived from living organisms. In chemistry, any compound containing carbon.

organophosphates: A class of organic chemicals containing phosphorus, several of which are used as pesticides.

P

pesticide: A chemical that kills insects or rodents; may include herbicides which are used to kill plants.

pH: A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 (most acid), to 14 (most alkaline) with a reading of 7 being neutral.

phosphorus: An essential food element that can contribute to the eutrophication of water bodies.

photosynthesis: The manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.

pincers: An organ used for grasping.

plankton: Tiny plants and animals that live in water.

pocosin: A swamp in an upland coastal region.

point source pollution: A type of pollution that can be tracked down to an easily noticeable cause -- such as, discharging pipes, people putting chemicals and trash into the water.

pollutant: Something that makes land, water and air dirty and unhealthy.

pollution: The presence of waste that makes the world around us dirty and contaminated.

precipitate: A solid that separates from a solution because of some chemical or physical change.

pretreatment: Processes used to reduce the amount of pollution in water before it enters the sewers or the treatment plant.

primary treatment: The first stage of waste water treatment; removal of floating debris and solids by screening and sedimentation.

R

raw sewage: Untreated waste water.

receiving waters: Any body of water where wastes are dumped.

refuge, wildlife: An area designated for the protection of wild animals, within which hunting and fishing are either prohibited or strictly controlled.

reservoir: Any holding area, natural or artificial, used to store, regulate, or control water.

riffle: A shallow area of water with a fast current.

riparian rights: Entitlement of a land owner to the water on or bordering their property, including the right to prevent diversion or misuse of it upstream.

river basin: The land area drained by a river and its tributaries.

rough fish: Those species not prized for game purposes or for eating: gar, suckers, etc. Most are more tolerant of changing environmental conditions than game species.

runoff: Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

S

salinity: The amount of salt in water.

salt water intrusion: The invasion of fresh surface or ground water by salt water. If the salt water comes from the ocean it's called sea water intrusion.

sanitary landfill, landfilling: Protecting the environment when disposing of solid waste. Waste is spread in thin layers, compacted by heavy machinery and covered with soil daily.

secondary treatment: Biochemical treatment of waste water after the primary stage, using bacteria to consume the organic wastes. Use of trickling filters or the activated sludge process removes floating and settleable solids and about 90% of oxygen-demanding substances and suspended solids. Disinfection with chlorine is the final stage of secondary treatment.

sediment: Soil, sand, and minerals washed from land into waterways.

sedimentation: When soil particles (sediment) settle to the bottom of a waterway.

seepage: Water that flows through the soil.

sewage: The organic waste and waste water produced by residential and commercial establishments.

sewer: A channel that carries waste water and stormwater runoff from the source to a treatment plant or receiving stream.

silt: Fine particles of soil or rock that can be picked up by air or water and deposited as sediment.

slumping: Sections of soil with or without vegetation that have come loose and slipped into the stream.

stagnation: When there is little water movement and pollutants are trapped in the same area for a long period of time.

storm sewer: A system that collects and carries rain and snow runoff to a point where it can soak back into the groundwater or flow into surface waters.

substrate: Solid material upon which an organism lives or to which it is attached.

suspended solids (SS): Tiny pieces of pollutants floating in sewage that cloud the water and require special treatment to remove.

swamp: A low, wet area dominated by trees and woody plants. (Contrast with marsh.)

synergism: A cooperative action of two substances that results in a greater effect than both of the substances could have had acting independently.

T

terracing: Dikes built along the contour of agricultural land to hold runoff and sediment, thus reducing erosion.

tertiary treatment: Advanced cleaning of waste water that goes beyond the secondary or biological stage. It removes nutrients such as phosphorus and nitrogen and most suspended solids.

thermal pollution: Discharge of heated water from industrial processes that can affect the life processes of aquatic plants and animals.

tidal marsh: Low, flat marshlands traversed by interlaced channels and tidal sloughs and subject to tidal inundation; normally, the only vegetation present is salt-tolerant bushes and grasses.

tolerance: The ability of an organism to cope with changes in its environment.

toxicity: The degree of danger posed by a substance to animal or plant life.

toxic substances: Poisonous matter (either chemical or natural) which causes sickness, disease and/or death to plants or animals.

turbidity: A cloudy condition in water due to suspended silt or organic material.

U

undercutting: A type of erosion which occurs when fine soils are swept away by the action of the stream, especially around curves. The result is an unstable overhang.

urban runoff: Storm water from city streets, usually carrying litter and organic wastes.

V

variance: Government permission for a delay or exception in the application of a given law, ordinance, or regulation.

W

waste: Unwanted materials left over from manufacturing processes, refuse from places of human or animal habitation.

waste water: Water carrying dissolved or suspended solids from homes, farms, businesses, and industries.

water pollution: The addition of enough objectionable material to damage water quality.

water quality standard: A management plan that considers (1) what water will be used for, (2) setting levels to protect those uses, (3) implementing and enforcing water treatment plans, and (4) protecting existing high quality waters.

watershed: All the land that serves as a drainage for a specific stream or river.

water table: The upper level of groundwater.

waterway: A natural or man-made place for water to run through (such as a river, stream, creek or channel).

wetland: An area of land that is regularly wet or flooded, such as a marsh or swamp.

Z

zooplankton: Tiny aquatic animals that fish feed on.


Centimeters
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2
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14