AQUATIC MACROINVERTEBRATES FIELD STUDY

Objectives: Students will understand the importance and roles of macroinvertebrates in the aquatic ecosystem by:
1) collecting macroinvertebrates from different instream microhabitats. (if present)
2) counting, and recording invertebrates from each habitat. (if present) (data form is available at the end of this section and in the Field Trip Data Forms section)
3) analyzing the data to determine the health of the stream. (in accordance with background materials)

Teaching Tips
Get students focused with introductions.

Review safety guidelines and site protocols:

- Macroinvertebrate sampling should be conducted well away from and downstream from spawning salmon and redds.
- No more than four students per teaching station in the stream/river at a time.
- In water above the knees, all participates are required to wear life vests.
- Avoid fast-moving water.
- Take care when walking on slippery rocks.
- Never drink the water – it could make you sick

Briefly describe the activity.

Model in-stream collecting techniques.

Divide the students into teams for each activity: collecting, sorting, identifying, etc. Insects can be divided by order (broad categories mayfly, stonefly, caddisfly, other groups).

Use field guides and cards to determine insect types.

Tolerant/Intolerant to Pollution cards can be passed out for de-brief/wrap up.

Materials:
D-frame nets or kicknets
Large shallow pans for sorting
Ice cube trays for specific sorting
Hand lens or 2-Way Magnifying Viewer
Forceps, brushes, turkey basters, eye droppers for picking up invertebrates
Guide to Pacific Northwest Aquatic Invertebrates *Second Edition*
Pollution tolerance group key
Tolerant/Intolerant to Pollution Macro Cards
Clipboard, data sheets, pencils
Rubber knee boots or hip boots (NECESSARY to collect insects)
The Macroinvertebrate Sampling Data Form; can be found at the end of this section and in the Field Trip Data Forms section of the binder.

Procedure:

1. Review safety procedures.
2. Identify the microhabitat(s), i.e. riffle, pool, glide, backwater, to be sampled.
3. Collect a sample from a 1-square-foot area immediately upstream from the net opening. To do this, approach site from downstream. Hold net downstream from area to be sampled, perpendicular to flow. Upstream, begin rubbing rocks, stocks or other leaf litter to remove any invertebrates. The invertebrates should flow into the net. Replace the rocks.
4. Repeat in up to **3 other locations** if necessary. (5 minutes at each location)
5. Remove net contents into a large shallow tray for sorting into groups in ice cube trays.
   Tip: It can help to use the analogy of a zoo when discussing the reasoning for sorting. In the zoo all animals are not in the same cage. You wouldn't see a lion in the same cage as an elephant; therefore we do our best to put all the mayflies with the mayflies and caddis flies with the caddis flies.
6. Count the different kinds of invertebrates and numbers of each kind for each of the four functional feeding groups. Use the field guides to help with identification.
7. Macros can also be sorted by habitat type or where found in the stream.
8. Record these numbers on the data sheets provided by the teacher.
9. If time allows students can sketch, label, and describe their favorite macro, how they move, feeding habits, breathing adaptations, etc.
10. Gently return macroinvertebrates to the stream.

For Discussion/wrap up:

Determine the health of the stream by the number and variety of insects found. Use the tolerant/intolerant insect group cards provided. Which group best reflects the insect community found in the stream sampled?

Habitat Requirements Questions

What species are you more likely to find in moving water? Calmer water?
Which particular nymph type (immature form) is only found in fast, cold water?
Why might one insect need less dissolved oxygen than another?
Why is there more dissolved oxygen in a fast flowing stream than in a pond?

Macroinvertebrates and Water Quality

Why are macroinvertebrates good indicators of water quality?
What area of the stream may contain the most diverse assemblage of insects?
What species would be more likely found in stagnant areas with more fine sediments?
What kind of links on the food chain are filled by aquatic insects? herbivores, carnivores, detritivores (insects that eat dead stuff)

What can you do?

What measures can be taken to protect a stream with healthy macroinvertebrate populations that supports salmonids?

