TAKE CARE OF TEXAS: EDUCATOR MATERIALS

LESSON PLAN

Testing Water: Biological Properties

Objectives

Students will learn what lives in a stream and how these organisms act as indicators of pollution. Rather than arriving at an accurate count, students will understand that it is more important to see how many different species of freshwater benthic macroinvertebrates are present in the body of water.

Prerequisites

Teachers should determine the number of supervisors needed and ensure that those supervisors understand their responsibilities before starting this lesson. You do not need a permit for handling insects; if you would like to handle other animals, please visit the Texas Parks and Wildlife Department's Wildlife Diversity Permits webpage for more information. In addition, you may want to build your own equipment; see the "Additional Resources" section for instructions on building your own dip nets and kicknets.

Duration

Two to three 40-minute lessons

Materials

- Student Worksheet
- Rubber boots or waders
- Magnification lenses
- Forceps
- Collection equipment (dip nets, and a hand screen or kicknets)
- White observation pans (enamel or plastic)

Introduction

TEACHER BACKGROUND INFORMATION

Below are several key indicators that scientists use to evaluate aquatic environments in Texas.

Fish and Benthic Macroinvertebrates

Biological communities (fish and freshwater macroinvertebrates) can be used to determine past and present water quality. You can also tell if the water quality is improving, degrading, or remaining the same by analyzing any changes to this community over time.

Fish and benthic macroinvertebrates are placed into categories based their tolerance to pollution and are used as indicator organisms in evaluating the health of streams.

The three main categories of pollution tolerance are:

- **Intolerant**: sensitive to poor stream conditions.
- **Intermediate**: moderately tolerant of degraded habitat and water quality.
- **Tolerant**: most tolerant of degraded habitat and water quality.

As a general rule for healthy streams, intolerant organisms will be present along with intermediate and tolerant organisms. Water quality is not always the limiting factor in the presence or absence of aquatic organisms. Physical habitat also plays a key role in the whether an organism inhabits a water body. The lack of physical habitat can be just as limiting as poor water quality.

The type and number of organisms present can tell a lot about a stream. If the aquatic community is made up of more intolerant species and a few intermediate and tolerant forms, the stream can be considered healthy. The presence of intolerant and intermediate species generally means that no significant pollution exists. Poor water quality is indicated when the number of tolerant species exceeds that of intermediate species, and intolerant species are absent. The number of individuals of any one species is also an indicator of quality. A good quality stream will have a larger number of species with fewer individuals per species, increased variety, and a balanced system. An unhealthy community includes a few species with numerous individuals, lacks variety, and is unbalanced.

Procedure

1. Separate students into groups of 3-4.
2. Remember to review safety procedures:
    a. stay only in shallow water
    b. wear rubber gloves when you are using your hands to disturb the substrate, aquatic vegetation, roots, or stick piles
    c. wear rubber boots or waders if entering the water
    d. wash your hands at the end of the lesson.
3. Review the information in the Introduction about benthic macroinvertebrates, including:
    a. Benthic macroinvertebrates are small animals without backbones that live on the bottom of water bodies.
    b. They are used to determine past and present water quality; in addition, continued sampling (over a period) can help you tell if the water quality is improving, degrading, or remaining the same.
    c. We categorize macroinvertebrates by their tolerance to pollution. For this lesson, the categories are **intolerant** (sensitive to poor stream conditions), **intermediate** (moderately tolerant to degraded habitat and water quality), and **tolerant** (most tolerant to degraded habitat and water quality).
    d. Water quality is not always the limiting factor in the presence or absence of aquatic organisms; physical habitat also plays a key role in the whether an organism inhabits a water body.
    e. As a general rule, a healthy stream contains intolerant species while polluted streams do not. Intermediate and tolerant species can be in both healthy and polluted streams.
4. Before you start, discuss the collection protocols including:
    a. Do not collect fish, oysters, shrimp, clams, mussels, or crabs; instead, count how many you see and write that number on your handout.
    b. Return benthic macroinvertebrates slightly downstream of the collection area.
5. Select a collection area:
    a. Teams using a hand screen or kicknets need to collect in habitats with running water, such as a **riffle**.
    b. Teams using the dip nets can collect in almost any of the aquatic habitats.

6. Review the two collection activities below with your group and tell them to keep the two questions in mind.
    a. What results do you expect from this study?
    b. Do you believe the stream seems more healthy or polluted?

