# Invert Investigator

# *Introduction*

What is an aquatic *macroinvertebrate*? What are the differences between them? Why are they important? What do they do in addition to providing food for fish?

Students answer these questions and more through exploring the creek ecosystem. It is home to macroinvertebrates and other organisms, which are all integral components of the complex aquatic food chain.

*"The first thing I did was to feel, raccoonlike, with the tips of my fingers the soil of the bank just below the water's edge. I listened for the sound of water on the outer bar. I observed the hunt of the caddisfly."*

*Barry Lopez*

# Teacher Section

## *Objectives*

Students will be able to:

1) Investigate macroinvertebrates found in the stream
2) Describe functional feeding groups and their role in watershed ecology
3) Discuss the concept of "indicator species"
4) List sensitive and tolerant species and explain how changes in water quality can impact those most sensitive and thus, the aquatic system
5) Recommend ways to maintain and restore watersheds for macroinvertebrate fauna
6) Analyze data collected from the field (at the site and in classroom post work activities)

WA Science Essential Academic Learning Requirements (EALRs): 1.1, 1.3, 2.1, 3.1

## *Concepts*

- Indicator species
- Aquatic insect metamorphosis (life cycle stages)
- Ecosystem functions of macroinvertebrates

## *Study Site Description*

Students meet at a designated site near the creek. With the assistance of the resource specialists, students are divided into two groups. Students enter the creek and collect a sample from a riffle, pool, or glide. When an adequate sample has been collected, students sort and identify the contents of the sample using microscopes, magnifying boxes, and benthic invertebrate keys. Tables are provided. As a team, students fill out survey forms and record their findings.

## *Vocabulary*

*(Definitions can be found in the Glossary)*

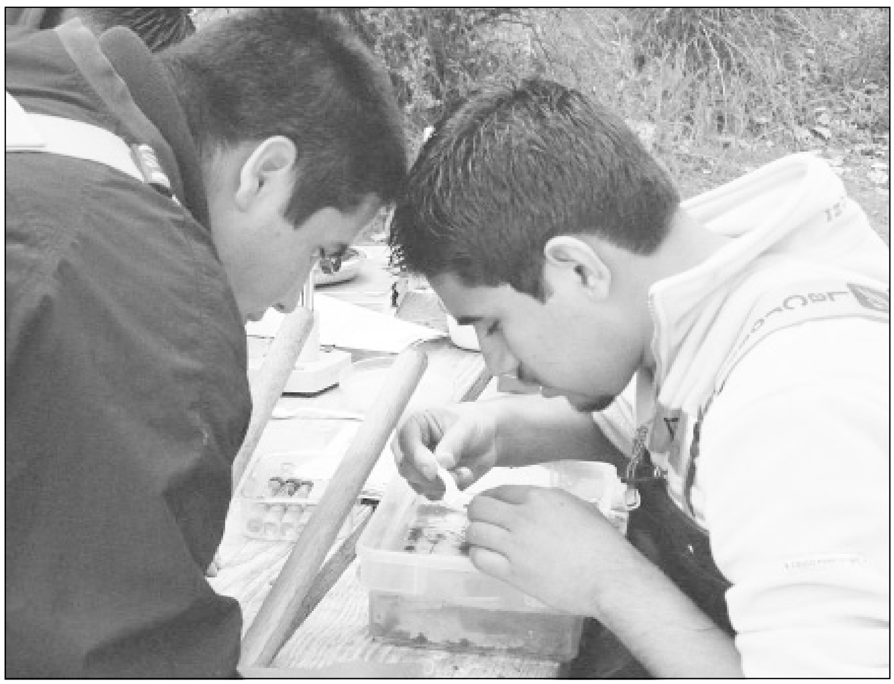
| | |
|---|---|
| Benthic | Instar |
| Ecosystem | Macroinvertebrate |
| Erosion | Metamorphosis |
| Geomorphology | Nymph |
| Hyporheic Zone | Riparian |
| Indicator species | Substrate |

## *Classroom Pre-work*

Options include:

- More Than a Bug
- Macroinvertebrate Mayhem
- The Right Body for the Job
- The River Continuum

**MINIMUM PRE-WORK NECESSARY FOR FIELD STUDY:**
Two hours minimum. It is important that students learn the life cycle differences between benthic invertebrate species as well as functional feeding groups and the connection between tolerance levels and water quality conditions. View student worksheets and the enclosed benthic invertebrate key ahead of time.



# More Than A Bug

*(30 minute activity)*

## Objective

Students will be able to:

1) Provide examples of complete vs. incomplete metamorphosis

## Materials

- ❏ Transparency of metamorphosis
- ❏ Overhead projector
- ❏ Screen
- ❏ Pen
- ❏ Scissors

## Background

Have you ever seen a molted shell of an aquatic insect on a stream-side rock? That insect just went through another *instar*. The insect life cycle is full of *metamorphosis*, and some species change over 20 times. Each change is called an instar. Most *benthic macroinvertebrates* fall into the category of either *complete* or *incomplete metamorphosis.* Mayflies and stoneflies undergo the more primitive incomplete (or simple) metamorphosis with three distinct stages: egg, *nymph*, and adult. The caddisfly is an example of complete metamorphosis: egg, larva, pupa, and adult. When students investigate the stream, they will notice the larval form does not look like the adult. However, the nymph does exhibit signs of what's to come later in life. In the adult form, other interesting differences between species are found. Some live two or more weeks and others just for hours. Time is so short they do not need any body parts for eating!

The following is a list of common northwest aquatic insects:

| **Incomplete Metamorphosis** | **Complete Metamorphosis** |
|---|---|
| Mayflies (Ephemeroptera) | Caddisflies (Trichoptera) |
| Stoneflies (Plecoptera) | Alder flies & Dobsonflies (Megaloptera) |
| Dragonflies and Damselflies (Odonata) | Beetles (Coleoptera) |
| Water Boatmen, Backswimmers | True Flies (Diptera) |

## Procedure

1. Ask students about the visual changes animals exhibit as they mature. Give examples of the life cycle of other animals. Which juveniles look similar to the adult form and which do not? Compare birds, fish, and fur bearing animals.

## *Procedure* *continued*

2. Find the *Aquatic Insect Life Cycle Stages* sheet (Figure 1), that demonstrates complete and incomplete metamorphosis. Cut up the sheet to separate the stages and distribute, one per student. Ask them to find other students that have the same insect. Tell them there should be four per group, each showing a different instar. Ask them to put together the growth changes in order on a piece of 8.5 x 11 paper. Display each group's insect in front of the class and ask students to look critically at everyone's work. Are they in correct order? What insects are they? Look at the *Key to Immature Aquatic Insects* (Figure 2) for the answer.

3. Make an overhead transparency of the *Aquatic Insect Life Cycle Stages* sheet so students can view the insect names and the correct arrangement of the life cycle.

4. Go for the details. Using the *Immature Aquatic Insects Key*, explore the classification (Kingdom, Phylum, Class, Order, Family, Genus, Species) to which each insect belongs. How many instars do they go through, what are the habitat requirements, and where do they live as adults?

## *Assessment*

Ask students to:

- ❑ Describe the life cycle differences between insects that undergo complete vs. incomplete metamorphosis.
- ❑ Illustrate and label the instars.

## *Extensions*

- ❑ Research macroinvertebrates from the list provided in the *Background* information. Note life cycle and habitat differences and similarities between species. Go in-depth and discover what animals prey upon them at various times in their lives.
- ❑ Order a dissection kit containing insects, collect your own, or call your state or federal entomologist for assistance. Try to get samples of various instars to compare growth changes with the help of a microscope.

# *Macroinvertebrate Mayhem*

*(45 minute activity)*

## *Objectives*

Students will be able to:

1) Illustrate how tolerance to water quality conditions vary among macroinverebrate organisms
2) Explain how population diversity provides insight into the health of an ecosystem

## *Materials*

- ❏ Samples of macroinvertebrate organisms (optional)
- ❏ Resources (texts, field guides, encyclopedia)
- ❏ Identification labels (Figure 3) for macroinvertebrate groups, one per student (divide the number of students by 7 and make that number of copies of each macroinvertebrate picture. One side of each label should have a picture of one of the seven macroinvertebrates. The other side of each label [except those midge larvae and rat-tailed maggots] should have a picture of either the midge larva or rat-tailed maggot. For durability, the cards may be laminated. Use a clothespin or paper clips to attach labels to students' clothing.
- ❏ Pillowcases or burlap bags
- ❏ Chart paper or a chalkboard

NOTE: To adapt this activity for your area, call the state Department of Natural Resources or U.S. Fish and Wildlife Service for information.

## *Making Connections*

People may be able to assess the water quality of a stream by its appearance and smell. Sometimes, however, a polluted stream looks and smells clean. Students may have already learned certain ways to test water quality and may have conducted macroinvertebrate stream studies. Simulating how environmental stressors affect macroinvertebrate populations helps students relate the concept of biodiversity to the health of aquatic ecosystems.

## *Background*

Macroinvertebrates are an integral part of wetland and stream *ecosystems*. Examples of macroinvertebrates include mayflies, dragonflies, rat-tailed maggots, scuds, snails and leeches. These organisms may spend all or part of their lives in water; usually their immature phases (larvae and nymphs) are spent entirely in water. Larvae do not show wing buds and are usually very different in appearance from the adult versions of the insects. Maggot is the term used for the larva of some flies. Nymphs generally resemble adults, but have no wings and are usually smaller.

A variety of environmental stressors can impact macroinvertebrate populations. Urban and/or agricultural runoff can produce conditions that some macroinvertebrates cannot tolerate. Sewage and fertilizers added to streams induce the growth of algae and bacteria that consume oxygen and make it unavailable for macroinvertebrates. Changes in land use from natural vegetation to a construction site or to poorly protected cropland may add sediment to the water. Sedimentation destroys habitats by smothering the rocky areas of the stream where macroinvertebrates live. Both the removal of trees along the banks of a river and alteration of stream velocity can alter normal water temperature patterns in the stream. Some organisms depend on certain temperature patterns to regulate changes in their life cycles. Other stressors include the introduction of alien species and stream channelization.

Some macroinvertebrates, such as the mayfly, stonefly, and caddisfly larvae, are sensitive (intolerant) to changes in the stream conditions brought about by pollutants. Some of these organisms will leave to find more favorable habitats, but others will be killed, or will be unable to reproduce. Macroinvertebrates that may thrive in polluted conditions (e.g., rat-tailed maggots and midge larvae) are called tolerant organisms. Other organisms, called facultative organisms (e.g., dragonflies, damsel flies, nymphs) prefer good stream quality but can survive polluted conditions.

