A scenic view of a stream flowing over mossy rocks in a lush, green, hilly landscape. The water is clear and flows over several small cascades and pools. The surrounding vegetation is dense and vibrant green, with some taller grasses on the left and right banks. The overall atmosphere is natural and serene.

Aquatic Macroinvertebrates and Stream Ecology

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What are macroinvertebrates and why do we use them?

- Larger (≥ 500 microns)
- Invertebrates (animals without backbones)
- Not as mobile as fish
- Fairly easily collected
- Fairly easily identified (at least to Order and often Family)
- Since a large portion (or all) of their life cycle is in the stream, they reflect changes (snapshot vs video)
- Many are sensitive to environmental degradation.

NABS (www.benthos.org)

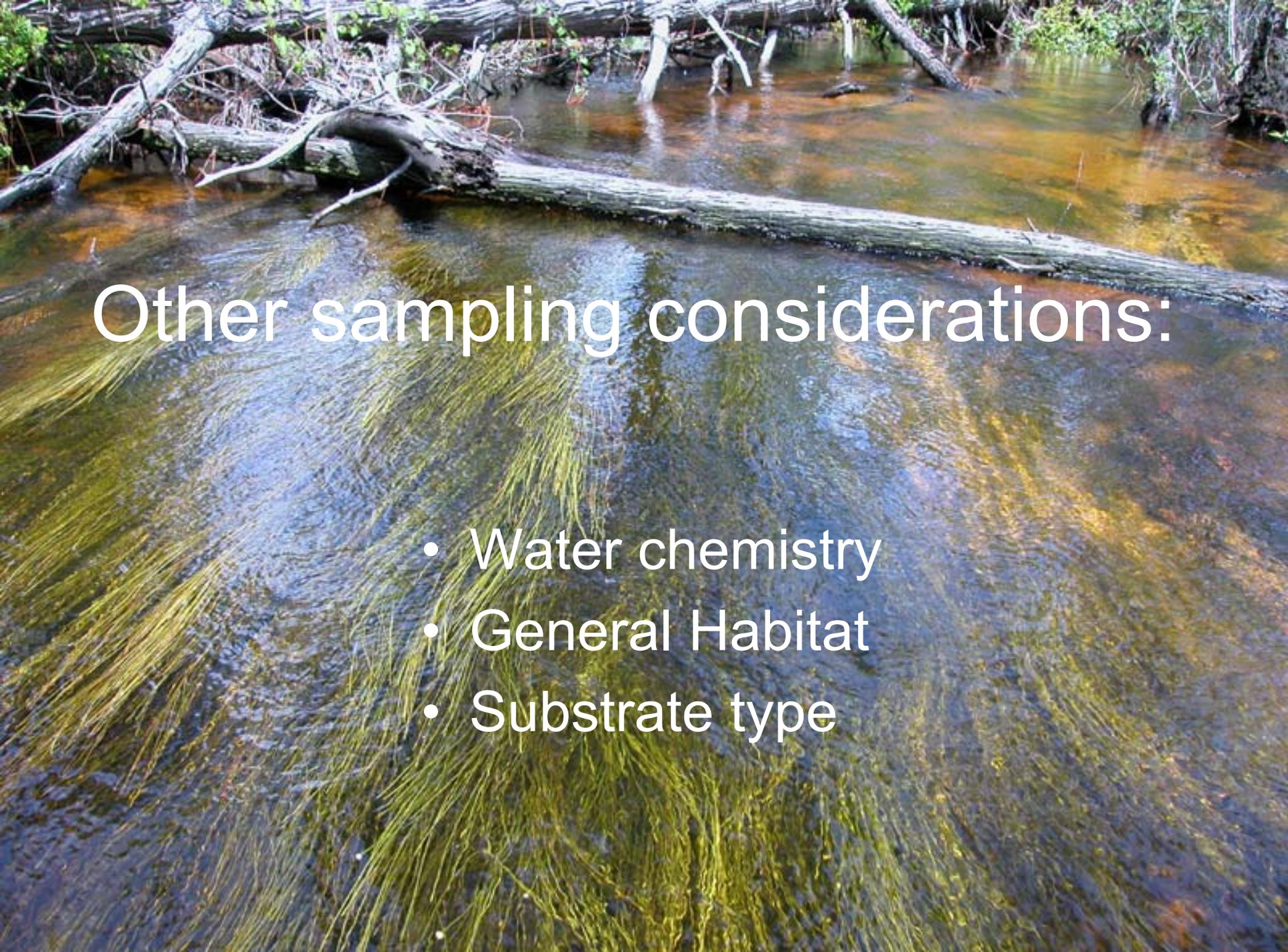
Stream Ecology

A photograph of a stream flowing through a forest. In the foreground, a large, dark, weathered log lies horizontally across the stream, partially submerged. The water flows over the log, creating white foam and rapids. The streambed is covered in light-colored gravel and sand. The banks are lined with green grass and various trees, including some with bare branches. The background is filled with dense forest foliage.

- **Study of the stream, it's processes, and the relationship of plants and animals (community structures) with the stream.**
- **Community structures are determined by many factors, such as:**
 - **Water Quality**
 - **Food types**
 - **Habitat/Substrate**

Questions

- What do I want to know?
- Will the macroinvertebrates alone give me the answer I'm after?
- What other information will help?
- What will I do with the data?

A photograph of a stream with fallen logs and green algae. The water is dark and reflective, with a large log lying across the middle. The background shows more logs and some green foliage.

Other sampling considerations:

- Water chemistry
- General Habitat
- Substrate type

Site Selection for Macroinvertebrates