Hand-Screen (or Kicknets) Collection

1. One team member will enter the water and stand in a location where they can disturb the substrate.
2. Two other team members (each one holding an end of the screen) will enter the water and firmly place the bottom of the screen into the substrate approximately 0.5 meter downstream from the first team member. The screen should be perpendicular to the substrate or slightly angled downstream so it can catch benthic macroinvertebrates and other dislodged material.
3. When ready, the team member upstream will disturb the substrate with their hands or feet (or both) for at least 5 minutes. The area in front of the net should be thoroughly disturbed.
4. In a scooping action, lift the screen out of the water so that all captured material remains on the screen.
5. Bring the screen to the bank and lay it down on the ground.
6. As a team, use the forceps to collect the benthic macroinvertebrates and put them into the observation pan.
7. Using the information above, identify the collected organisms and enter the number for each species.

Dip-Net Collection

1. Use the following procedures when collecting benthic macroinvertebrates found on roots, stick piles, or aquatic vegetation:
    a. Place the dip net slightly downstream on the substrate. If there is little to no water movement, place the net in a manner that would catch the benthic macroinvertebrates.
    b. Vigorously move the vegetation, etc. for several seconds.
    c. In a scooping action, bring the dip net to the bank and pour its contents into an observation pan.
    d. Use the forceps to collect benthic macroinvertebrates and put them into another observation pan.
    e. Using the information above, identify the collected organisms and enter the number for each species.
2. To collect benthic macroinvertebrates from the substrate, follow the hand-screen procedures; however, only one team member needs to hold the dip net to the substrate.

Once you complete the handout, discuss the results with your team. If you found:

- Intolerant species and a few intermediate and tolerant species, then the stream is considered healthy.
- No intolerant species, and more tolerant species than intermediate species, then the water quality is considered poor.

Glossary

- **Intermediate Species** – species that are moderately tolerant of degraded habitat and water quality
- **Intolerant Species** – species that are sensitive to poor stream conditions
- **Riffle** – the shallow portion characterized by relatively fast-moving, turbulent water with bottom materials composed of cobble, gravel, or bedrock.
- **Tolerant Species** – species that are the most tolerant of degraded habitat and water quality

Applicable TEKS

Science TEKS

- **6th Grade** – §112.26.b. 1A-H; 5A-G; 11A-B; 12A-C.
- **7th Grade** – §112.27.b. 1A-H; 5A-G; 11A-B; 12A-B.
- **8th Grade** – §112.28.b. 1A-H; 5A-G; 11A-B; 12A-C.

Pollution Indicators: Benthic Macroinvertebrates

The following list includes some of the benthic macroinvertebrates commonly found in Texas.

Intolerant Species

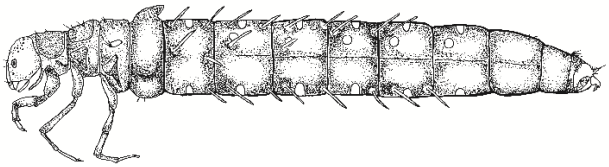
Sensitive to poor stream conditions

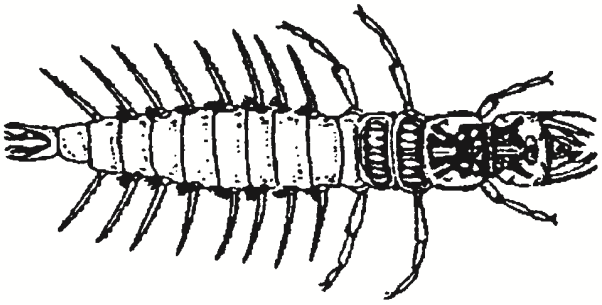
CADDIS-FLY LARVAE

Order: Trichoptera

Size: 3 to 13 mm

Description: Most are found in streams and rivers, with a few inhabiting ponds and lakes. Caddis-fly larvae have three pairs of thoracic legs (near head) and short anal prolegs (no joint) at the end of the abdomen with pointed anal claws. Some species will build snail-like cases made from sticks and small particles of rock. They can usually be seen moving about on the substrate.





