Appendix

- Resources Available on the Adopt-A-Stream Website
- How to Make A Kick Seine
- Background on Aquatic Insects
- Habitat Enhancement
- Glossary of Stream Related Terms

Resources Available on the Adopt-A-Stream Website

www.GeorgiaAdoptAStream.org

- Chemical Data Form
- Macroinvertebrate Data Form
- Field Directions for Core Tests of Chemical Monitoring
- Aquatic Macroinvertebrate Field Guide for Georgia's Streams
- Chemical Monitoring Training Presentation
- Macroinvertebrate Monitoring Training Presentation
- Chemical and Macroinvertebrate Equipment Purchasing Information

How to Make A Kick Seine

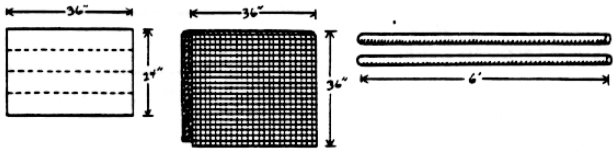
For collecting macroinvertebrates
(Courtesy of the Tennessee Valley Authority)

Materials:

- 3 foot by 3 foot piece of nylon or metal window screening
- 4 strips of heavy canvas (6 inches by 36 inches)
- 2 broom handles or wooden dowels (5 or 6 feet long)
- finishing nails
- thread
- sewing machine
- hammer
- iron and ironing board

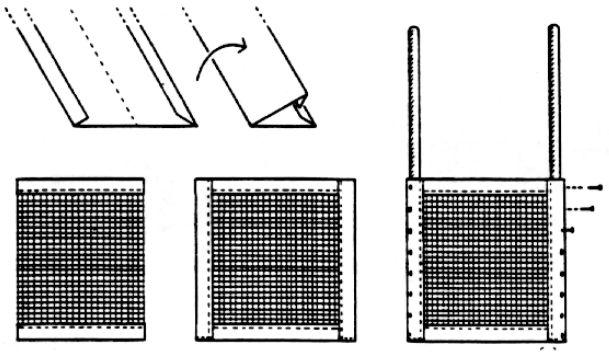
Procedure:

1. Fold edges of canvas strips under, 1/2 inch, and press with iron.
2. Sew 2 strips at top and bottom and then use other 2 strips to make casings for broom handles or dowels on left and right sides. Sew bottom of casings shut.
3. Insert broom handles or dowels into casings and nail into place with finishing nails.



Speed method:

1. Lay 3 foot by 3 foot piece of screening over broom handles.
2. Staple or nail screen to broom handles.



Background on Aquatic Insects

To understand and identify aquatic insects, one must start with how all animals are classified. The most general category is first, with the species level being the most specific. Volunteers will learn to identify aquatic insects to the order level. A stonefly is classified as an example.

Kingdom	Animal (all animals)
Phylum	Arthropoda (all animals with exoskeletons)
Class	Insecta (all insects)
Order	Plecoptera (all stoneflies)
Family	Perlidae (Perlid stoneflies)
Genus	*Acroneuria*
Species	*Acroneuria lycorias* (Golden Stonefly)