What measures can be taken to help restore a system that has been degraded and has lost the diversity of insects that are part of a healthy watershed for fish?

Macroinvertebrates and the Aquatic Food Web

Macroinvertebrates are critically important in the aquatic food web. Some serve directly as food for predators such as fish, amphibians, birds, and other invertebrates; others help make more food available in the aquatic system by breaking down leaves and plant material. Fish populations depend on healthy macroinvertebrate populations to survive. The availability of macroinvertebrates as food is determined by both the physical and biological condition of the stream.

Macroinvertebrates have a wide variety of shapes, sizes, appearances, and mouthparts, and this diversity reflects a diversity of feeding habits as well. Macroinvertebrates may feed on living material (algae, plants, or other invertebrates), as well as on dead or decomposing material and particles of organic detritus, and they are often classified according to the way in which they obtain nutrients. The major different functional feeding groups (FFG) are shredders, collectors, scraper/grazers, and predators. These distinctions are somewhat artificial, as some may fit into more than one category (i.e. scrapers may eat detritus while they graze on algae), but they are still a valuable method of classifying the stream macroinvertebrate community. By looking at the feeding habits of these invertebrates, you can begin to sort out different roles these animals play in the ecology of watersheds. The main categories of functional feeding groups include:

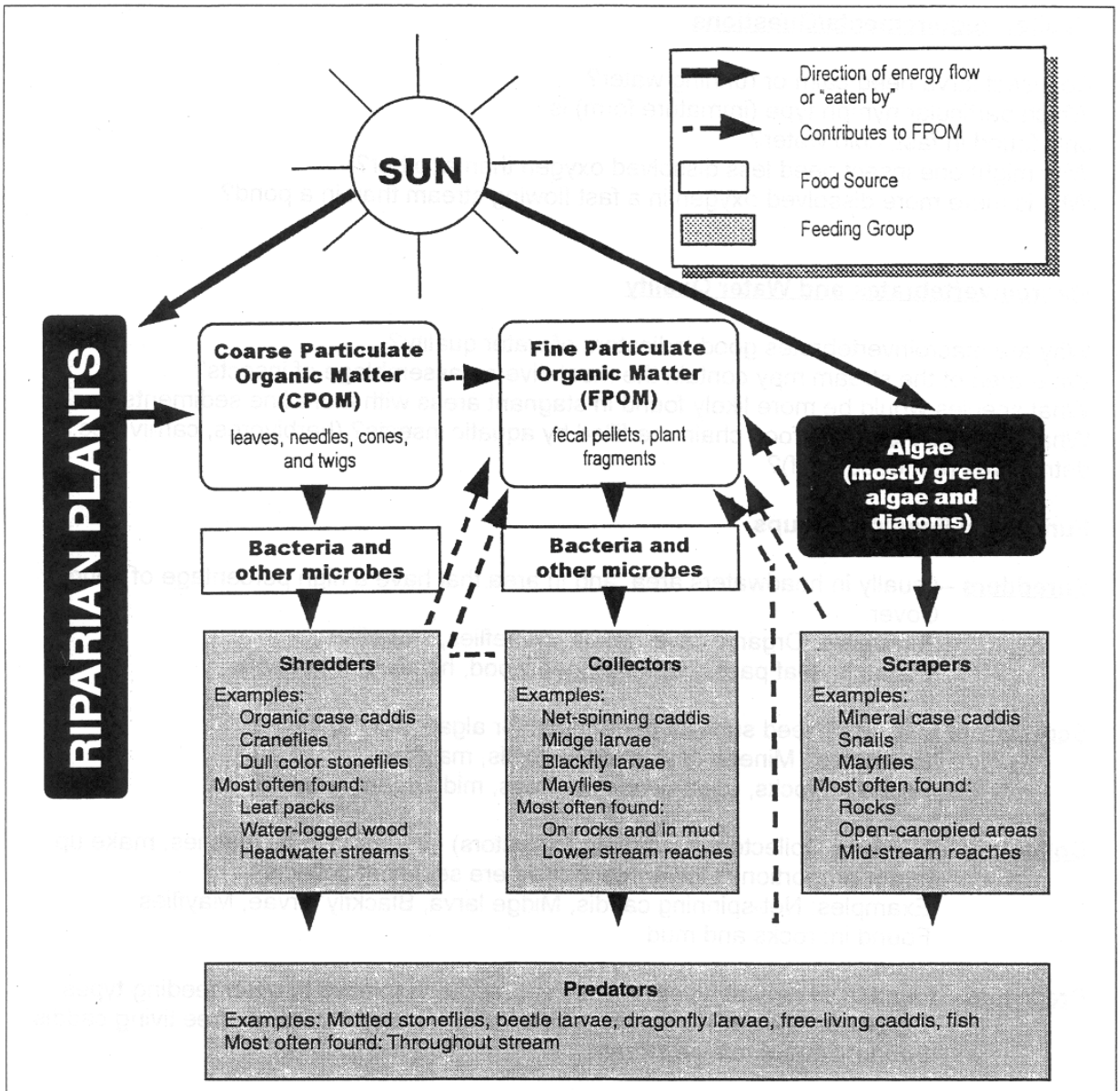
Shredders:
Chew on intact or large pieces (>1 mm) of plant material
Usually found in headwaters and areas with a high percentage of canopy cover
Examples: giant stoneflies, Northern caddisflies
Found in: leaf packs, water-logged wood, headwater streams