DOBSONFLY AND ALDERFLY LARVAE

Order: Megaloptera

Size: 13 to 76 mm

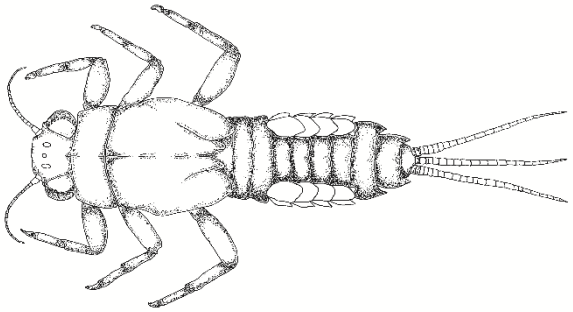
Description: Dobsonfly larvae are found under rocks in riffles (and other stream habitats with fast-moving water) while alder-fly larvae are found mostly in deposited sediments of streams, ponds, and lakes. The dobsonfly and alderfly larvae look similar, except alderfly larvae are smaller. Both have mandibles (unsegmented jaws) and lateral filaments (thread-like extrusions on both sides of its body); dobsonfly larvae have eight pairs of lateral filaments, while alderfly larvae have seven.

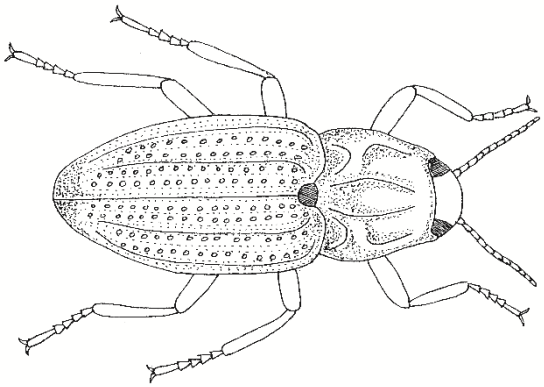
MAYFLY NYMPHS

Order: Ephemeroptera

Size: 3 to 19 mm

Description: Found in a variety of stream habitats. Mayfly nymphs have antennae, wing pads, and three caudal filaments (tails).





RIFFLE BEETLES

Order: Coleoptera

Size: Less than 6 mm

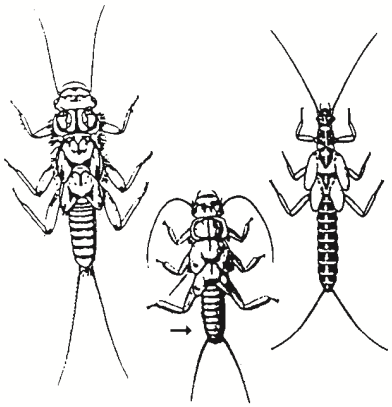
Description: Found on stones, logs, and other debris in the swiftest-moving water of a stream or on a wave-swept shore. Riffle beetles are oval to cylindrical, brown or black; they have long legs, and two long claws at the end of each leg.

STONEFLY NYMPHS

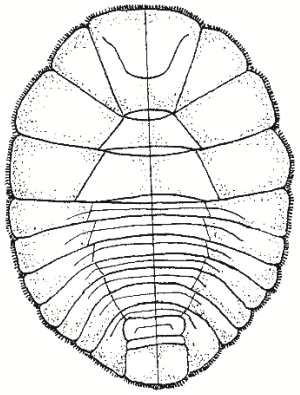
Order: Plecoptera

Size: 6 to 13 mm

Description: Found under rocks, in debris, and in thick mats of algae. Stonefly nymphs need an oxygen-rich environment due to the lack of extensive gills. The nymph has long antennae, wing pads, two long caudal filaments (tails), and two long claws at the end of each leg.



Source: Save Our Springs



WATER-PENNY LARVAE

Order: Coleoptera

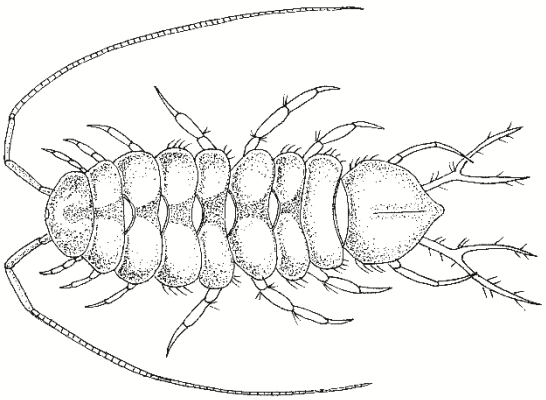
Size: About 6 mm

Description: Found on the underside of rocks in fast-moving water and on wave-swept shores. Each water-penny larva has a flat and round body, is brownish, and has legs underneath.