Life Stages of Insects

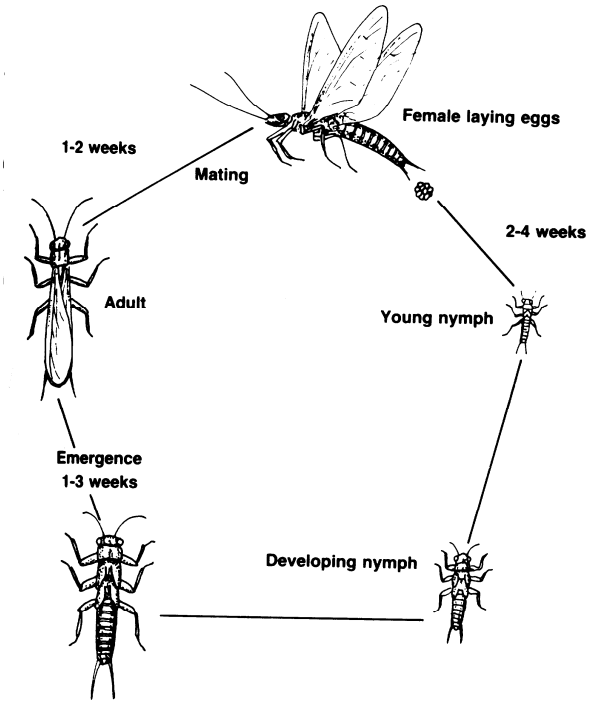
Identifying insects is complicated because of the different stages they pass through during their development. The changes from the egg stage to the adult are often dramatic. The incredible change of a caterpillar into a butterfly is well known; most aquatic insects experience similar changes. The process of changing form during the life cycle is called metamorphosis, of which three types are possible: ametabolous, incomplete, and complete.

Ametabolous Metamorphosis

This type of metamorphosis means “without change” and refers to the lack of change between the immature and adult stages. It's found in only a few very primitive orders of insects that have no wings as adults. Some species are semiaquatic.

Incomplete Metamorphosis

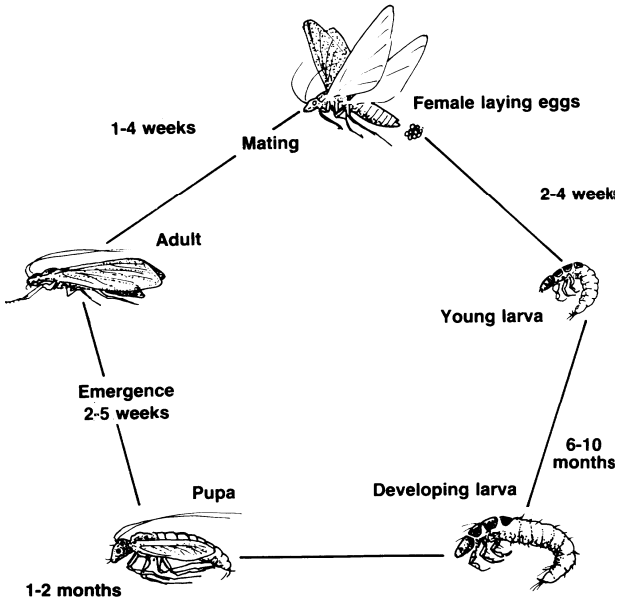
Insects with incomplete metamorphosis pass through three distinct stages: egg, nymph, and adult. The time required to complete each stage varies widely, with the greatest amount of time usually spent in the nymphal stage. In most cases, the entire cycle requires one year to complete, although this also varies with different species. Nymphs often look similar to their adult stage. As nymphs mature, the adult wings begin developing in stiff pouch-like structures on the thorax called wing pads. This is an obvious and unique characteristic of insects with incomplete metamorphosis. The wing pads on fully mature nymphs will be quite dark, almost black, in color. The orders of aquatic insects with incomplete metamorphosis include:



- Mayflies (Order Ephemeroptera)
- Dragonflies and Damselflies (Order Odonata)
- Stoneflies (Order Plecoptera)
- Water Bugs (Order Hemiptera)

Complete Metamorphosis

Insects with complete metamorphosis pass through four distinct stages: egg, larva, pupa, and adult. The addition of the pupal stage separates insects with complete metamorphosis from those with incomplete metamorphosis. While the length of time needed to complete each stage again varies widely, the entire cycle usually takes one year. Most of the cycle is generally spent in the larval stage. Unlike nymphs, larvae bear little resemblance to the adults and show no development of wing pads. It is during the pupal stage that the wing pads and other adult features develop. The orders of aquatic insects include:



- Dobsonflies and Alderflies (Order Megaloptera)
- Caddisflies (Order Trichoptera)
- Aquatic Moths (Order Lepidoptera)
- Aquatic Flies (Order Diptera)
- Aquatic Beetles (Order Coleoptera)

Growth And Development

The growth of insects occurs in a series of stages called **instars**. The exoskeleton of insects must be periodically shed in order for growth to continue. The process of shedding the old exoskeleton is called **molting**. When the old exoskeleton is cast aside, a new, slightly larger one is present underneath. The old empty exoskeleton is often referred to as a **shuck**. Except for mayflies, molting stops once the insect reaches the winged adult stage. Most insects molt five or six times during their development. Mayflies, stoneflies, dragonflies, and damselflies, however, may molt 15-30 times before reaching their adult stage.