*Background continued*

Water quality researchers often sample macroinvertebrate populations to monitor changes in stream conditions over time and to assess the cumulative effects of environmental stressors. Environmental degradation will likely decrease the diversity of a community by eliminating intolerant organisms and increasing the number of tolerant organisms. If the environmental stress is severe enough, species of intolerant macroinvertebrates may disappear altogether. For example, if a sample of macroinvertebrates in a stream consists of rat-tailed maggots, snails, and dragonfly nymphs, the water quality conditions of that stream are probably poor (i.e., low oxygen level, increased sediment, traces of contaminants). If, on the other hand, the sample contains a diversity of organisms, the stream conditions are likely good. However, baseline data is essential because some healthy streams may contain only a few macroinvertebrate species. A variety of food sources, adequate oxygen levels and temperature conducive to growth all characterize a healthy stream.

## *Procedure*

1. Review the conditions that are necessary for a healthy ecosystem.

2. Ask students to describe what could happen to an ecosystem if these conditions were altered or eliminated. What clues would students look for to determine if an ecosystem was healthy or not?

3. Remind students that a stream is a type of ecosystem. Ask them how they would assess the health of a stream. Students may suggest conducting a visual survey of the surrounding area and answer the following questions:
   What land use practices are visible in this area?
   How might these practices affect the stream?
   Is there plant cover on the banks of the stream or are the banks eroded? What color is the water? What is living in the stream?

4. Identify several environmental stressors (e.g., urban and agricultural runoff, sedimentation, introduction of alien species) and discuss how they can affect the health of a stream.

5. Review the many types of plants and animals, including insects, that live in the streams. How might environmental stressors affect these organisms? Would all organisms be affected in the same way? Why or why not?

*Procedure*
*continued*

**Part 1**

1. Introduce the practice of sampling macroinvertebrate populations to monitor stream quality. Show students pictures or samples of macroinvertebrates used to monitor stream quality.

2. Divide the class into seven groups and assign one macroinvertebrate (from *Macroinvertebrate Groups*) to each group. Have group members conduct library research to prepare a report for the class about their organism. The report should include the conditions ( e.g., clean water, abundant oxygen supplies, cool water) the organism must have to survive.

3. Have students present their reports to the class and compare each organism's tolerance of different stream conditions.

**Part 2**

1. Tell students they are going to play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. Show students the playing field and indicate the boundaries.

2. Have one student volunteer to be an environmental stressor (e.g., sedimentation, sewage, or fertilizer). Discuss the ways that a stream can become polluted and how this can alter stream conditions. With a large class or playing field, more students will need to be stressors.

| **Macroinvertebrate Groups** | |
|---|---|
| Caddisfly larva | Damselfly nymph |
| Mayfly larva | Midge larva |
| Stonefly larva | Rat-tailed maggot |
| Dragonfly nymph | |

*Macroinvertebrate Mayhem* is used with the permission from The Watercourse/Montana State University and the Council for Environmental Education (CEE) from Project WET Curriculum and Activity Guide. For further information about Project WET (Water Education for Teachers), contact the national office at (406)994-5392.

3. **Divide** the rest of the class into the seven groups to play the game. Each group represents one type of macroinvertebrate species listed in *Macroinvertebrate Groups*. Record the number of members in each group, using a table similar to a *Sample of Data From Macroinvertebrate Mayhem.*

4. **Distribute** appropriate identification labels to all group members**.** The picture of each group's macroinvertebrate should face outward when labels are attached.

5. **Inform students** that some macroinvertebrates have hindrances to crossing the field (see *Intolerant Macroinvertebrates and Hindrances*). These obstacles symbolize sensitive organisms' intolerance to pollutants. Have students practice their motions.

## Intolerant Macroinvertbrates and Hindrances

| ORGANISM | HINDRANCE | RATIONALE FOR HINDRANCE |
|---|---|---|
| Caddisfly | Must place both feet in a bag* and hop across field, stopping to gasp for breath every five hops. | Caddisflies are intolerant of low oxygen levels. |
| Stonefly | Must do a push up every ten steps. | When oxygen levels drop, stoneflies undulate their abdomens to increase the flow of water over their bodies. |
| Mayfly | Must flap arms and spin in circles when crossing field. | Mayflies often increase oxygen absorption by moving their gills. |

* Caddisfly larvae build cases and attach themselves to rocks for protection and stabilization.

NOTE: Try to have at least four students in each group. For smaller classes, reduce the number of groups. For example, eliminate the stonefly nymph and damselfly nymph groups.

*Procedure*
*continued*

6. Assemble the macroinvertebrate groups at one end of the playing field and the environmental stressor(s) at mid-field. When a round starts, macroinvertebrates will move toward the opposite end of the field and the stressor will try to tag them. To “survive,” the macroinvertebrates must reach the opposite end of the field without being tagged by the environmental stressor. The environmental stressor can try to tag any of the macroinvertebrates, but will find it easier to catch those with hindered movements.

7. Begin the first round of the game. Tagged macroinvertebrates must go to the sideline and flip their identification labels to display the more tolerant species (i.e., rat-tailed maggot or midge larva). Tagged players who are already in a tolerant species group do not flip their labels.

8. The round ends when all of the macroinvertebrates have either been tagged or have reached the opposite end of the playing field. Record the new number of members in each species.

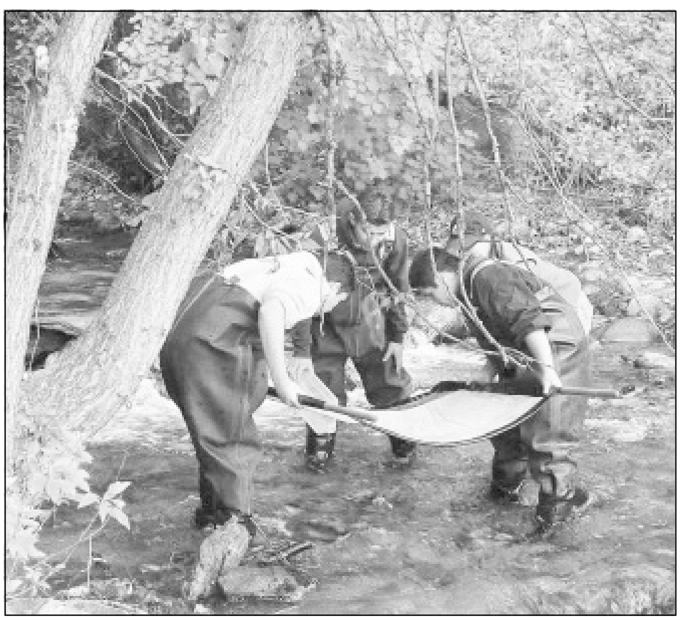
9. Complete two more rounds, with all tagged players rejoining the macroinvertebrates who successfully survived the previous round. Record the number of members in each species of macroinvertebrates at the conclusion of each round. Because some players will have flipped their identification labels, there will be a larger number of tolerant species in each successive round.

## A Sample of Data From Macroinvertebrate Mayhem

| | | NUMBERS (AT START AND AFTER EACH ROUND) | | | |
|---|---|---|---|---|---|
| ORGANISM | TOLERANCE | START | ROUND 1 | ROUND 2 | ROUND 3 |
| Caddisfly larva | Intolerant | 5 | 2 | 2 | 2 |
| Mayfly nymph | Intolerant | 5 | 4 | 1 | 0 |
| Stonefly nymph | Intolerant | 4 | 4 | 4 | 2 |
| Dragonfly nymph | Facultative | 5 | 5 | 4 | 4 |
| Damselfly nymph | Facultative | 4 | 4 | 4 | 3 |
| Midge larva | Tolerant | 4 | 6 | 7 | 9 |
| Rat-tailed maggot | Tolerant | 4 | 6 | 9 | 11 |
| TOTAL | | 31 | 31 | 31 | 31 |

### *Wrap Up*

The game is completed after three rounds. Discuss the outcome with students. Emphasize the changes in the distribution of organisms among groups. Have students compare population sizes of groups at the beginning and end of the game and provide reasons for the changes. Review why some organisms are more tolerant of poor environmental conditions than others. Have students compare the stream environment at the beginning of the game to the environment at the end.



Ask students to investigate a nearby stream. What types of macroinvertebrates live there? Graphics of *Aquatic Insects Tolerant and Sensitive to Water Pollution* (Figures 4 & 5) and *A Key to Immature Aquatic Insects* (Figure 2) may prove helpful for identification. How would students describe the diversity of organisms? Do students' findings provide insight into the quality of the stream? What other observations can students make to determine stream quality? They may want to report their findings to local watershed managers or water quality inspectors.

## Assessment

Have students:

- ❑ Analyze a stream based on a visual assessment.
- ❑ Describe macroinvertebrate organisms and identify what stream conditions they need to survive.
- ❑ Explain how some organisms indicate stream quality.
- ❑ Interpret stream quality based on the diversity and types of organisms found there.

Upon completing the activity, for further assessment have students:

- ❑ Develop a matching game in which pictures of streams in varying conditions are matched with organisms that might live there.

## Extensions

- ❑ Supplement the students' macroinvertebrate survey of a stream with chemical tests and analyses.
- ❑ Have students design their own caddisfly case.
- ❑ Have students study aspects of biodiversity by adding another round to the game. For example, add a fourth round in which all organisms are caddisflies. This round will demonstrate how a few intolerant species or a single species can be quickly eliminated.

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# The Right Body for the Job

*(30 minute activity)*

## Objectives

Students will be able to:
1) List benthic macroinvertebrate functional feeding groups
2) Describe characteristics of each feeding group
3) Show connections between the vital role macroinvertebrates play and watershed ecology
4) Demonstrate that juvenile insects are well adapted to function in their niches

## Background

What happens to leaves and woody debris that fall into a stream? What about dead fish? How do they decompose? Aquatic insects have specialized adaptations for the aquatic environment and fit into functional feeding groups. Keep in mind that some fall into more than one category.

***SHREDDERS*** use chewing mouthparts to bite into large pieces of organic material such as leaf litter and wood. They prefer food that has been softened and pre-conditioned by microorganisms (fungi and bacteria) and often leave veins and other finer material behind for the eating pleasure of their fellow macroinvertebrates! Some, like the caddisfly, make a home or case of what is eaten.

***COLLECTORS*** dine on smaller organic particles, usually less than one millimeter in diameter. Sometimes fecal matter left from other organisms may be on the menu. They eat algae and fragments of animals and plants. When you pick up a rock, sometimes you feel mucous on it. You could be looking at a *filtering collector*, capturing particles by using a fan (black fly larvae) or spinning a net (free-living caddisfly) made of a sticky substance. Who will help decompose material on the stream bottom? *Gathering collectors* such as mayfly nymphs and beetle larvae are anatomically designed (mouths and appendages) to burrow and live in lower *substrate* and become part of the *hyporheic zone.*

***SCRAPERS*** or grazers eat algae from rock and stream surfaces. They are not swept downstream in swift currents because some have suction disks on their abdomens and most are flat. Snails and some mayfly nymphs fall into this category. Scraper caddisflies construct homes from the stones they collect.