Intermediate Species

Moderately tolerant of degraded habitat and water quality

AQUATIC SOWBUGS

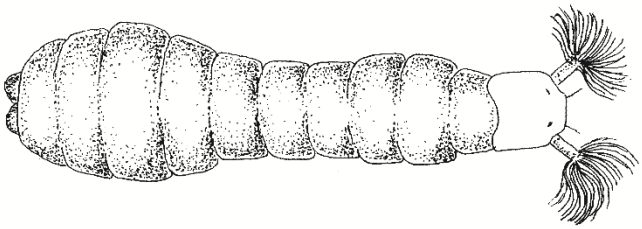


Order: Isopoda

Size: 6 to 13 mm

Description: Found on vegetation and also in shallow water under logs and rocks. Aquatic sowbugs are dorsoventrally flattened and have seven pairs of leg-like appendages.

BLACK-FLY LARVAE



Order: Diptera

Size: 3 to 6 mm

Description: Found in flowing water on stones, vegetation, or other objects (usually in the swiftest part of the stream). In many cases, the larvae are so numerous that they appear moss-like over the surface of the attached object. Black-fly larvae have swollen abdomens that are attached to rocks and other debris by a caudal (posterior-end) sucker.

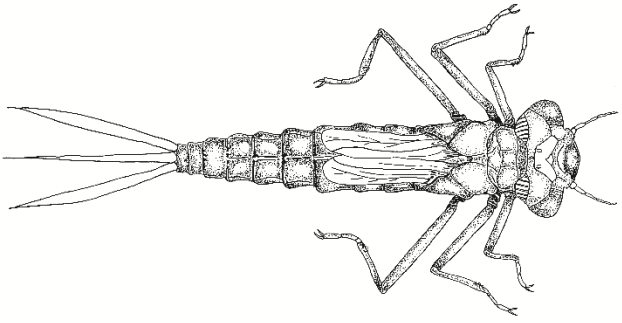
CRANE-FLY LARVAE

Order: Diptera

Size: 10 to 25 mm

Description: Found in both running-water and standing-water habitats. Crane-fly larvae have worm-like, thick-skinned bodies that range in color from brownish-green to somewhat transparent white. Larvae also have spiracles (external openings for the respiratory system) that extend from the end of the body.

DAMSELFLY NYMPHS



Order: Odonata

Size: 6 to 25 mm

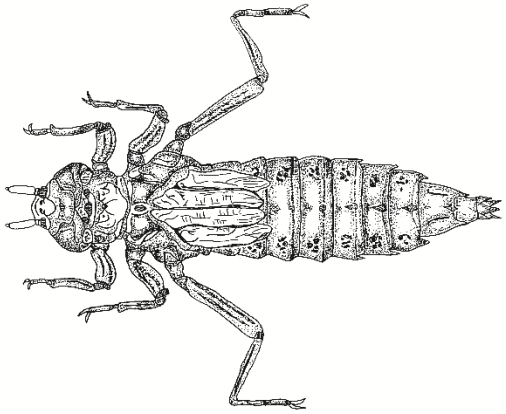
Description: Found underneath rocks and logs in streams, lakes, and ponds. Damselfly nymphs appear to have three tails, but those are actually gills that help them breathe in oxygen from the water.

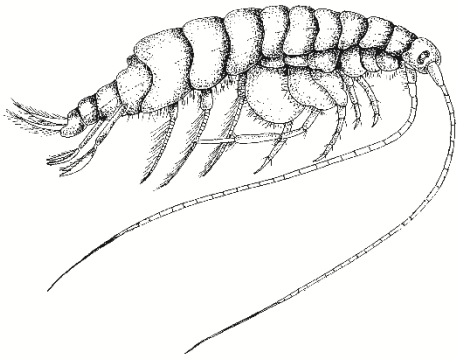
DRAGONFLY NYMPHS

Order: Odonata

Size: 6 to 51 mm

Description: Found in all types of freshwater areas, such as ponds, lakes, streams, and swampy areas. Dragonfly nymphs are dark brown to greenish and have wing pads and three triangular cerci (dorsal appendages at the end of the abdomen).





SCUDS

Order: Amphipoda

Size: 3 to 6 mm

Description: Found in lakes, streams, ponds, springs, and subterranean waters. Scuds live close to the bottom or among submerged objects to avoid light. Scuds have a laterally flattened body (like a flea's) and have seven pairs of leg-like appendages.