Recognizing the insect's stage and degree of development can help anglers determine what insect to imitate. Mature nymphs and larvae often become more active in the water as they move to emergence or pupation sites. This increased activity makes them more available to fish and thus makes them more important to imitate. Looking for and imitating the most mature insects will normally produce the best fishing.

One of the most vulnerable periods in the insect's life cycle is during emergence from the immature to the adult stage. At the time of emergence, mature nymphs or pupae typically crawl out of the water or swim to the water's surface. Those that emerge in the surface film must break through the surface tension, which can take from several seconds to over a minute. Thus, during emergence the shelter of the lake or stream bottom no longer protects insects. Fish readily take advantage of the insects' vulnerability and often feed selectively on emerging nymphs or pupae. The angler who recognizes this activity will find fish fast by imitating the shape and action of the natural prey.

Adult insects often rest on the water's surface after emerging from the nymphal or pupal shuck. Then, after mating, most aquatic insects return to the water to lay their eggs. Insects resting or laying eggs on the surface provide fish with many easy meals.

Source: An Angler's Guide to Aquatic Insects and their Imitations, Hafele and Roederer, 1987.

Habitat Enhancement

(from Protecting Community Streams: A Guidebook for Local Governments in Georgia, Atlanta Regional Commission, 1994)

Stream habitat enhancement projects directly improve the health of streams by improving the adjacent (riparian) area, stream bank, or streambed habitat. All three of these areas function together to make up a stream ecosystem.

Stream habitat enhancement projects can be complicated. Check with your local Natural Resources Conservation Service, Cooperative Extension Service, the Fish and Wildlife Service, or a private consultant to be sure your efforts will yield the results you seek. Also, a Corps of Engineers permit may be needed before any material is placed in a stream or adjacent wetlands. Small projects are usually exempt. Call the Corps' office for more information on Georgia streams, 678-422-2721 (North Georgia) and 229-430-8566 (South Georgia).

Stream habitat enhancement projects may occur on private property with permission of landowners or on public property in cooperation with the local or State agency responsible for property management. Habitat enhancement projects involve three major activities:

- riparian reforestation
- streambank stabilization
- streambed restoration

Riparian Reforestation

The contribution of trees and woody understory vegetation to the maintenance of stream health cannot be overstated. Streamside forested areas not only provide habitat, shade, and forage for both aquatic and land-based species, but their ability to filter pollutants and rainfall provides a buffer – a last line of defense – from watershed runoff. Restoring streamside areas is one of the most cost-effective steps a community or Adopt-A-Stream program can take to protect stream health. The objective should be to replicate or mimic the natural ecosystem as much as possible; therefore, a mix of young and older native plant and tree species are preferred. Follow these steps to conduct a riparian reforestation project:

1. Evaluate current water quality conditions – take "before" pictures and/or conduct physical/chemical, macroinvertebrate, bacterial or visual assessments.
2. Choose a site(s) that needs additional vegetation to protect water quality from stormwater runoff.
3. Purchase a variety of plants that will tolerate wet conditions.
4. Plant trees, shrubs and grasses in the area immediately adjacent to your stream. Plant enough so that the vegetation will actually protect the stream – filter pollutants from stormwater, stop sediment from entering water, etc.
5. Water after planting and as needed.
6. Check each week for four to six weeks to ensure that plants are healthy.
7. Once plants are well established, evaluate water quality improvement – take "after" photograph and/or compare with initial water quality tests.