## Background *continued*

***PREDATORS*** like cranefly larvae and dragonfly, damselfly, and stonefly nymphs, are perfectly adapted eating machines. Some capture other aquatic insects by grasping with forelegs and biting and chewing with strong opposable mouthparts. Others use tube-like mouthparts to suck body fluids from their prey (*piercers*) or just eat their meal whole (*engulfers*).

Aquatic insects are located in waterways according to what they eat. *Shredders* can be found in upper reaches of streams where there is abundant vegetation. *Scrapers* prefer open areas or after leaf fall, when sunlight can penetrate the stream and reach the larger substrate to photosynthesize algae. They are typically found in riffles with *filtering collectors*. *Gathering collectors* prefer slower areas where sediments are allowed to accumulate. *Predators* are on the prowl in all aquatic habitats.

## Procedure

1. Copy the mayfly anatomy graphics (Figures 6 & 6A) onto overhead transparencies. Show the immature insect anatomy picture where no body parts are labeled. Ask students how they think the parts function and what they should be called by looking at them. At first, relate functions to the human body. The legs have tibias and femurs, there are abdomens, and so on. Show the picture with the parts labeled and discuss how they function. Remember that insects are anatomically adapted according to their role in the environment, and have six legs, four wings (adults), and ten-segmented abdomens. By looking at its anatomy, in which functional feeding group does the mayfly fit? Using the *Key to Immature Aquatic Insects* (Figure 2), look at the other insects and predict what roles they might play in the stream based on physical features.

2. Food Processing in Streams (Figure 7) shows macroinvertebrates in the four feeding groups and where they are commonly located in a stream. Make an overhead transparency of the chart and ask students to list adaptations an insect's body would need to fit in one of the groups. Ask them to draw such a creature, labeling the body parts. Have them use their imagination. They must be able to explain how the insect's adaptations help it to survive in its habitat.

## *Assessment*

Ask students to:

- ❑ Write a report about the “jobs” performed by macroinvertebrates in a stream’s ecosystem.
- ❑ Describe the physical characteristics an aquatic insect needs to be in a specific functional feeding group.

## *Preparing for the Field Study Station*

- ❑ Familiarize students with station equipment listed in the Resource Specialist section
- ❑ Make copies of the following for each student. Use waterproof paper if available: *Aquatic Insect Survey,* the *River Continuum, Aquatic Insect Life Cycle Stages,* and the illustrations of *Aquatic Invertebrates Tolerant and Sensitive to Water Pollution*
- ❑ *Students must save worksheets for post work!*

# *The River Continuum*

*(minimum 30 minute activity)*

## *Objectives*

Students will be able to:

1) Describe where macroinvertebrates are located in a stream, based on their functional feeding groups
2) Illustrate a stream, from headwaters to the mouth, and identify the vegetation, macroinvertebrates and fish that are likely to be present in various sections

## *Background*

The *geomorphology* of a stream is generally based on precipitation, land forms or geology, and elevation. Land processes, such as floods, *erosion*, earthquakes, etc., cause channels and patterns of channels to develop. Channels (see Riparian Rx section) form into different types or reaches, thus forming different aquatic habitats.

The headwaters of a river or stream contain different features than the lower, wider reaches. Usually, upper reaches are more complex with *riparian* vegetation, substrate, woody debris, and lower temperatures. Aquatic life may differ depending on where they are found in the stream. For example, the headwaters attract more shredders because of the abundance of organic litter. Bull trout, steelhead, spring Chinook salmon, and other cool water fish species often dwell in this habitat. These upper areas are sometimes classified as first or second order streams. Mid reaches generally contain the greatest diversity of species and act as a transition zone, having features from both the upper and lower reaches. Like the headwaters, all four functional feeding groups are typically found here. However, there will be fewer shredders and more of the others. Fish like summer Chinook salmon might also be in this third order section. The lower reach or mainstem river, where the vegetation canopy lessens and sun has a more pronounced effect, grows algae harvested by collectors. Thus, they dominate the area along with northern pikeminnow, white fish, and other slower water fish.

## *Procedure*

1. Make a transparency of *The River Continuum* (Figure 8) and show it to students. Review the functional feeding groups with them. Ask them where the feeding groups are found in the river and why they are there. What fish might be feeding on them? Investigate the macroinvertebrates of a local river and see if their predictions of where the insects are found is correct.

## *Extensions*

❏ Mayflies can be found in more than one location in the stream, working as collectors or scrapers. Other aquatic insects are multi-tasked as well. Form research groups by assigning students to one of four feeding groups. What insects fit into their groups? Study the physical characteristics they have to survive. Give a copy of *The River Continuum* illustration to each group.
Ask students how their insect of study relates to other macroinvertebrates, to fish, vegetation, and to the rest of the environment? Why are some found in slower water and others in faster, more oxygenated water? Report findings to the class.


❏ Data Analysis: Gather data from other schools who participated in the *Kids in the Creek* program on a day when your school was not there. Ask students to compare the information. How many macroinvertebrates did they find? Were they from the same functional feeding groups? If there were differences, why? Was there an event like rain, snow, drought, or debris slides that occurred?

❏ Invite a guest from an organization like Trout Unlimited or a fly fishing club to discuss aquatic macroinvertebrates from the perspective of an angler. Ask them to demonstrate the art of tying flies and explain the thinking behind the designs. Some angling organizations have videotapes to share on various topics relating to the aquatic environment.

## *Extensions* *continued*

- ❏ Have students analyze the *The Case of the Skink River* scenario found in the student section and answer the questions. Clues for you are:
  - Carp, black flies, and aquatic beetles are very tolerant species.
  - Water should be tested at several different reaches of Catkin Creek (the tributary) and the Skink River.
  - Tests must include dissolved oxygen and pH and should include water chemistry analysis.
  - Fish must be sampled for lab analysis.
  - Loss of aquatic life is due to depleted levels of dissolved oxygen and hydrogen sulfide poisoning (rotten eggs).
  - Remind students that looking back on what they learned during Kids in the Creek will be helpful during their investigation.

## *Assessment*

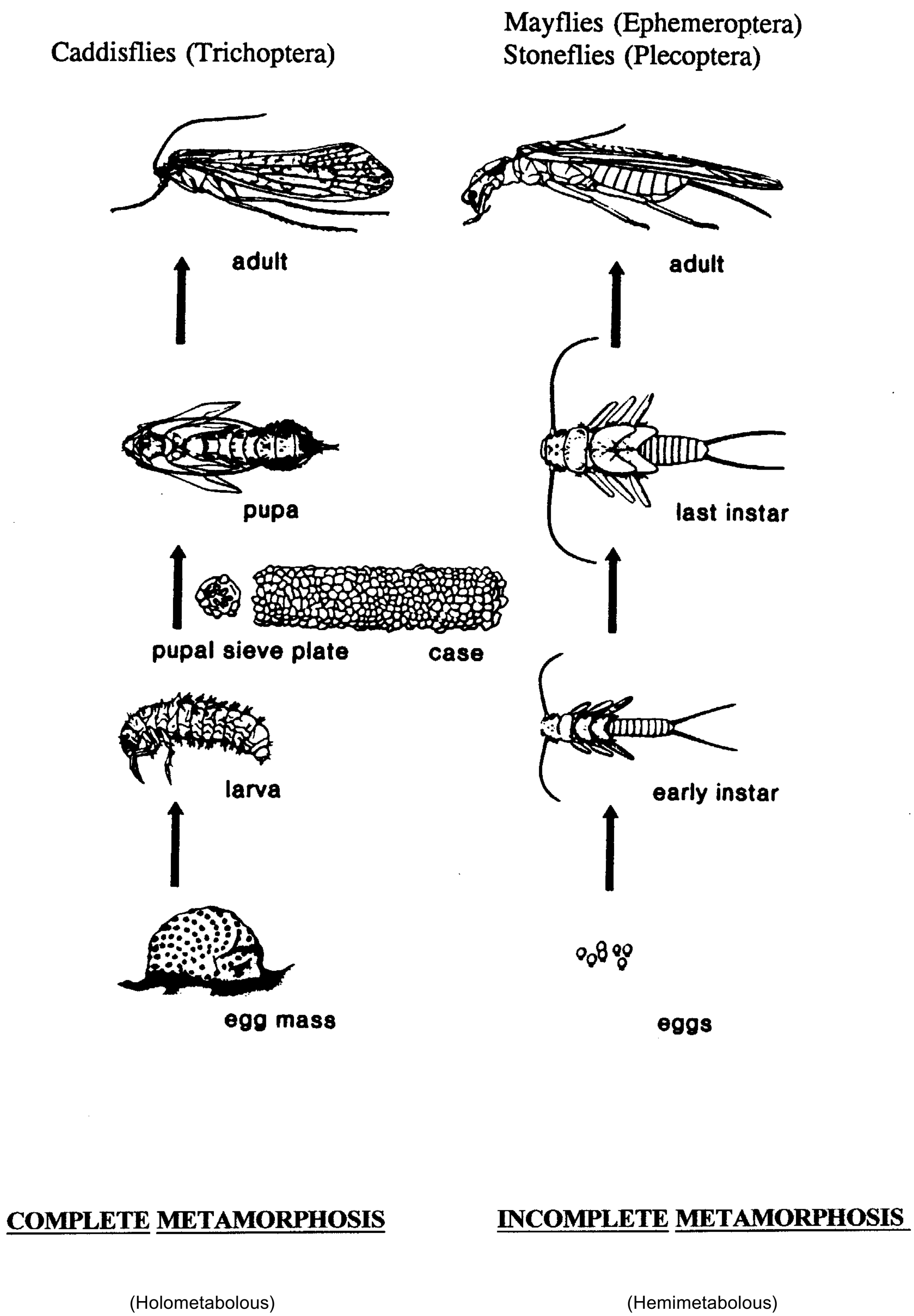
- ❏ Ask students to analyze data collected from the *Kids in the Creek* field study by adding up how many macroinvertebrates from each functional feeding group were found. What do these insects eat? What anatomical adaptations are required to survive in each category? What are the anatomical differences between scrapers, collectors, shredders and predators? Distribute *The River Continuum* sheet provided, and have students label where the macroinvertebrates were found. Species investigated during *Kids the Creek* must be included in the assignment. Is the study creek healthy or unhealthy and why?

- ❏ Using the *Key to Immature Aquatic Insects* (Figure 2), ask students to identify the stage of development for selected insects and their names (block out names on the sheet). Students then may describe the level of tolerance to environmental changes for each insect.