- Choosing the most productive area(s) in your stream.



Productive areas for Macroinvertebrates

- Riffles
- Leaf Packs
- Roots/Bank Habitat
- Soft Sediment



Sampling methodology

- **Kick Net**
 - Used primarily in streams that are dominated by riffle habitat.
 - Usually a 2 person job with one holding the net (aimed upstream) and one kicking/disturbing the substrate just upstream of the net so bugs float into the net.
 - Sample is either placed in a pan for picking or put into jar and preserved for later analysis.



- Dip Net

- Most often used in streams dominated by soft substrate (sand/silt) and in streams not dominated by riffle. But, can also be used for riffle sampling.
- A one person job consisting of sweeping or jabbing the selected habitat (bank, roots, or sediment). Sample is then placed into a pan for picking or into a jar and preserved for later analysis.



Macroinvertebrate Taxonomy

(Who's Who)

Kingdom (eg. Animalia)

Phylum/Superphylum (eg. Arthropoda)

Class (eg. Insecta)

Order (eg. Ephemeroptera)

Family (eg. Baetiscidae)

Genus (eg. Baetisca)

Species (eg. lacustris)

What can I expect to find?

- Mollusca
snails/clams/mussels
- Crustacea
crawfish/amphipods/
isopods
- Insecta
mayflies/stoneflies/
caddisflies/dragonflies/
horseflies/ beetles, etc
- Annelida
vermiform or “wormy”
things, leeches, etc



Indicator Organisms

- Animals that, by their presence/absence or abundance, can tell you about their environment.
- Most commonly used sensitive indicator organisms:
 - **Ephemeroptera** (Mayflies)
 - **Plecoptera** (Stoneflies)
 - **Trichoptera** (Caddisflies)

Ephemeroptera (Mayflies)

- **Family: Heptageniidae**
 - Scrapers, Grazers
 - Body is dorso-ventrally compressed
 - Cling to rocks/cobble
 - Sensitivity: Moderate to Sensitive



A damselfly nymph is shown resting on a green plant stem underwater. The nymph has a dark, segmented body with lighter spots, long antennae, and six legs. The background is a clear, blue-green water environment with other green plant leaves visible.