Streambank Stabilization

If you have an eroding or collapsing streambank, you need to first determine the cause of the problem. Streambank erosion occurs for a number of reasons, including increased stream velocity, obstacles in the stream, floating debris, wave action, and direct rainfall. Streambank failure occurs when a large section of streambank collapses into the stream channel. Among the causes of streambank failure are downcutting of the streambed and undercutting of the bank, increased load on the top of the bank, and internal pressure from uneven water absorption.

Selection of an appropriate bank stabilization method requires careful analysis of each site. No single method is appropriate in all situations. Technical advice will often be needed. Consult the Soil and Water Conservation Commission's "Guidelines for Streambank Restoration".

One technique to stabilize streambanks is called "soil bioengineering", which involves using vegetation as the structural control to stabilize banks. Plantings of woody vegetation, such as willows (either as individual live cuttings or in bundles of cuttings), grow into a dense network of protective vegetation. See Figures 1 and 2. The vegetation's root structure provides resistance to the sliding and shear displacement forces involved in slope erosion.

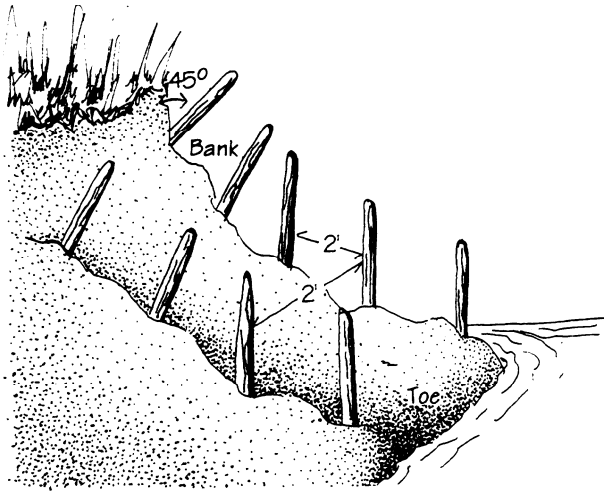


Figure 1 - Willow plantings

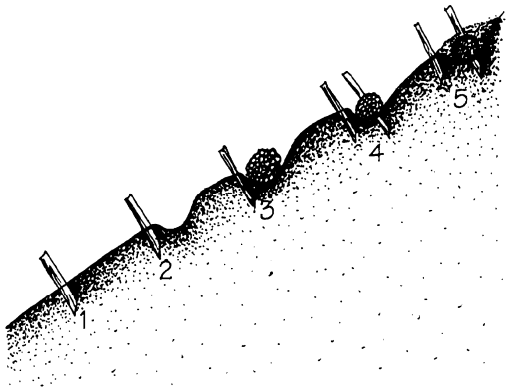


Figure 2

In some cases, a solely vegetative approach may be all that is needed. In others, conditions such as excessive stream velocities or poor soil conditions may require a combination of vegetative and structural elements (such as stone walls or bulkheads). See figure 3