- ❏ Draw a cross section of the river, showing where specific insects may be found. Explain what aquatic insects contribute to the ecosystem.

- ❏ Assess answers written by students relating to this section in the *Kids in the Creek Scavenger Hunt.*

# *Aquatic Invertebrate Life Cycle Stages*




Source: Rob Plotnikiff, Ambient Monitoring Section, Washington Dept. of Ecology

Figure 1.

# *Key to Immature Aquatic Insects or Invertebrates*

**Things you should know before using this key.**

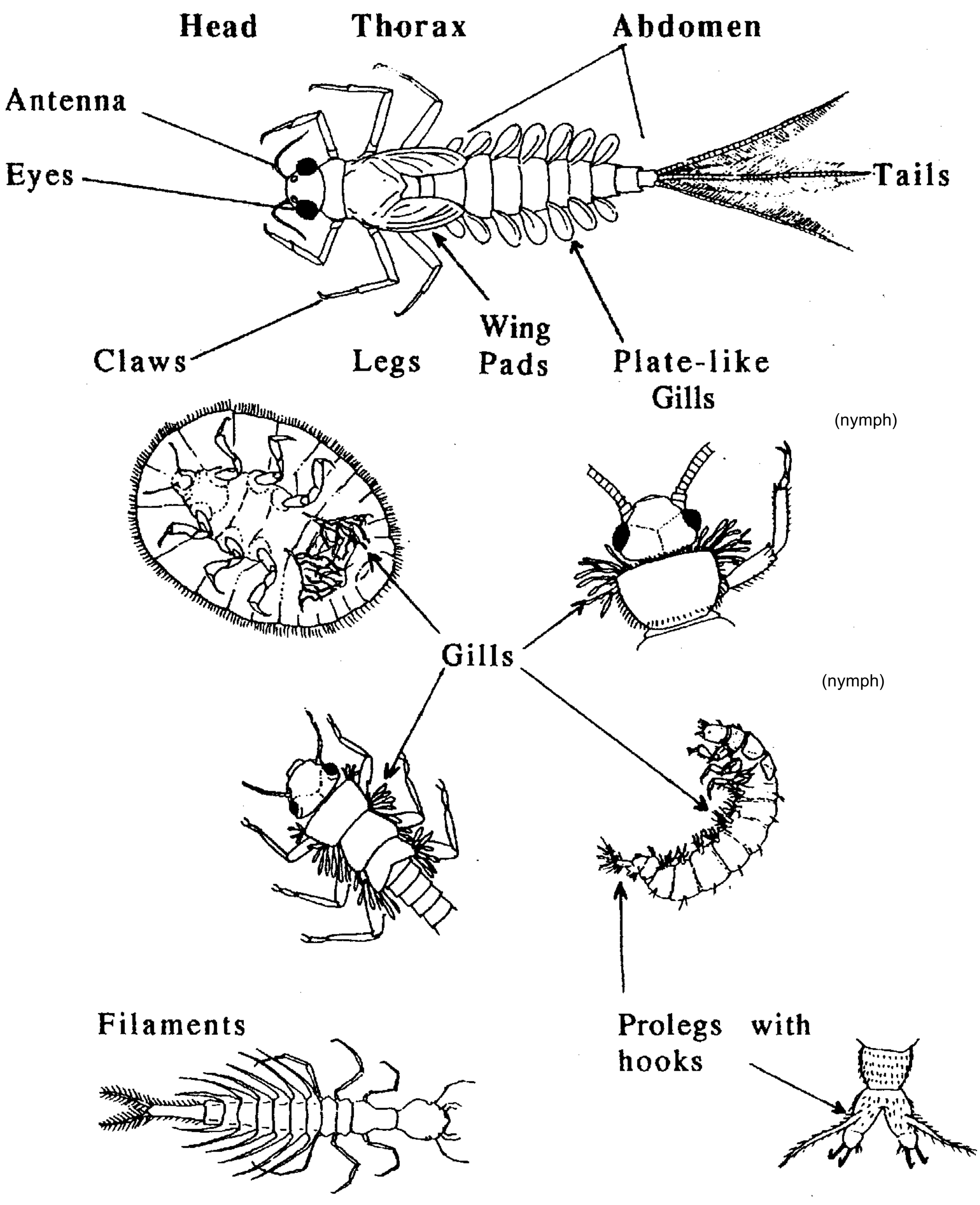



Figure 2. Key to Immature Aquatic Insects. Klamath River Education Program ©1992.

# A KEY TO IMMATURE AQUATIC INVERTEBRATES - Page 1

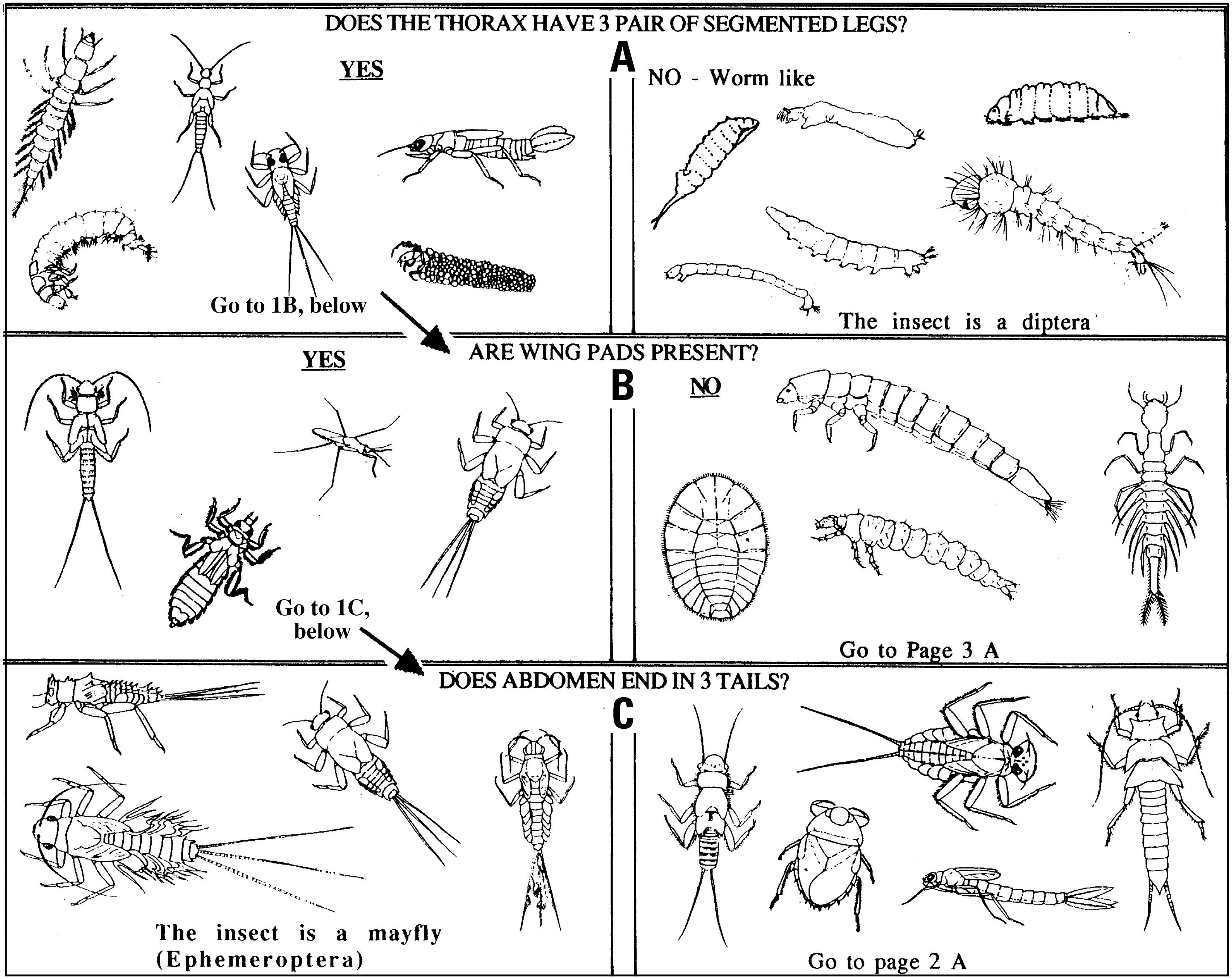
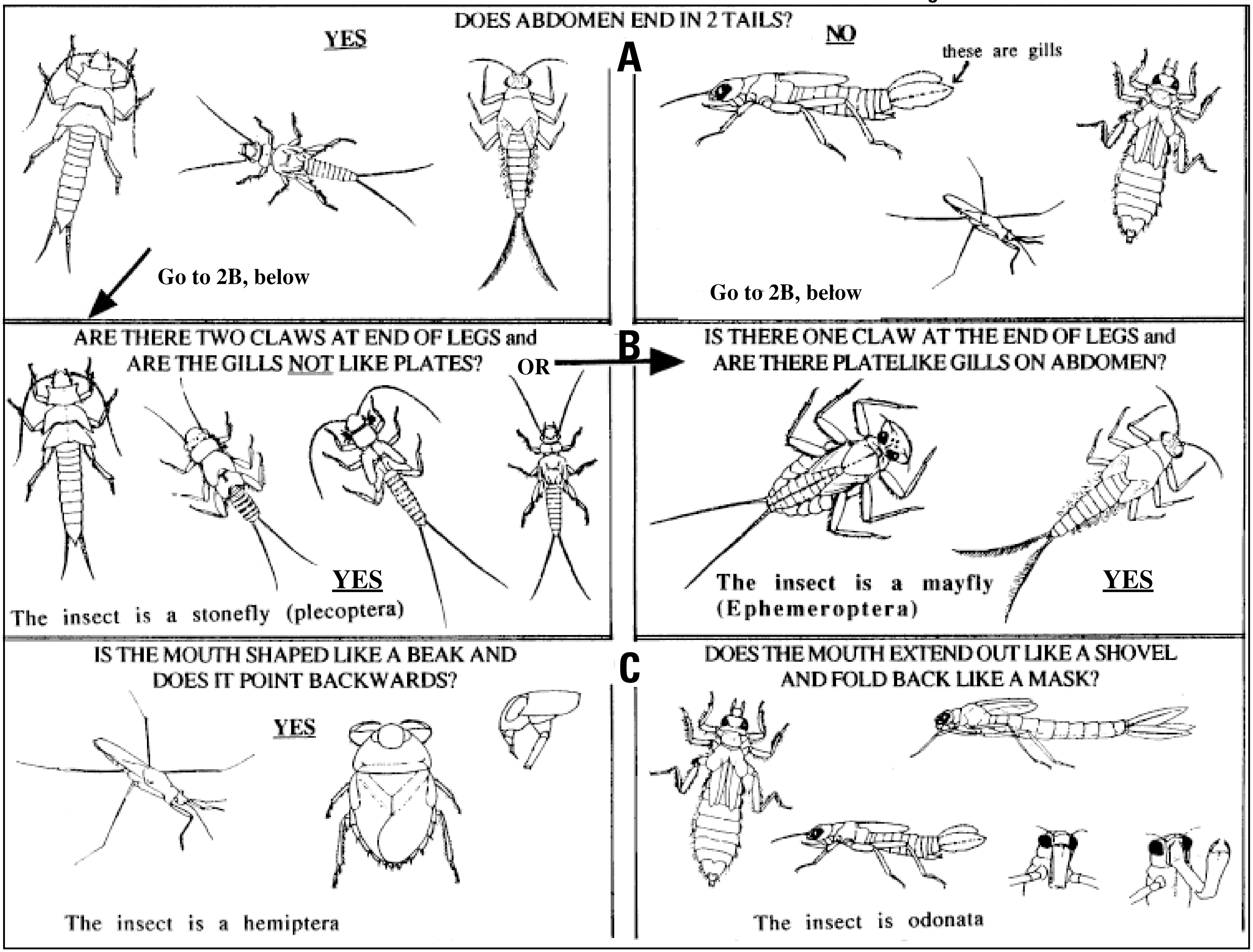