Scrapers/grazers:
scrape off and consume thin layer of algae growing on solid substrates in shallower waters
Examples: snails, flatheaded mayflies, water pennies
Found in: more open areas with enough sunlight to support algal growth; rocks in open- canopied areas, mid-stream reaches

Collectors (collector/filterers and collector/gatherers):
consume very small pieces of detritus (<1 mm)
Examples: common netspinner caddisflies, back flies, brush-legged mayflies, mussels
Found in: rocks and mud; common in all reaches, but make up larger proportion in lower reaches where sediment collects

Predators:
feed on living animals; may swallow smaller prey whole, tear pieces out of larger prey, or suck out body fluids
Examples: predaceous diving beetles, dragonfly larvae, common stoneflies
Found in: all habitat types, in smaller proportion relative to other feeding groups

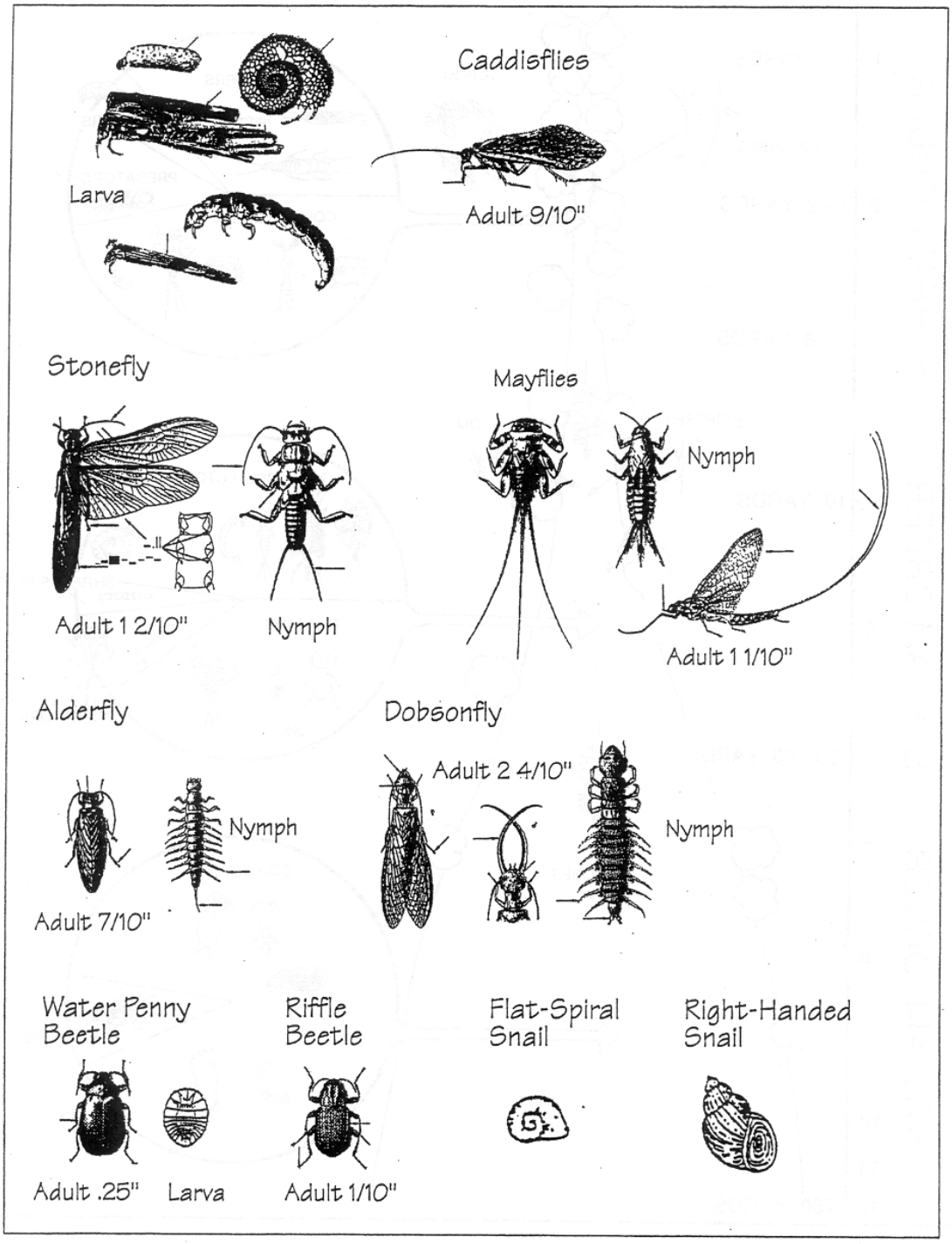
Pathways of energy from the sun to the four main macroinvertebrate groups. Some scientists add salmon carcasses as another source of energy.