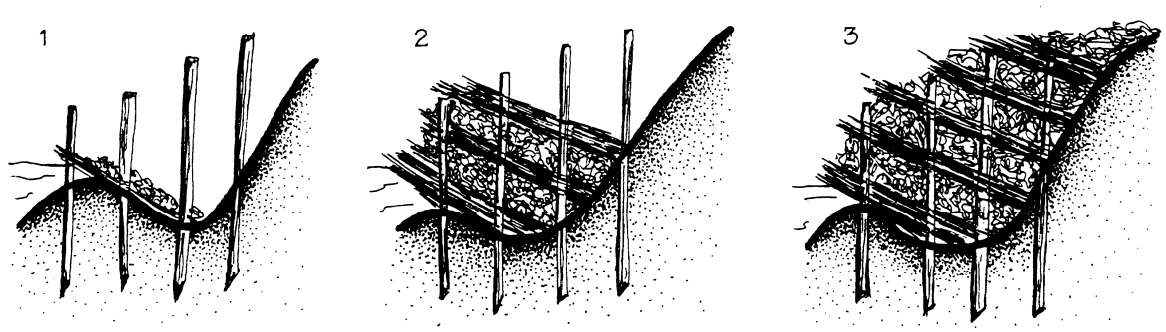


Figure 3

Streambed Restoration

Prior to any streambed restoration, upstream conditions should be assessed. Without corrective measures or retrofitting upstream, stormwater flows could quickly destroy any streambed restoration work. If the stream is in equilibrium, or if appropriate corrective measures are in place, streambed restoration can recreate the habitat conditions needed to support aquatic life. Several goals may be accomplished when restoring a streambed, including:

- Replacement of pools and riffles (in north Georgia and Piedmont areas)
- Velocity control
- Restoration of the stream gradient and normal flow channel
- Removal of major stream obstructions
- Restoration of suitable channel patterns such as:

    - Meandering – repetitive bends
    - Irregular – more or less straight
    - Braided – stream separates and rejoins around islands

- Restoration of substrate (removal of sediment and replacement with gravel and cobbles, as appropriate)

Some of these techniques permit the stream water flows to work to restore healthier streambed conditions; others require excavation and physical realignment of the stream channel. Three basic techniques include deflectors, in-stream boulders and drop structures.

Deflectors can easily be constructed from common, local materials such as cobbles, boulders and logs and are adaptable to a variety of conditions and stream sizes. They are sited in the channel with the intent of deflecting the current into a narrower channel. Deflectors can use the streamflow for a variety of purposes, including deepening channels,

developing downstream pools, enhancing pool/riffle ratios and assisting in the restoration of meander patterns with channeled reaches. There are several deflector designs. Figure 4 (left) shows a simple double "wing deflector" that consists of rock structures on each bank deflecting the streamflow to a central channel. Single deflectors along one bank are also used as shown in Figure 4 (center). Deflectors can be offset on opposite banks of a stream to imitate meanders, as shown in Figure 4 (right). (Pennsylvania DER, 1986).

A third type of deflector is the V-type, which is placed in the middle of the channel with the point of the "V" pointing upstream deflecting water towards both banks. This type of deflector helps re-establish riffles and pools downstream. An underpass deflector is a log placed across a small stream several inches off the bottom. Water is deflected under the log, which helps remove sediment deposits and restore pools. (Gore, Ed. 1985) (Kumble, 1990).

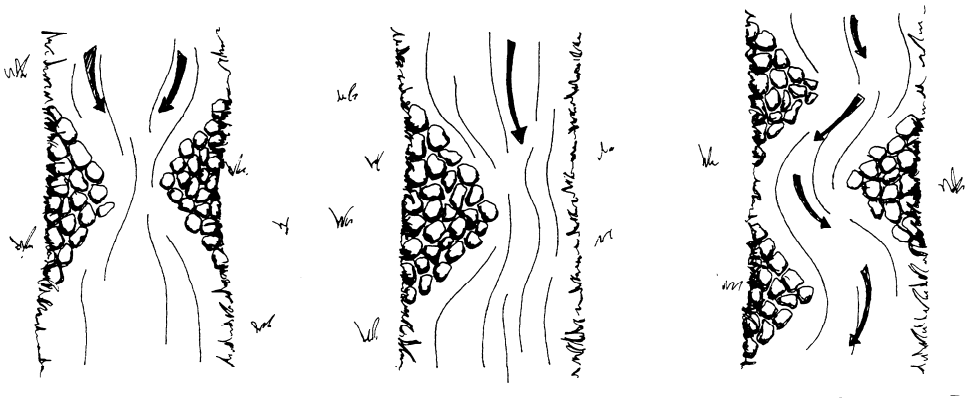
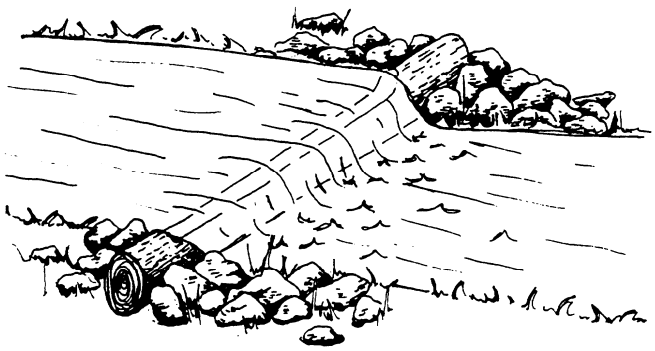