Figure 2., Continued / Klamath River Educational Program ©1992

# A Key to Immature Aquatic Invertebrates - Page 2

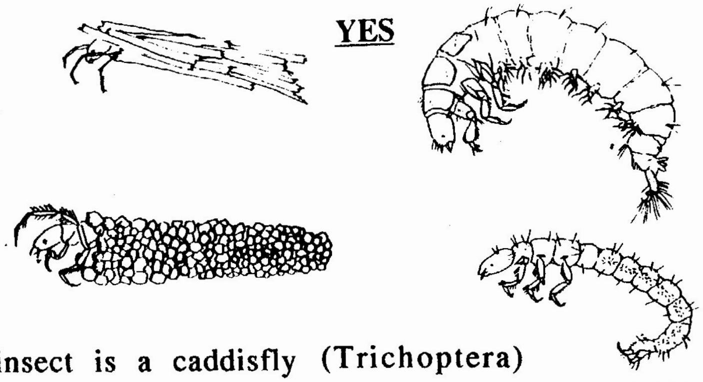


# A KEY TO IMMATURE AQUATIC INVERTEBRATES - Page 3

## A

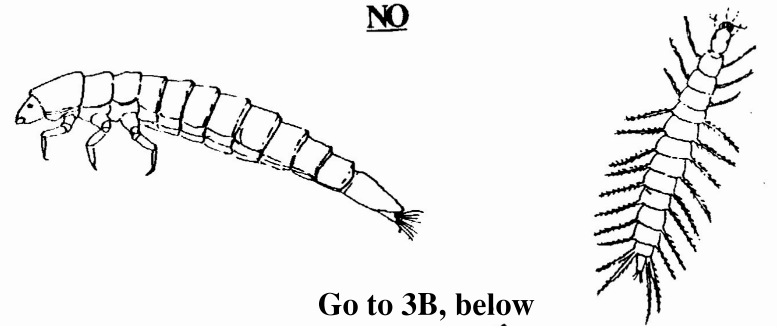
DOES ABDOMEN END IN PAIR OF CLAWS or IS INSECT INSIDE A CASE?

**YES**



The insect is a caddisfly (Trichoptera)

**NO**

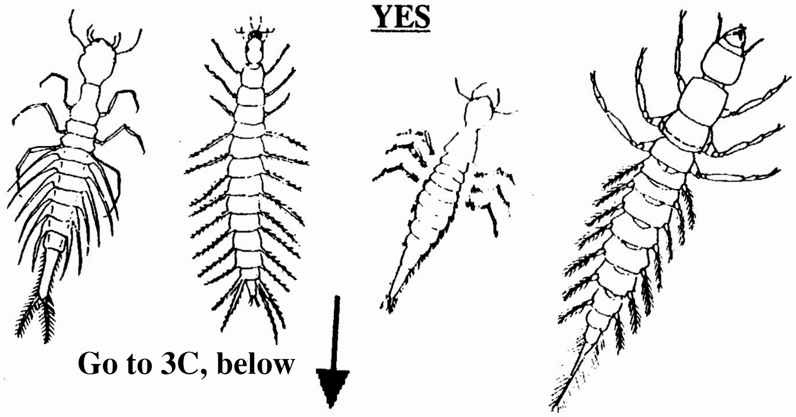


Go to 3B, below

## B

ARE THERE MANY FILAMENTS ON THE SIDES OF THE ABDOMEN?

**YES**



Go to 3C, below

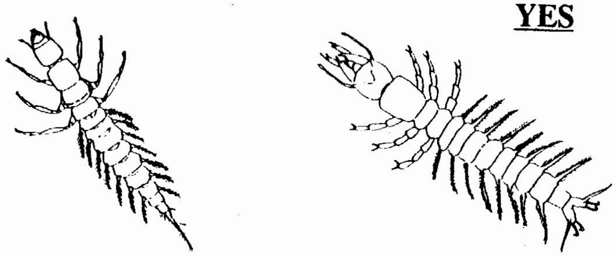
**NO**


The insect is a Coleoptera

## C

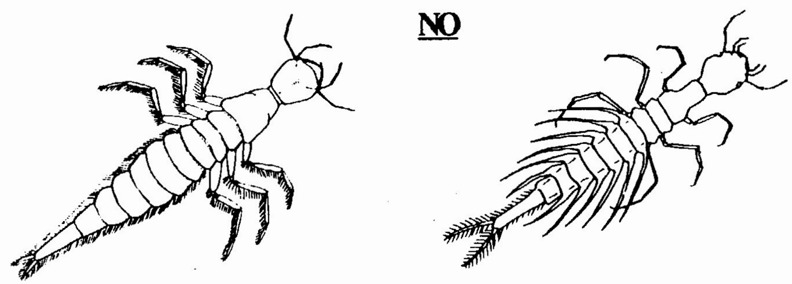
DOES ABDOMEN END IN ONE LONG, SLENDER TAIL or IN A PAIR OF PROLEGS, EACH WITH A PAIR OF HOOKS?

**YES**



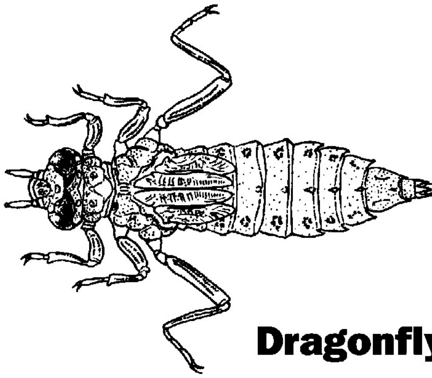
The insect is a megaloptera

**NO**



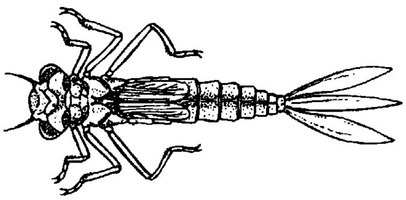
The insect is a coleoptera

# IDENTIFICATION LABELS

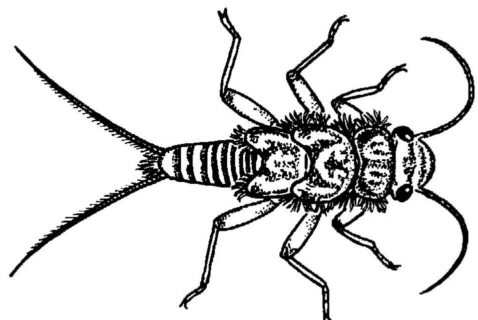


**Dragonfly Nymph**

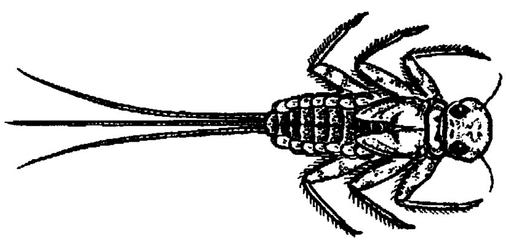
**Caddisfly Larva**



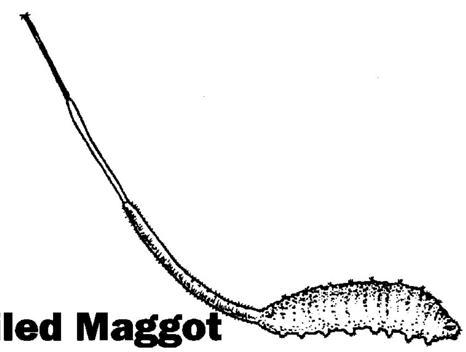
**Damselfly Nymph**



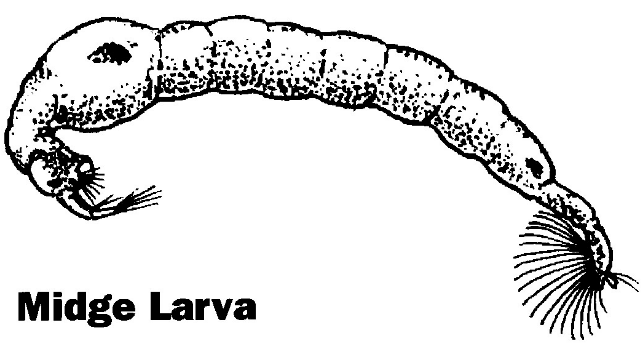
**Stonefly Nymph**



**Mayfly Nymph**



**Rat-tailed Maggot**



**Midge Larva**

**Environmental Stressor**

ILLUSTRATION OF MACROINVERTEBRATES USED WITH PERMISSION OF THE ARTIST, TAMARA SAYRE.