Family: Ephemereididae

- Scrapers, Grazers and Collector/Gatherers
- Body is more cylindrical than heptageniids.
- Abdominal gills separate or can overlap.
- Most live on rocks/cobble/gravel, many readily swim.
- Sensitivity: Generally Sensitive

Mayflies



Family: Baetidae

Collector/Gatherer

Sensitivity: range from tolerant to somewhat sensitive

Substrate type: All



Family: Isonychiidae

Filter feeder

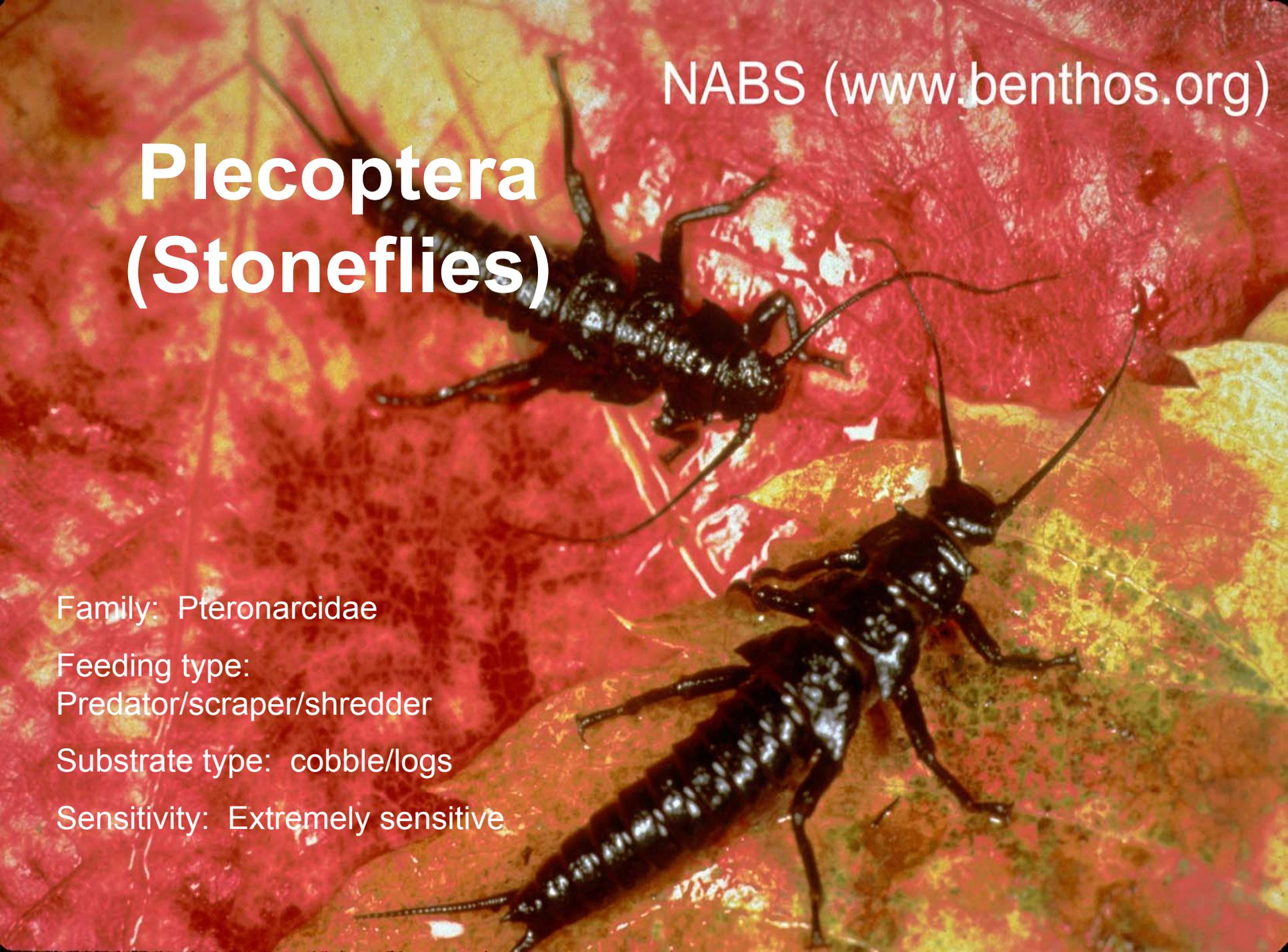
Sensitivity: Somewhat sensitive

Substrate type: rocks/cobble/ swift water

Mayfly Adult



NABS (www.benthos.org)

The image shows two dark-colored stoneflies (Plecoptera) resting on a leaf with vibrant red and yellow autumn colors. The stoneflies have long antennae and segmented bodies. One is positioned in the upper left, and the other is in the lower right, both facing towards the right side of the frame.