Figure 4 – wing deflector (left), single deflector (center) and double deflector (right)

Drop structures include a number of variations such as weirs, check dams, sills and plunges. They can serve a variety of functions in streambed restoration depending upon their design, including: slowing stream flow; deepening existing pools; and creating new pools upstream and downstream. Structures with notches can be used to control heavy stormwater flows and can help re-establish deep pools immediately downstream. Drop structures can be made of concrete, logs or boulders. Log or boulder structures can be used to replicate small falls or rapids. Single log dams across a streambed are simple and effective in restoring plunge pools (figure 5). The K-dam is a variant of the single log dam, so named by adding downstream bracing. In some areas, especially headwater areas, reintroducing beavers has been effective in restoring the habitat. Their dams function as drop structures in headwaters and on small streams.

Figure 5



Boulder placement is a third in-channel treatment that can assist streambed restoration. Boulders can be used to reduce velocity, restore pools and riffles, restore meanders, provide cover and protect eroded banks by deflecting flow. Boulders can be placed randomly or in a pattern. Placing them in a "V" pointed upstream produces eddies that replicate riffles as well as restores downstream pools (Figure 6). Combined with placement of cobbles and gravel, boulder placement can also help restore the stream substrate.

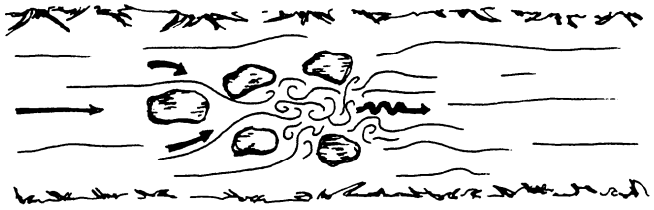


Figure 6

Excavation and fill may also be necessary to restore the stream gradient, the normal flow channel and the stream channel pattern, including meanders and braids, where appropriate. Channel pattern restoration should be combined with streambank restoration and re-vegetation.

Streams that have been severely degraded by large amounts of sediment or heavy stormwater flows may require greater restoration work. Sediment may have to be removed mechanically and replaced with gravel and cobbles to replicate the original streambed. Major debris accumulation that is obstructing flows may also need removal.

Additional references:

- Guidelines for Streambank Restoration. Georgia Soil and Water Conservation Commission. 1994.
- A Georgia Guide to Controlling EROSION with Vegetation. Georgia Soil and Water Conservation Commission. 1994.
- Protecting Community Streams: A Guidebook for Local Governments in Georgia. Atlanta Regional Commission. 1994.
- Gore, James A., editor. The Restoration of Rivers and Streams. 1985.
- Barnett, John L. Stream Restoration Along the Greenways in Boulder, Colorado. 1991.
- Commonwealth of Pennsylvania, Department of Environmental Resources. A Streambank Stabilization and Management Guide for Pennsylvania Landowners. 1986.

Glossary of Stream Related Terms

Accuracy – a measure of how close repeated trials are to the desired target.

Acid rain – rain with a pH of less than 5.6; results from atmospheric moisture mixing with sulfur and nitrogen oxides emitted from burning fossil fuels; causes damage to buildings, car finishes, crops, forests, and aquatic life.

Acidity – a measure of the number of free hydrogen ions (H+) in a solution that can chemically react with other substances.

Algae – simple plants which do not grow true roots, stems, or leaves and live mainly in water, providing a base for the food chain.

Algal bloom – a heavy growth of algae in and on a body of water as a result of high nitrate and phosphate concentrations from farm fertilizers and detergents.