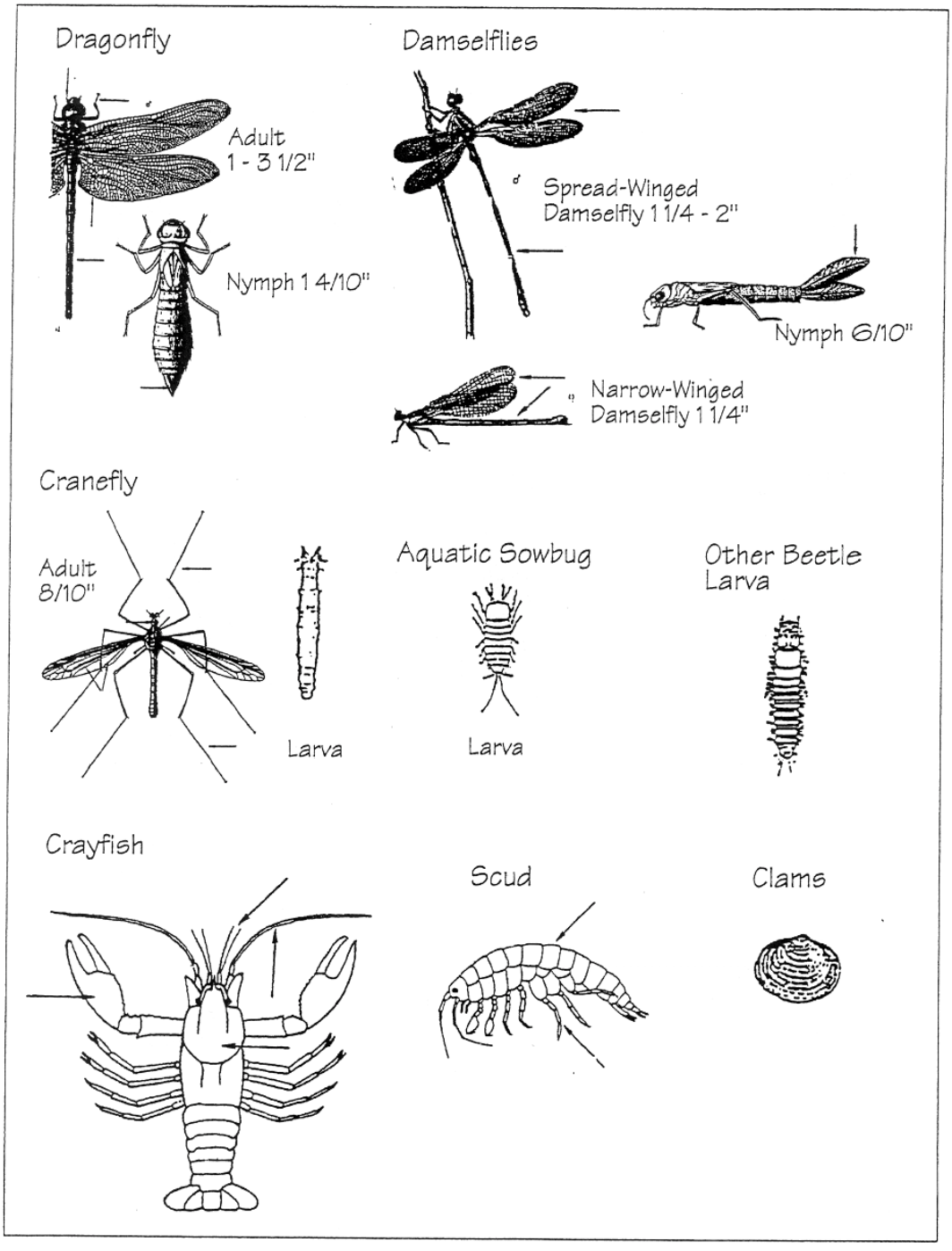
Food processing in streams. (*Adopted from ""From Headwater Streams to Rivers," by Ken Cummins, American Biology Teacher, May 1977, p. 307*)