NABS (www.benthos.org)

Plecoptera (Stoneflies)

Family: Pteronarcidae

Feeding type:

Predator/scrapper/shredder

Substrate type: cobble/logs

Sensitivity: Extremely sensitive



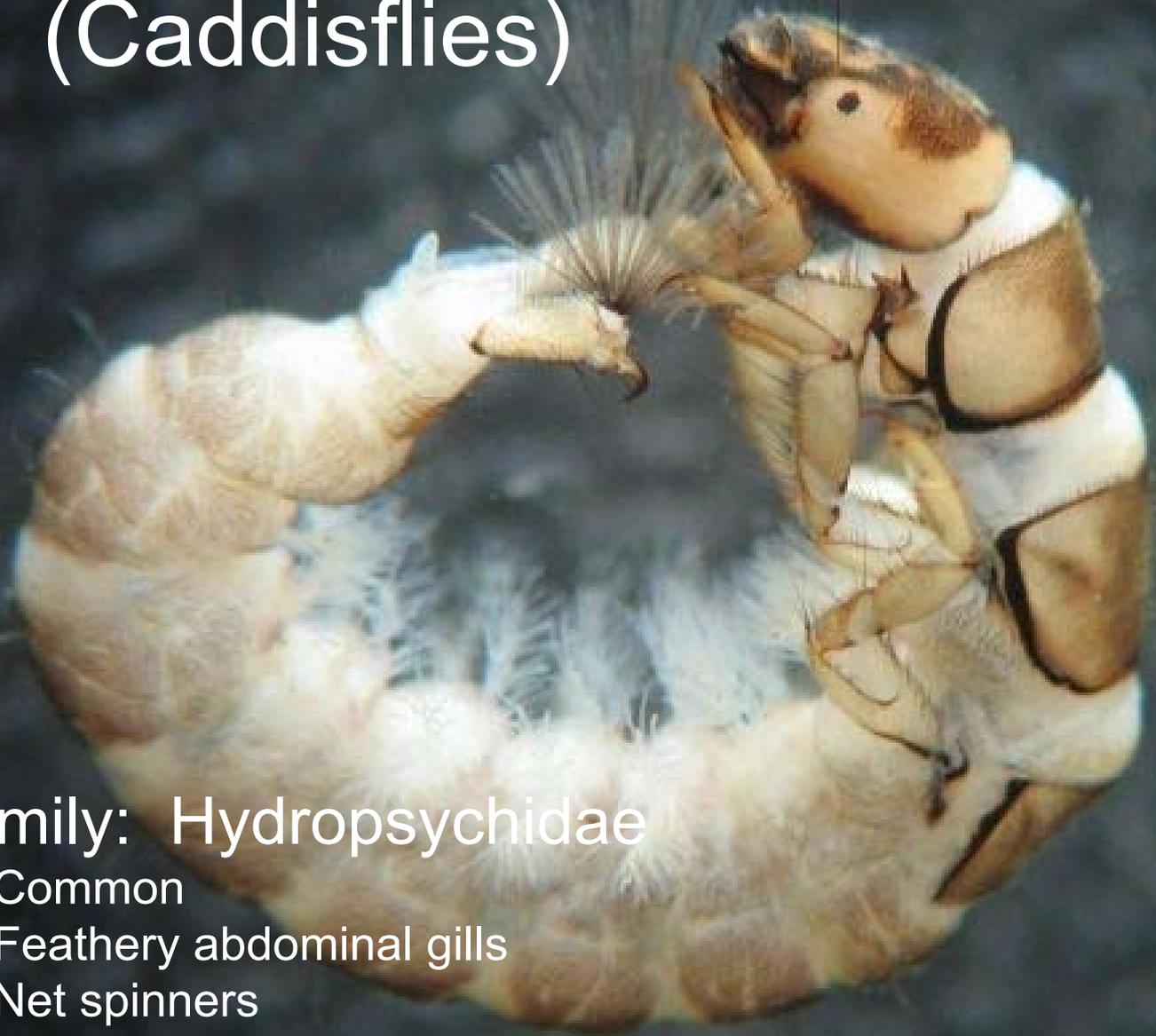
Family: Perlidae

Feeding type: Predators

Substrate type: cobble

Sensitivity: Sensitive

Trichoptera (Caddisflies)



- **Family: Hydropsychidae**
 - Common
 - Feathery abdominal gills
 - Net spinners
 - Feeding type: filter feeders
 - Sensitivity: can range from sensitive to moderately sensitive.