Alkalinity – a measure of the negative ions available to react and neutralize free hydrogen ions. Some of most common of these include hydroxide (OH), sulfate (SO_4), phosphate (PO_4), bicarbonate (HCO_3) and carbonate (CO_3)

Ambient – pertaining to the current environmental condition.

Assemblage – the set of related organisms that represent a portion of a biological community (e.g., benthic macroinvertebrates).

Benthic – pertaining to the bottom (bed) of a water body.

Best management practices - an engineered structure or management activity, or combination of these, that eliminates or reduces an adverse environmental effect of pollutants.

Biochemical oxygen demand (BOD) – the amount of oxygen consumed by microorganisms as they decompose organic materials in water.

Biological criteria – numerical values or narrative descriptions that depict the biological integrity of aquatic communities in that state. May be listed in State water quality standards.

Channel - the section of the stream that contains the main flow.

Channelization - the straightening of a stream; this is often a result of human activity.

Chemical constituents - chemical components that are part of a whole.

Clear cutting – felling and removing all trees in a forest area.

Cobble stone –Stones 2-10 inches in diameter, among which aquatic insects are commonly found.

Combined sewer overflow (CSO) - sewer systems in which sanitary waste and stormwater are combined in heavy rains; this is especially common in older cities. The discharge from CSOs is typically untreated.

Community - the whole of the plant and animal population inhabiting a given area.

Culvert – a man-made closed passageway (such as a pipe) under roadways and embankments, which drains surface water and diverts the natural flow.

Designated uses – state-established desirable uses that waters should support, such as fishing, swimming, and aquatic life. Listed in State water quality standards.

Dissolved oxygen (DO) – oxygen dissolved in water and available for living organisms to use for respiration.

Distilled water – water that has had most of its impurities removed.

Dredge – to remove sediments from the stream bed to deepen or widen the channel.

Effluent – an out-flowing branch of a main stream or lake; waste material (i.e. liquid industrial refuse, sewage) discharged into the environment.

Ecoregion – geographic areas that are distinguished from others by ecological characteristics such as climate, soils, geology, and vegetation.

Embeddedness – the degree to which rocks in the streambed are surrounded by sediment.

Emergent plants – plants rooted underwater, but with their tops extending above the water.

Erosion – the wearing away of land by wind or water.

Eutrophication – the natural and artificial addition of nutrients to a waterbody, which may lead to depleted oxygen concentrations. Eutrophication is a natural process that is frequently accelerated and intensified by human activities.

Floating plants – plants that grow free-floating, rather than being attached to the stream bed.

Flocculent (floc) – a mass of particles that form into a clump as a result of a chemical reaction.

Glide/run – section of a stream with a relatively high velocity and with little or no turbulence on the surface of the water.

Fish kill – the sudden death of fish due to the introduction of pollutants or the reduction of dissolved oxygen concentration in a water body.

Floodplain – a low area of land surrounding streams or rivers which holds the overflow of water during a flood.

Flow – the direction of movement of a stream or river.

Groundwater – a supply of fresh water under the earth's surface which forms a natural reservoir.

Headwaters – the origins of a stream.

Hypoxia – depletion of dissolved oxygen in an aquatic system.

Impairment – degradation.

Impoundment – a body of water contained by a barrier, such as a dam.

Land uses – activities that take place on the land, such as construction, farming, or tree clearing.

Leaching – the process in which material in the soil (such as nutrients, pesticides, chemicals) are washed into lower layers of soil or are dissolved and carried away by water.

Macroinvertebrate – organisms that lack a backbone and can be seen with the naked eye.

Nonpoint source pollution – pollution that cannot be traced to a specific point, but rather from many individual places (e.g., urban and agricultural runoff).

NPDES – National Pollutant Discharge Elimination System, a national program in which pollution dischargers such as factories and sewage treatment plants are given permits to discharge. These permits contain limits on the pollutants they are allowed to discharge.