Figure 3.
Macroinvertebrate Mayhem
Invertebrates

# AQUATIC INVERTEBRATES THAT ARE GENERALLY TOLERANT OF WATER POLLUTION

(found commonly in pool or depositional areas of streams or rivers)

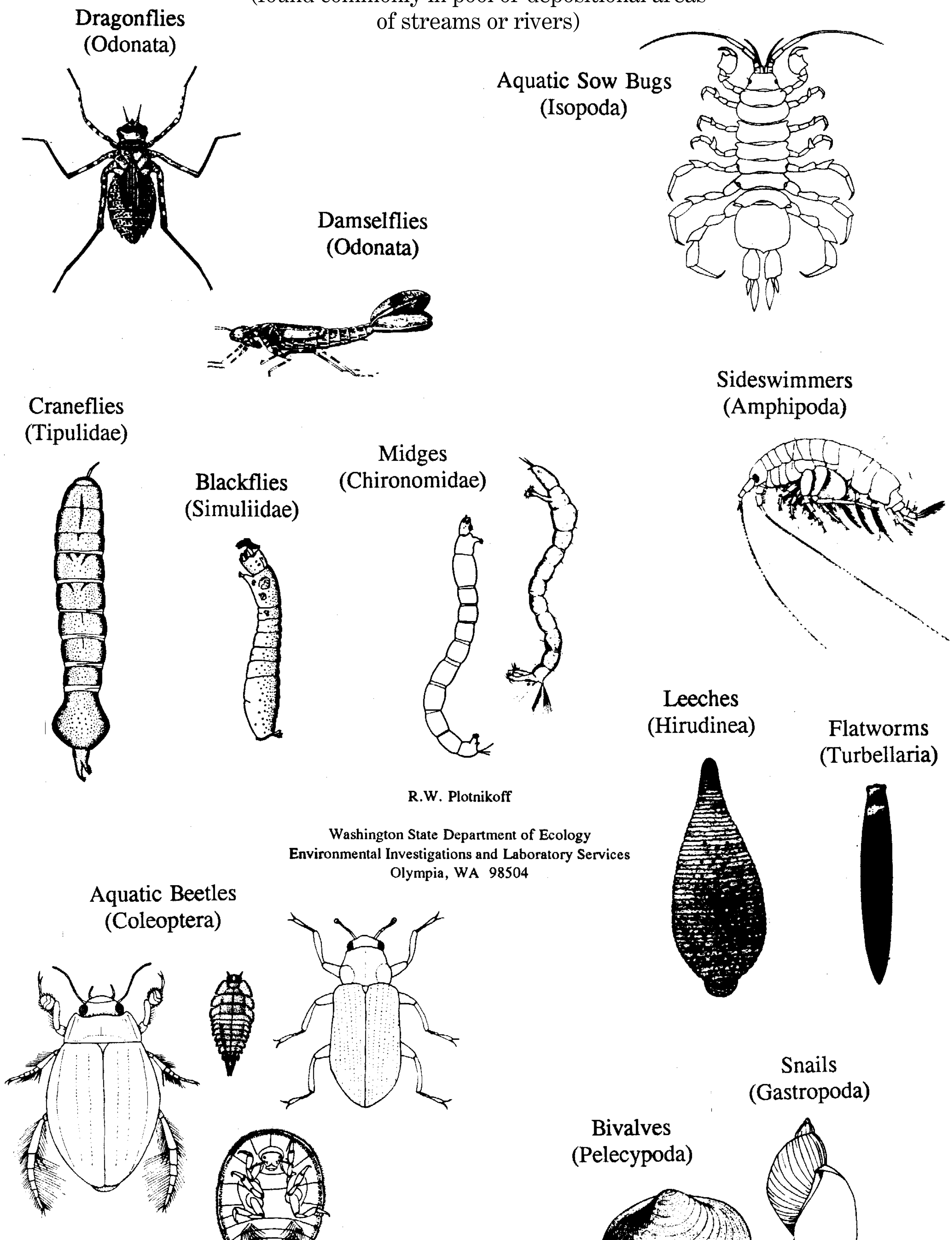



Figure 4.
Aquatic Invertebrates Tolerant
to Water Pollution.
Klamath River Educational Program @1992

# Aquatic Invertebrates That Are Generally Sensitive to Water Pollution

(found commonly in moderate to fast running areas of streams or rivers)

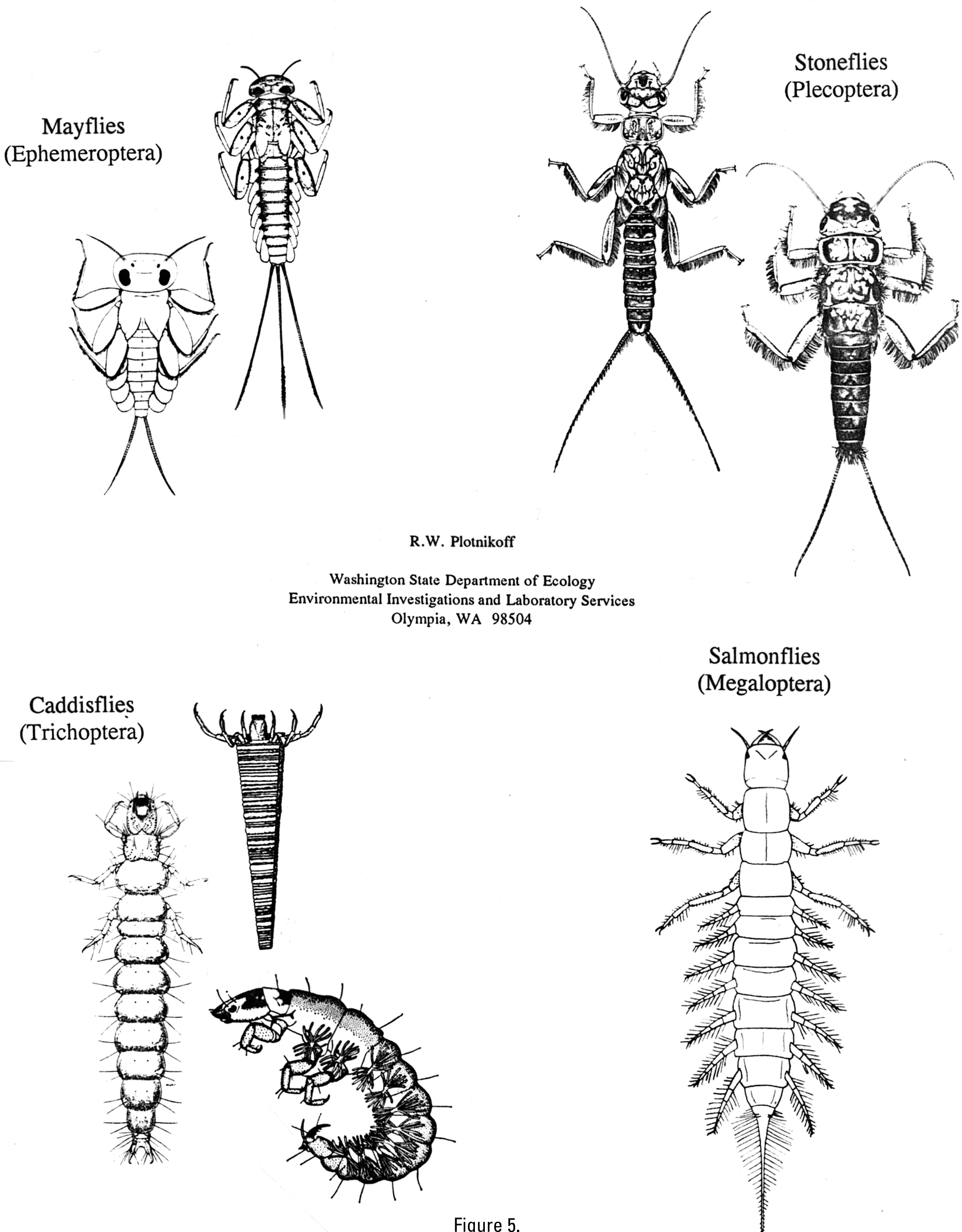



Figure 5.
Aquatic Invertebrates Sensitive to Water Pollution.
Klamath River Educational Program @1992