INSECT GROUPS ARRANGED BY TOLERANCE TO POLLUTION

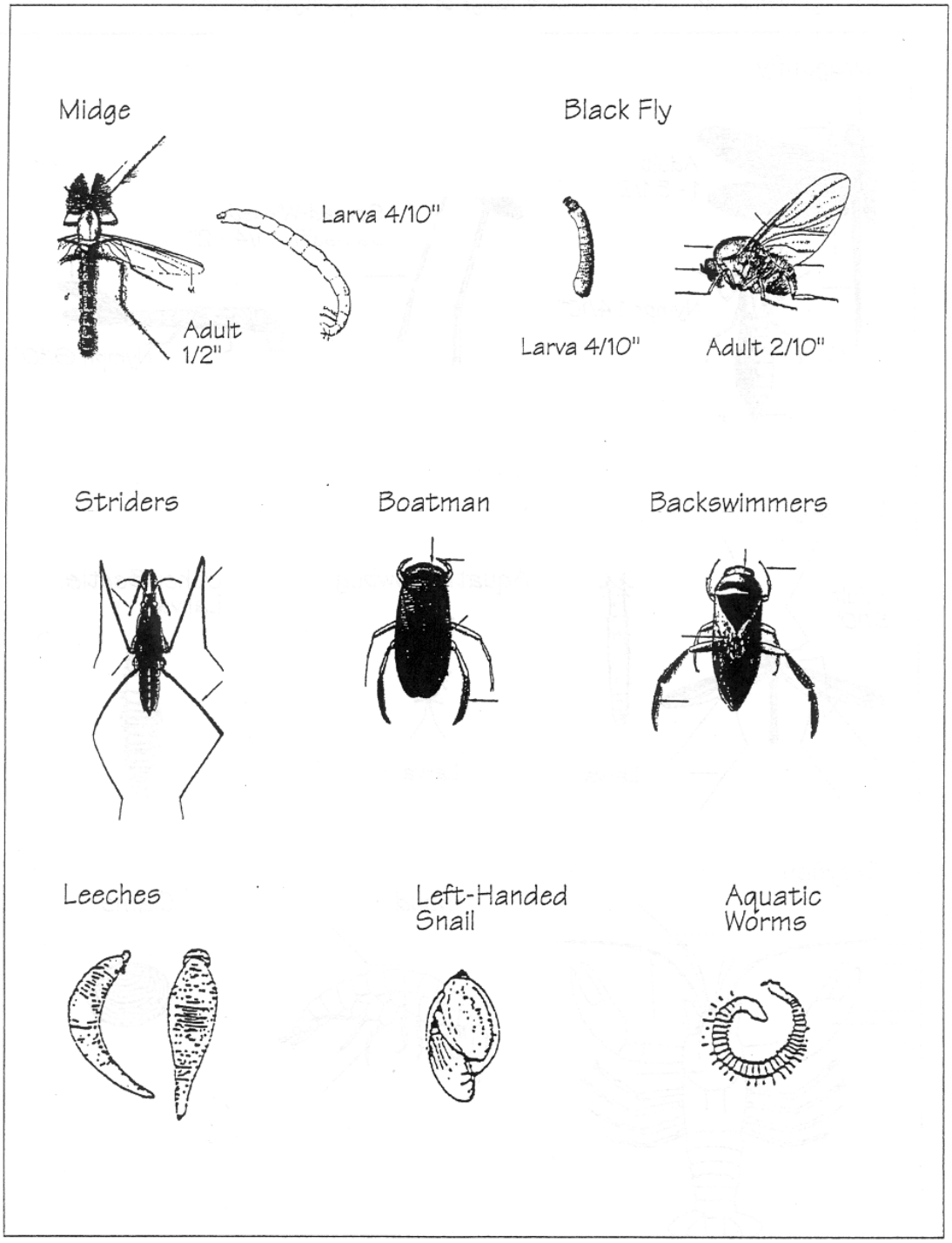
Group 1: Intolerant
These organisms are sensitive to pollution.
Their dominance generally suggests good water quality.



Group 2: Somewhat Tolerant
These organisms can tolerate a wider range of water quality conditions.



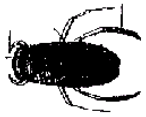
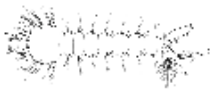
Group 3: Tolerant
These organisms are generally tolerant of pollution. Their dominance suggests poor water quality.

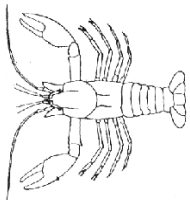


QUICK REFERENCE GUIDE TO AQUATIC INVERTEBRATES

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Stonefly Nymph 	2 tails, 2 sets wing pads, (wing pads not always noticeable)	Cold running water	Through body surface; some small gills; does "pushups to increase oxygen flow	Predator or herbivore	Streamlined body for crawling on rocks; requires high oxygen levels
Mayfly Nymph 	3 tails (sometimes 2); 1 set wing pads.	Cool or cold running water	Through gills along abdomen; may wave gills in water to increase oxygen flow	Herbivore or scavenger	Requires high to medium oxygen levels
Caddisfly Larva 	Most species build cases or nets soft body, some free living	Cool or cold running water; ponds	Through body surface; some finger-like gills	Filter feeder, herbivore, predator	Builds cases of heavy material (rocks) to avoid being swept away by fast-flowing streams; uses grass and plants to make cases as well
Water Penny Larva 	Round, flat, segmented, disk-like body	Cold running water	Usually through gills on underside	Herbivore—grazes on algae	Flattened body resists pull of current
Predaceous Diving Beetle Larva 	Up to 6 cm long; robust jaws	Most still and moving water habitats	Through body surface	Voracious predator	Special channels in jaws to suck body fluids of prey