Nutrient – substance which is necessary for growth of all living things (i.e. phosphorous, nitrogen and carbon).

Orthophosphate – inorganic phosphorus dissolved in water.

Outfall - the pipe through which industrial facilities and wastewater treatment plants discharge their effluent (wastewater) into a waterbody.

Permeable – porous; having openings through which liquid or gaseous substances can penetrate.

Pesticide – a chemical that kills insects and rodents. Pesticides can poison aquatic life when they reach surface waters through runoff.

pH – a numerical measure of the hydrogen ion concentration used to indicate the alkalinity or acidity of a substance. Measured on a scale of 1.0 (acidic) to 14.0 (basic); 7.0 is neutral.

Phosphorus – a nutrient that is essential for plants and animals.

Photosynthesis – the chemical reaction in plants that utilizes light energy from the sun to convert water and carbon dioxide into simple sugars. This reaction is facilitated by chlorophyll.

Point source pollution – a type of pollution that can be tracked down to a specific source such as a factory discharge pipe.

Pollutant – something that makes land, water or air dirty and unhealthful.

Pool – deeper portion of a stream where water flows more slowly than in neighboring, shallower portions.

Precision – a measure of how close the results of repeated trials are to each other.

Protocol – defined procedure.

Reagent – a substance or chemical used to indicate the presence of a chemical or to induce a chemical reaction to determine the chemical characteristics of a solution.

Riffle – a shallow area of a stream or river with a fast-moving current bubbling over rocks.

Riparian – of or pertaining to the banks of a body of water.

Riparian zone – the vegetated area on each bank of a body of water.

Riprap – rocks used on an embankment to protect against bank erosion.

Runoff – water, including rain and snow, which is not absorbed into the ground but instead flows across the land and eventually runs into streams and rivers. Runoff can pick up pollutants from the air and land, carrying them into the stream.

Saturated – inundated; filled to the point of capacity or beyond.

Sediment – soil, sand, and materials washed from land into waterways. Other pollutants may attach to sediment and be carried into the stream.

Sedimentation – when soil particles (sediment) settle to the bottom of a waterway.

Septic tank – a domestic wastewater treatment system into which wastes are piped directly from the home; bacteria decompose the organic waste, sludge settles to the bottom of the tank, and the treated effluent flows out into the ground through drainage pipes.

Sheen – the glimmering effect that oil has on water as light is reflected more sharply off the surface.

Silviculture – forestry and the commercial farming of trees.

Slumping – sections of soil on a streambank 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.

Submergent plants – plants that live and grow fully submerged under the water.

Substrate – refers to a surface. This includes the material comprising the stream bed or the surfaces to which plants or animals may attach or upon which they live.

Surface water – precipitation which does not soak into the ground or return to the atmosphere by evaporation or transpiration and is stored in streams, lakes, wetlands, and reservoirs.

Taxon (plural taxa) – a level of classification within a scientific system that categorizes living organisms based on their physical characteristics.

Taxonomic key – a quick reference guide used to identify organisms. They are available in varying degrees of complexity and detail.

Tolerance – the ability to withstand a particular condition, e.g., pollution-tolerant indicates the ability to live in polluted waters.

Toxic substances – poisonous matter (either chemical or natural) which causes sickness, disease and/or death to plants or animals.

Tributaries – a body of water that drains into another, typically larger, body of water.

Turbidity – murkiness or cloudiness of water, indicating the presence of some suspended sediments, dissolved solids, natural or man-made chemicals, algae, etc.

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 overhanging bank.

Water cycle – the cycle of the earth's water supply from the atmosphere to the earth and back which includes precipitation, transpiration, evaporation, runoff, infiltration, and storage in water bodies and groundwater.

Water quality criteria – maximum concentrations of pollutants that are acceptable, if those waters are to meet water quality standards. Listed in State water quality standards.

Water quality standards – written goals for State waters, established by each State and approved by EPA.

Watershed – land area from which water drains to a particular water body.

Water table – the upper level of groundwater.

Waterway – a natural or man-made route 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.