# Mayfly External Anatomy

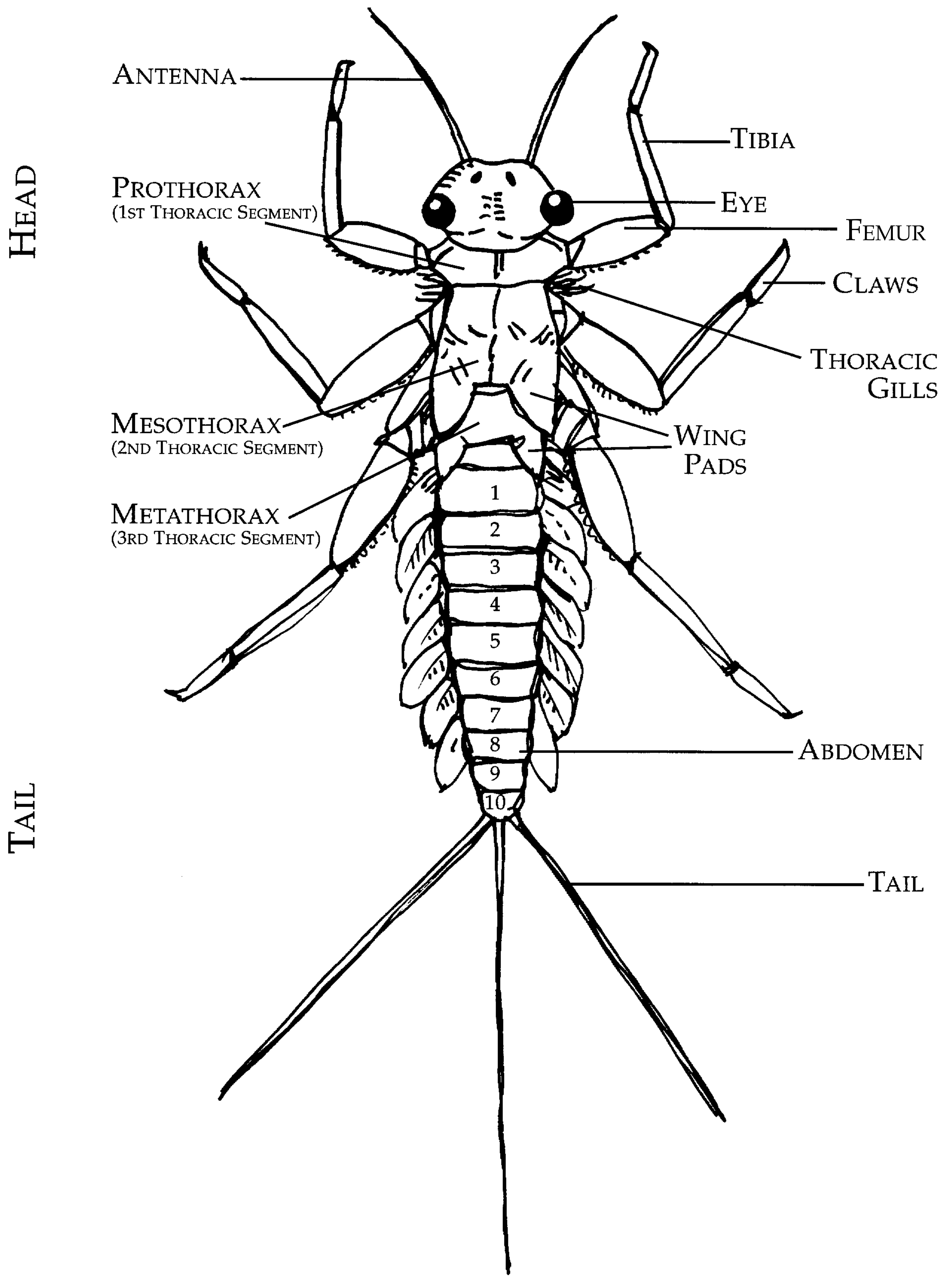
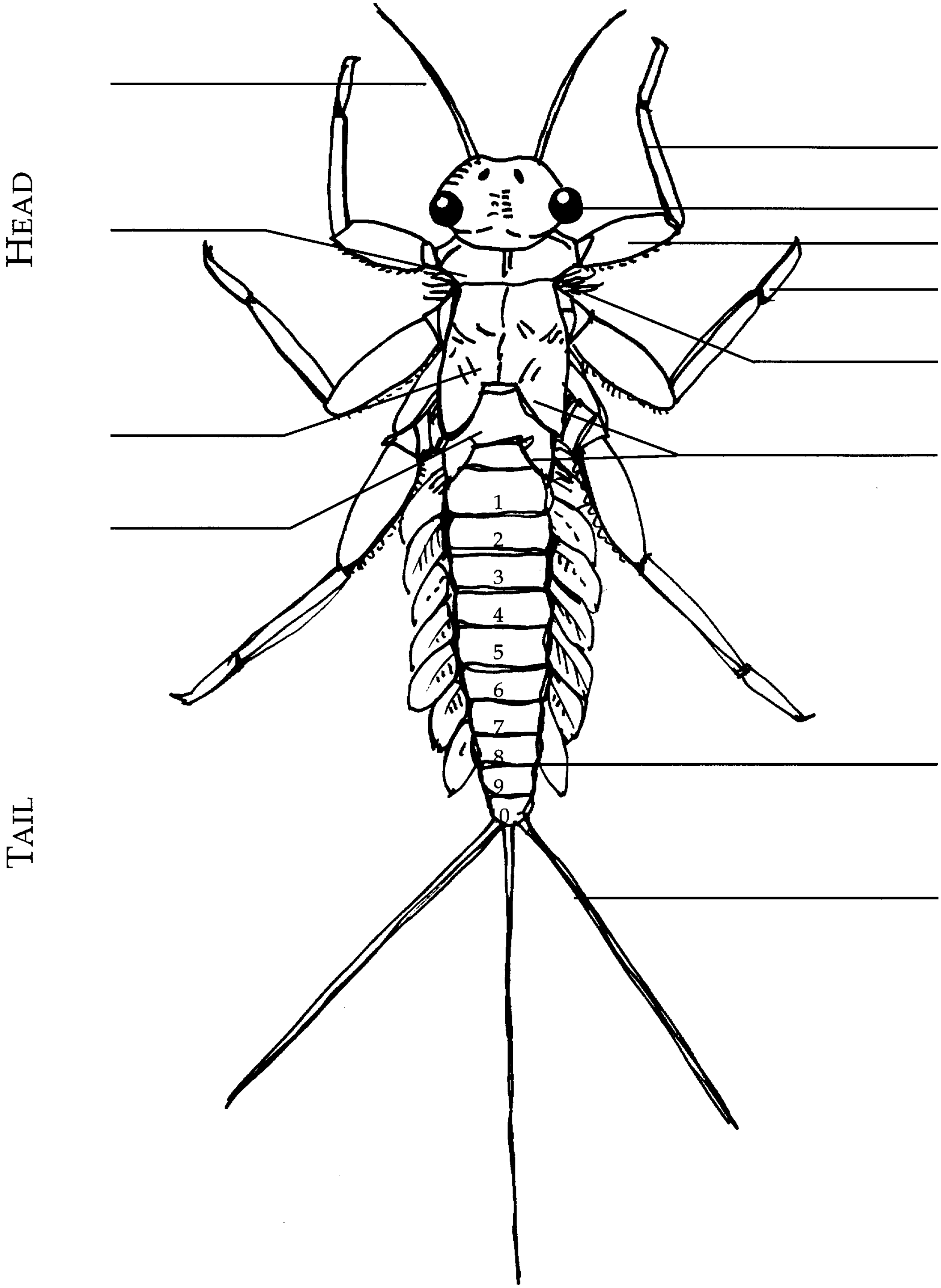



Figure 6. Mayfly External Anatomy / Klamath River Educational Program @1992

# Mayfly External Anatomy




Name ________________________________________

Figure 6A. Mayfly External Anatomy / Klamath River Educational Program @1992

# Food Processing in Streams

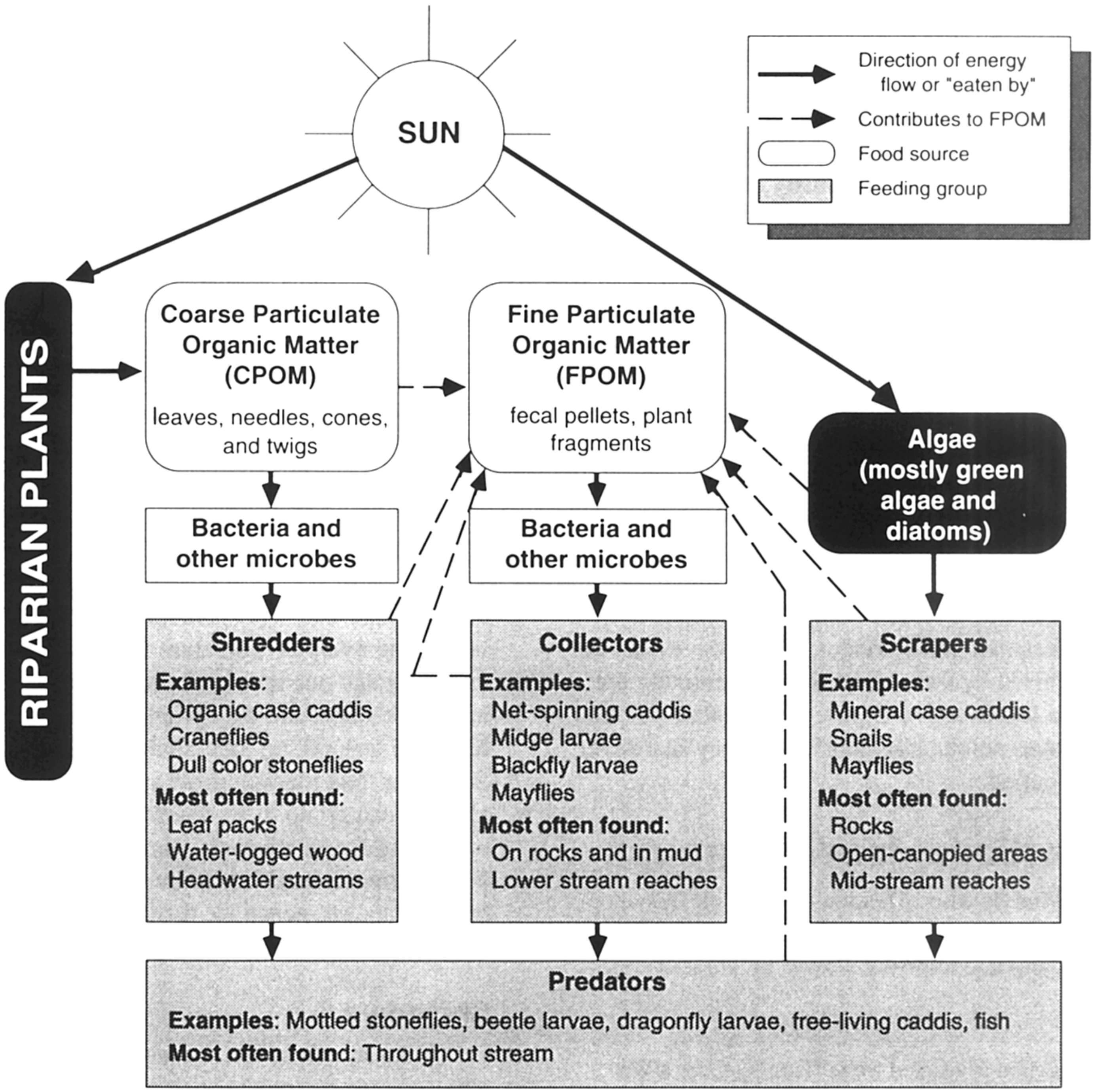
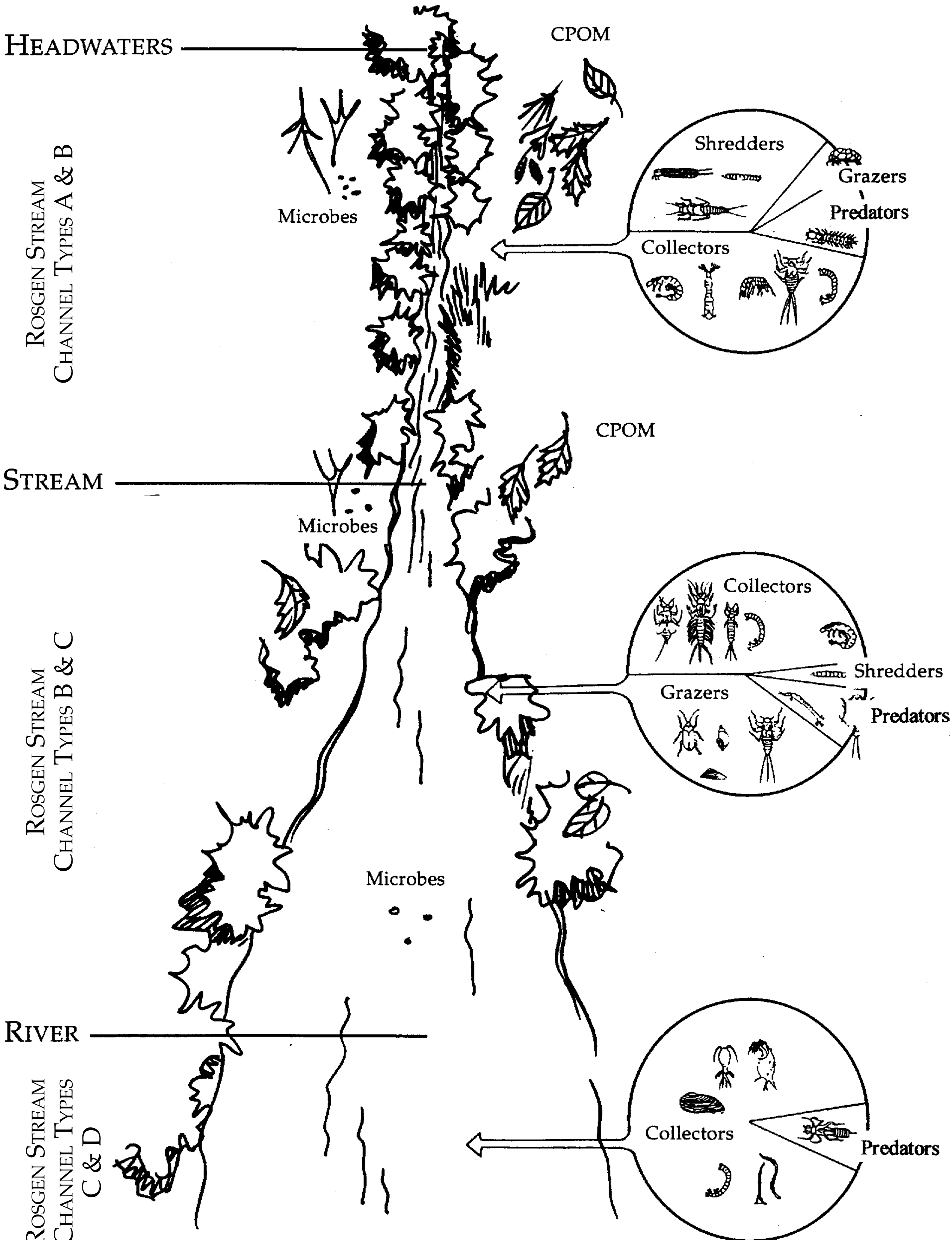