Tolerant Species

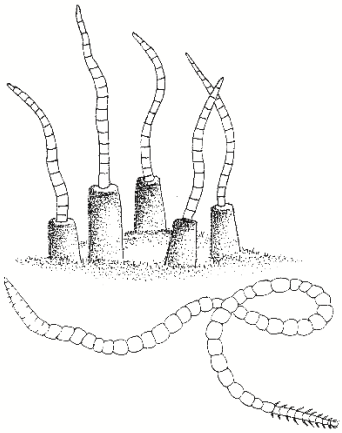
Most tolerant of degraded habitat and water quality

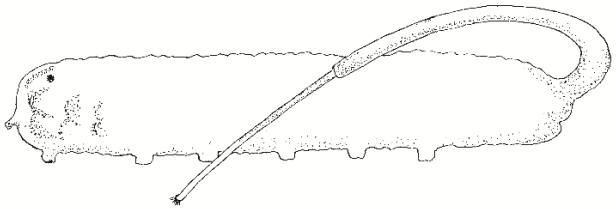
AQUATIC WORMS

Class: Oligochaeta

Size: 3 to 13 mm

Description: Found on the substrate of all types of water bodies; commonly found in soft mud. They sometimes become very abundant where water is polluted. Aquatic worms have segmented bodies and have many bristles.





DRONE-FLY LARVAE (RAT-TAIL MAGGOTS)

Order: Diptera

Size: Body about 19 mm

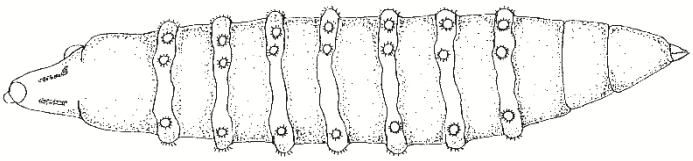
Description: Found in standing-water habitats, along the edges of running-water habitats, and sewage lagoons; commonly found in areas with large amounts of decomposing organic matter and sludge. Drone-fly larvae are very tolerant of poor water quality, including low dissolved-oxygen levels. Each larva has a breathing tube to get oxygen from the air; it can be extended three to four times its body length.

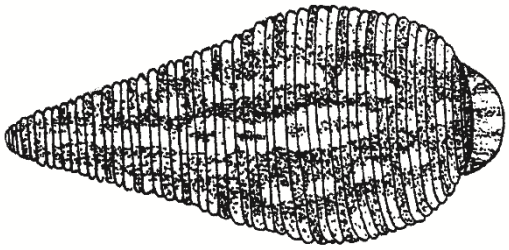
HORSEFLY LARVAE

Order: Diptera

Size: 10 to 25 mm

Description: Found in stream riffles, shallow stream margins, and shallow vegetated habitats. Horsefly larvae have no pro-legs (fleshy legs on the abdomen); instead, they have six or more pseudopods (false feet) on most abdominal segments.





LEECHES

Class: Hirudinea

Size: 6 to 25 mm

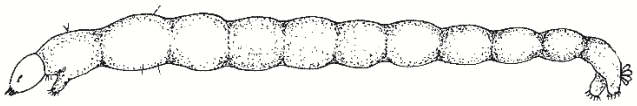
Description: Found often in calm, shallow, warm waters that have bottoms cluttered with debris. Leeches are dorsoventrally flattened and segmented, with anterior and posterior suckers, and are usually dark brown to black.

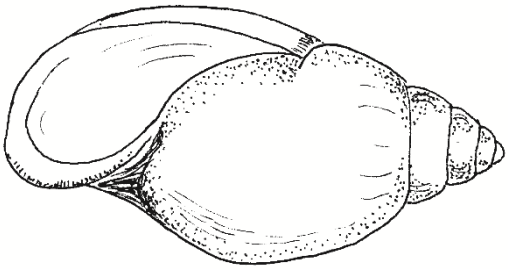
MIDGE-FLY LARVAE

Class: Diptera

Size: 3 to 6 mm

Description: Found in the shallow water areas of lakes, ponds, and streams. Midge-fly larvae prefer soft, mucky substrate because they use this type of material to construct their tube-like homes. The larvae are extremely tolerant of low levels of dissolved oxygen. Midge-fly larvae have narrow bodies and antennae that resemble two feathers on the front of their heads.





POUCH SNAILS

Class: Gastropoda

Size: 3 to 25 mm

Description: Snails are found in every freshwater environment, from the smallest ponds and ditches to the largest lakes and rivers. While most snails need high dissolved-oxygen concentrations, pouch snails do not since they breathe air from the atmosphere. Therefore, pouch snails are very tolerant of pollution. Pouch snails creep along any type of substrate, generally in waters up to 2 meters deep.