- Family: Hydroptilidae (micro caddisflies)

Hard to see.

Generally prefer finer substrate

Feeding type:

Scrapers/collectors/piercers

Sensitivity: moderately sensitive



NABS (www.benthos.org)

- Family: Brachycentridae

Fairly common

Case builder, needs appropriate particles to build case

Feeding type: Filter feed/collector

Substrate type: pebble/sand/wood

Sensitivity: Moderate to sensitive



Got Data?

- **Data analysis**
 - Takes on different forms depending on how rigorous your identification.
 - Depends on what your known stressors are in the stream.
 - Hinges upon on your original question.

Some Common Types of Analyses

- EPT Index
- Richness (eg. Number of Families/Genera/Species)
- Trophic (feeding) groups
- Percent dominance

EPT Index

The number of:

- Mayfly families
- Stonefly families
- Caddisfly families

The higher the index,
the better the stream
condition.



Richness

- The higher the number of different kinds of animals, the better the stream.
- Can be calculated on Families, or Genera, or Species

Feeding Groups

A scenic view of a river flowing through a canyon. The river is in the foreground, with white water rapids. The banks are lined with trees, some with yellow and green foliage. In the background, there are red rock walls and a small waterfall.

- Scrapers
- Shredders
- Collector/Gatherers
- Predators

The proportions of these groups add an extra dimension of understanding to what's going on.

AMD and your bugs

- AMD affects your bug fauna in several ways:
 - The water is too alkaline or too acidic, limiting what species you'll find, if any.
 - The dissolved metals can be toxic to the bugs.
 - The metals that are precipitating are physically smothering the benthic (bottom) habitat so bugs can't live there.

Sedimentation and your bugs

- Sedimentation, whether from AMD or field runoff or erosional areas in the streambank, covers the bottom habitat.
- Sedimentation from soils can be an indicator of higher nutrient levels in the water which can spur rampant algae growth.

Acid Rain and your bugs

- Acidic condition in stream erodes integument.
- Acidic conditions can make toxins such as some metals, more available to the bugs.
- Several species are very sensitive to acidic conditions in the stream.