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things To Look For
Whirligig Beetle 	Black; congregates in schools	Surface of quiet water	From atmosphere	Predator or scavenger	Has two pairs of eyes to see above and below water's surface; has type of "radar" to locate object in water; secretes white odorous substance to deter predators
Black Fly Larva 	Small body; small hooks at end of abdomen attach to rocks	Cold running water	Through body surface; small gills	Filter feeder	Anchors to rocks with silk; only needs medium to high oxygen levels
Dragonfly Nymph 	Stout body; arm-like grabbing mouthpart	Cool still water	Dissolved oxygen, through gills in internal body chamber	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Damselfly Nymph 	3 leaf-like gills at end; arm-like grabbing mouthpart	Cool still water	Through gills at end of abdomen	Active predator	Clings to vegetation or hides in clumps of dead leaves or sediment
Hellgrammite (Dobsonfly, Alderfly or fishfly Larva 	Up to 9 cm. Long	Cool or cold, slow to fast moving water	Through gills along side of abdomen; some fish flies have breathing tubes	Active predator	Can swallow prey without chewing

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things to Look For
Water Strider Adult 	Skates on water's surface	Ponds or still pools of stream	From atmosphere	Active predator	Can stay on water's surface because feet have small surface area and are water repellant
Water Boatman Adult 	Long swimming hairs on legs	Ponds or still pools of stream	From atmosphere, by carrying air bubble from water's surface on body	Omnivore, herbivore, or scavenger	Has swimming hairs on legs that act as oars
Backswimmer Adult 	Light-colored underside; swims on back	Ponds or still pools of streams	From atmosphere, by carrying air bubble from water's surface on body	Predator	Swim on back, sleek body shape
Cranefly Larva 	Cylindrical body; often has lobes at hind end, may have small soft legs	Bottoms of streams and ponds in sediment and algae	From atmosphere through spiracles (openings) at hind end	Active predator, herbivore, or omnivore	Species that eat woody decaying matter have gut bacteria to digest cellulose
Mosquito Larva 	Small body; floats at surface	Cool to warm still water	From atmosphere through breathing tube, on hind end as a larva and front end as pupa	Scavenger —feeds on micro-organisms	Swims or dives when disturbed

Name	Distinguishing Characteristics	Where Found	How Oxygen is Obtained	Food Gathering	Things to Look For
Aquatic Sowbug 	Flattened body, top to bottom; 7 pairs legs	Shallow freshwater, among rocks and dead leaves	Through body surface on legs	Scavenger —eats decaying matter---or omnivore	Male clasps female under it during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Crayfish 	5 pairs of legs, first pair often robust; looks like small lobster	Under rocks or in burrows in shallow freshwater	Through gills under body	Scavenger or omnivore	Crawls backwards when disturbed; males display some courtship behavior to reduce female aggressiveness
Scud 	Flattened body, side to side swims on side	Bottom of lakes, streams or ponds, or streams	Through gills under body	Scavenger or omnivore	Male carries female on its back during mating; female then sheds half of exoskeleton, which becomes case into which fertilized eggs are placed
Midge Larva 	Small thin body with a hard head and small legs on the hind end	Most still and moving water habitats	Through body surface, small gills	Predator, herbivore, or omnivore	Extremely common; sometimes red because they have hemoglobin in their blood to help transport oxygen; wiggle actively
Rat-Tailed Maggot Larva 	Cylindrical body; tail-like breathing tube	Cool to warm water with low oxygen levels	From atmosphere through breathing tube	Scavenger —eats decaying matter and sewage	Can survive low oxygen levels fatal to most invertebrates