Figure 7. Food Processing In Streams
Adapted from: Ken Cummins, "From Headwater Streams to Rivers," American Biology Teacher, May 1977, p. 307

# The River Continuum




CPOM = Coarse Particulate Organic Matter
Figure 8. The River Continuum
Adapted with permission . . .

# Student Section

## Aquatic Invertebrate Survey

Name ____________________________________________

River or Creek _____________________ Date____________

KEEP A RECORD OF EACH TYPE OF ORGANISM YOU FIND IN YOUR SEARCH.

- ❏ Observe and record the descriptive features of the invertebrate you are investigating.
- ❏ Determine if they are tolerant or intolerant to pollution; note the number of each found and its habitat (pool, riffle, glide).
- ❏ Note the stage of development of the macroinvertebrate you find: adult, nymph or larva.
- ❏ To what functional feeding group does it belong? Shredder, collector, scraper, or predator? Look closely at anatomical adaptations for clues.
- ❏ Use the handouts provided by your teacher to help with some of the answers.

| COMMON NAME | TOLERANT/INTOLERANT & Habitat Each was Found | STAGE OF DEVELOPMENT | FUNCTIONAL FEEDING GROUP |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Total __________ | Totals<br>Intolerant:<br>Intolerant habitats:<br>Tolerant:<br>Tolerant habitats: | Totals<br>Nymphs:<br>Larvae:<br>Adults: | Totals<br>Scrapers:<br>Shredders:<br>Collectors:<br>Predators: |

Adapted from: *A Look at the Salmon's Environment*, Bonneville Power Administration.

## The Case of the Skink River

Catkin Creek, tributary to the meandering and slow Skink River, has a steeply graded watershed at the upper end, and a large wood processing plant and several retail farm and garden chemical stores at the lower end. In August, there was a partial kill of fish and aquatic insects in the Skink River. When investigators arrived at 11:00 a.m., many carp were seen swimming about at the surface, but all other fish seen were dead. Closer observation revealed live black fly larvae and aquatic beetles, but no other macroinvertebrates.
The water had been dark green earlier in the week, but had suddenly turned dark and odorous. On the preceding day, a heavy rain fell in the area. The city, whose drinking water comes partially from the river, was concerned that a toxic substance might have washed into the waterway from the chemical companies or the wood processing plant. They hired water specialists to take steps necessary to identify the compound. At 1:00 p.m., the dissolved oxygen was 2 ppm. The river level had risen after the rain and there was a strong odor of rotten eggs.

*What initial conclusions can be reached after reading the above scenario?*

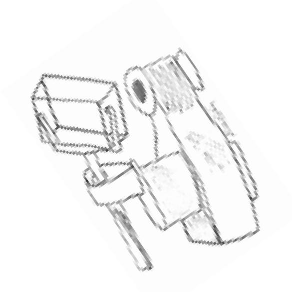
*What steps should an investigator take to learn what happened?*

*What tests should be taken to ascertain how the aquatic ecosystem was affected (remember what you learned at Kids in the Creek)?*

**The lab and field work produced these results**:

- When the carp were picked up, aneurysms were evident on the gills. In many fish, the gills were chocolate brown instead of bright red.
- Water samples showed high levels of hydrogen sulfide, CO2, nitrites, and nitrates.
- Blood samples were highly acidic.
- Upper reaches of the tributary had caddisflies and mayflies, while lower areas did not.

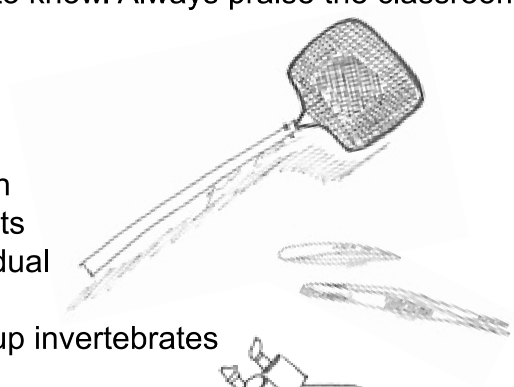
*What are your final conclusions?  Use the back of the page if necessary.*



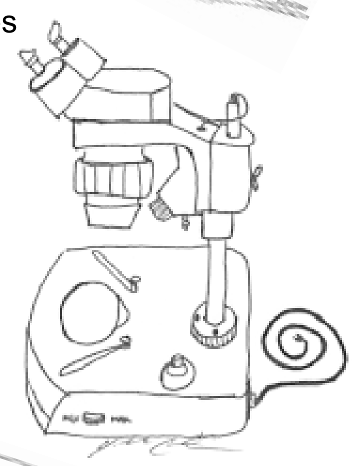
# Resource Specialist Section

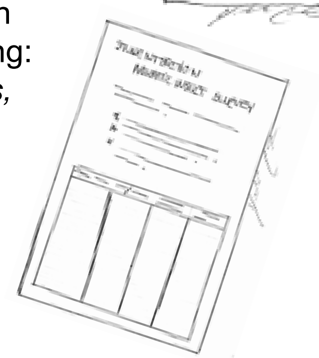
1. Review *Tips and Tricks for Resource Specialists* in the Appendix.

2. Read the entire Invert Investigator section to become familiar with the pre-work. This will give you an idea as to what the student is expected to know. Always praise the classroom teacher for prepared and attentive students!



3. A checklist of equipment necessary for this station:
   - ❑ Kick net or D-frame net for collecting
   - ❑ Enamel or plexiglass shallow pan durable enough to sit on rocks; used for holding and sorting insects
   - ❑ Aluminum or plastic containers suitable for individual student insect collection
   - ❑ Forceps, tweezers, or plastic spoons for picking up invertebrates
   - ❑ Hand lenses or field hand microscopes
   - ❑ Larger lab microscope for outdoor use; magnifying boxes and Discover-scopes are also helpful
   - ❑ Petri dishes used with above microscope
   - ❑ Laminated copies of the *Key to Immature Aquatic Insect Invertebrates* (see Teacher section)
   - ❑ Hip or chest waders for you and students; chest waders are preferred in the spring
   - ❑ Table(s) for study equipment
   - ❑ *Aquatic Insect Survey* forms; teachers have been asked to provide these ( you might have some extra copies on write-in-the-rain or regular paper) and handouts showing: *The River Continuum, Aquatic Insect Life Cycle Stages,* and *Aquatic Invertebrates Tolerant and Sensitive of Water Pollution* (See Teacher Section)





4. Procedure
   After your introduction, divide students into small groups; each resource specialist takes one group.

   Distribute equipment. Each group should have a kick net, one large shallow pan to hold the group's insects and two smaller containers for individual collections from rocks/vegetation.

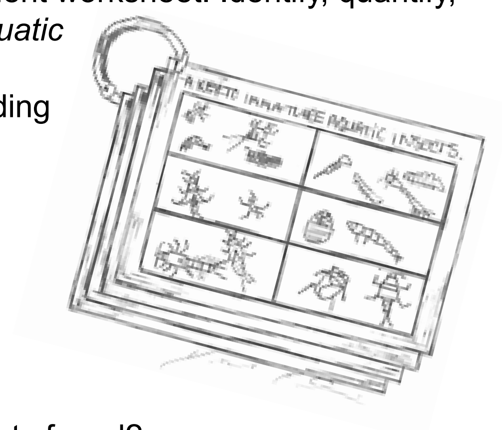
   If the habitat allows, one group should look for insects in a riffle, and the other explore a pool or glide to compare the richness of insects in each habitat.

   Get them in the water right away! This is *student directed learning*. The instructor becomes the guide rather than the informer. Be part of the experience to answer questions and keep students on the right track.

*While in the water ask:*

- ❑ In which habitat (pool, riffle, glide) will you find the most invertebrates?
- ❑ What will the differences be between the invertebrates found in each habitat?
- ❑ Where are you finding them (substrate, vegetation, woody debris)?
- ❑ What functions are the macroinvertebrates serving there?
- ❑ What is the connection between riparian vegetation and macro-invertebrates?
- ❑ What is the connection between stream size and channel type and macroinvertebrates?
- ❑ What role does poor water quality play in the number of species and number of macroinvertebrates you might observe?

- ❑ When enough aquatic invertebrates have been collected, take the specimens and students back to the tables.
- ❑ Pair up students, each pair with an insect key and student worksheet. Identify, quantify, and classify, using worksheet and *Key to Immature Aquatic Insects*, magnifying lenses and microscope.
- ❑ Students divide macroinvertebrates into functional feeding and water quality tolerant/intolerant groupings.




In the final **15 minutes**, reconvene and discuss findings.

- ✓ Where were most insects found?
- ✓ What functional feeding group was most represented?
- ✓ How many insects fell into each tolerance level group?
- ✓ From what channel type were most of the aquatic insects found?
- ✓ What living conditions do sensitive macroinvertebrates require?
- ✓ How would you rate the water quality of this stream from 1-10?
- ✓ What fish and other wildlife prey on them?
- ✓ What stage of development was most prevalent?
- ✓ What role do aquatic insects play and how do they contribute to the ecosystem?
- ✓ How will warm water or highly sedimented streams affect the variety of species and their populations?
- ✓ What is the role of geomorphology in aquatic habitat (see Habitat Sense, What's in that H20?, and Riparian Rx)?