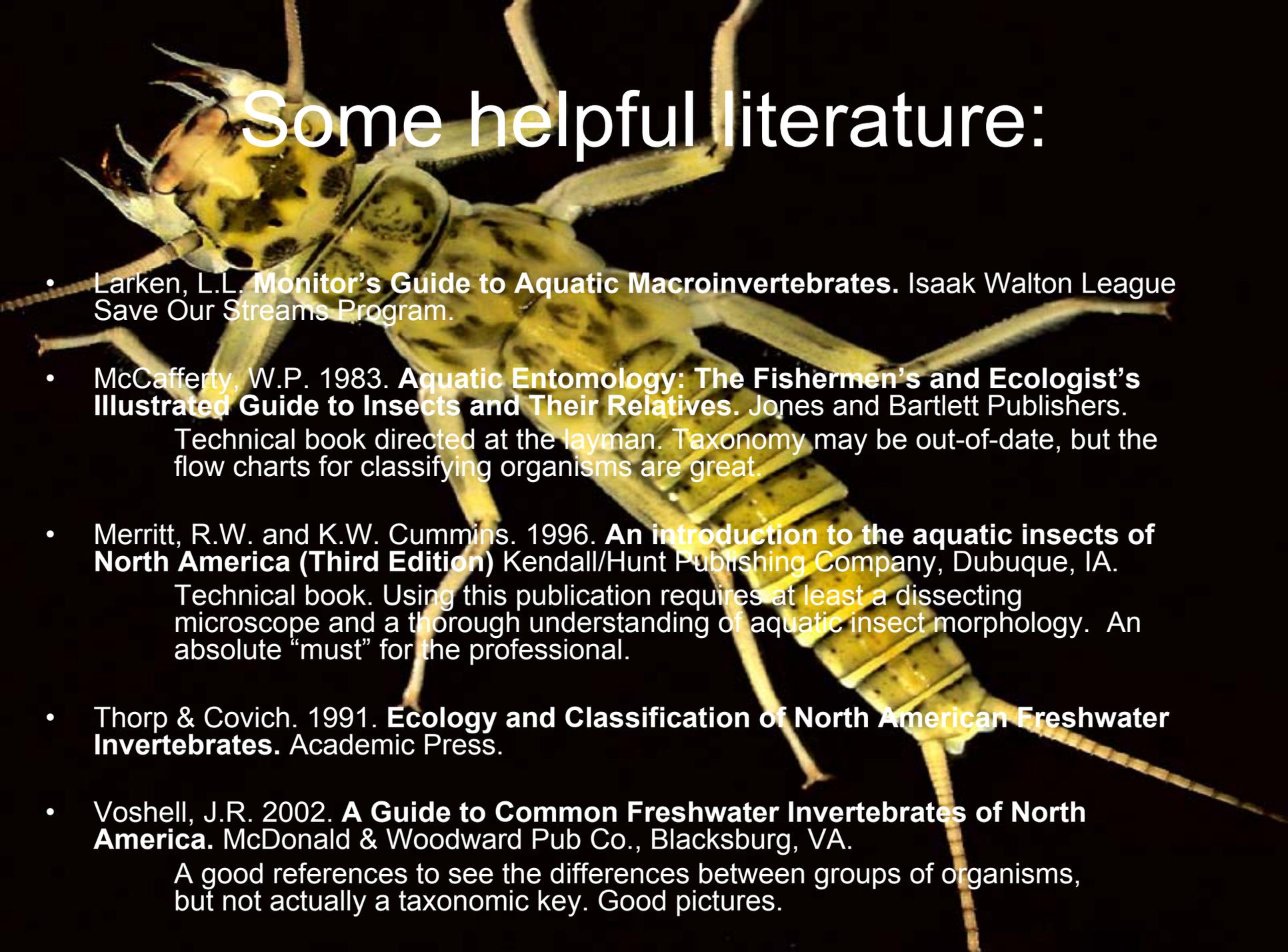
Nutrients and your bugs

- **Nutrients in and of themselves do not harm the bugs. Rather, they contribute to excessive algae growth which decreases oxygen at night, interferes with bug feeding habits, and coats important habitat.**

The End Product

A scenic view of a small waterfall cascading over rocks in a lush, green, mossy forest setting. The water flows from the top center towards the bottom center, surrounded by dense vegetation and moss-covered rocks.

Taking in all the information about what has happened and addressing it in the “here and now” as a unified “whole”.



Some helpful literature:

- Larken, L.L. **Monitor's Guide to Aquatic Macroinvertebrates**. Isaak Walton League Save Our Streams Program.
- McCafferty, W.P. 1983. **Aquatic Entomology: The Fishermen's and Ecologist's Illustrated Guide to Insects and Their Relatives**. Jones and Bartlett Publishers.
Technical book directed at the layman. Taxonomy may be out-of-date, but the flow charts for classifying organisms are great.
- Merritt, R.W. and K.W. Cummins. 1996. **An introduction to the aquatic insects of North America (Third Edition)** Kendall/Hunt Publishing Company, Dubuque, IA.
Technical book. Using this publication requires at least a dissecting microscope and a thorough understanding of aquatic insect morphology. An absolute "must" for the professional.
- Thorp & Covich. 1991. **Ecology and Classification of North American Freshwater Invertebrates**. Academic Press.
- Voshell, J.R. 2002. **A Guide to Common Freshwater Invertebrates of North America**. McDonald & Woodward Pub Co., Blacksburg, VA.
A good references to see the differences between groups of organisms, but not actually a taxonomic key. Good pictures.