MAINE STREAM EXPLORERS

A treasure hunt to find healthy streams in Maine

Volume 1: Basic Macroinvertebrate Guide

Maine Audubon

Department of Environmental Protection, State of Maine

L.E.A. Lakes Environmental Assn.

Portland Water District

Maine Outdoor Heritage Fund

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2. **Biodiversity Institute of Ontario** - Amphipod
3. **Brandon Woo** (bugguide.net) – adult Alderfly (*Sialis*) and water penny (*Psephenus herricki*)
4. **Don Chandler** (buigguide.net) - *Anax junius* naiad
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7. **Ian Alexander** (commons.wikimedia.org) - *Glossosoma* egg mass
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9. **Jan Hamrsky** (lifeinfreshwater.net) – Hydropsychidae in net and *Glossosoma* on rock
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20. **Tom Danielson**
21. **Tom Murray** (bugguide.net) – adult caddisfly (*Hydropsyche*), adult non-biting midge (*Chironomus*), isopod (*Assellus*), dragon hunter naiad (*Hagenius brevistylus*)
22. **Thomas Palmer** (bugguide.net) – riffle beetle larva (*Macronychus*)
23. **Welter Schultes** (www.animalbase.uni-goettingen.de) – *Lymnaea* snails

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Introduction to Maine Stream Explorers

Maine Stream Explorers is a treasure hunt to find healthy streams in Maine. Volunteers are trained to collect and identify "sensitive", "moderately sensitive", and "tolerant" macroinvertebrates in Maine's streams. Macroinvertebrates are animals without backbones that can be seen without magnification. Most macroinvertebrates are insects that have an adult life stage that live out of water and an immature life stage that lives in the water. For example, dragonflies and damselflies that are seen flying around streams and lakes have young that live in the water. Many trout fisherman make artificial lures, "flies", that resemble mayflies, stoneflies, and caddisflies that trout love to eat. Of course, the infamous blackfly starts its life in a stream too. In addition to insects, macroinvertebrates include crayfish, snails, mussels, and many other kinds of animals.

Macroinvertebrates are excellent indicators of water quality because they are exposed to all environmental stressors during their time in the water. They are a direct measure of the biological health of a stream. Also, there are many kinds of macroinvertebrates with a wide range of tolerance to polluted water. This allows biologists with the Maine Department of Environmental Protection (DEP) to evaluate the health of rivers and streams by collecting macroinvertebrates and evaluating how many and what kinds live in a stream. Overall, DEP Biologists have collected more than 1,400 kinds of macroinvertebrates in Maine streams and rivers. Some species require streams with cold, clean water and good habitat. These are the "sensitive" macroinvertebrates in the Stream Explorers program. Other species can tolerate slightly more pollution and degraded habitat. These are the "moderately sensitive" macroinvertebrates. Finally, some macroinvertebrates have adaptations that allow them to survive in tough conditions, such as warm or polluted water. These are the "tolerant" macroinvertebrates. *The tolerant macroinvertebrates are not bad, they are just tough*. They can be found in very nice streams too. Healthy streams often have four or more kinds of "Sensitive" macroinvertebrates and a variety of "moderately sensitive" and "tolerant" macroinvertebrates too. Unfortunately, some streams in Maine are polluted to the point where "Sensitive" macroinvertebrates can no longer live there. The most abundant macroinvertebrates in those streams may be the "tolerant" kinds.

As a volunteer in the Stream Explorers program, you will gather valuable information about the health of Maine streams. You and your fellow citizen scientists will venture forth to find healthy streams by looking at macroinvertebrates living in them. In some cases, you may be the first people to collect and identify macroinvertebrates in some streams. In other cases, you may visit streams previously sampled to check up on their condition. You may find streams that are loaded with "sensitive" macroinvertebrates. In other streams, you may find none of them. Regardless, your hard work will provide a valuable assessment of stream health. The program coordinators will compile the results of all the stream assessments and share them with project partners. Ultimately, your data will be shared with the DEP biologists, who will use the data to help target and prioritize limited funding and staff time for more comprehensive surveys.

Training

The main goals of the Stream Explorers program are environmental education and collecting valuable data. As Rachel Carson once said, everyone has a "sense of wonder" about nature when young. Volunteers will receive training to collect good quality data but also to nurture their sense of wonder about the amazing creatures living in Maine streams. Volunteers in the Stream Explorer program receive annual training for both collecting and identifying macroinvertebrates. Experts in the field will help you learn how to identify the sensitive, moderately sensitive, and tolerant macroinvertebrates. This training will come in the form of this guide, classroom-style workshops, outdoor workshops, and videos and other resources on the Stream Explorer website. In addition, there are interactive on-line resources where you can practice identifying macroinvertebrates.

Sampling Methods

Sampling consists of collecting macroinvertebrates with a net. You will be provided necessary materials in the sampling kits that are available to check out. Typically, sampling is done with two or more people. Plan on being at the stream for at least an hour and half; time flies when you are having fun. Wear clothing and footwear that are comfortable and you don't mind getting wet. Please be careful walking around and in the stream because of slippery rocks.

Equipment

The sampling equipment kit that you check out will come with:

- Net
- 3 trays (6"x9" or larger)
- Ice cube trays
- Plastic spoons
- Brushes/tweezers
- Pipettes
- Laminated guide and macroinvertebrate keys
- Magnifying lens
- Petri dishes and containers
- Magiscope (only some kits have this)

Sampling Overview

You and your partner(s) will collect 6 samples at your location. Some habitats within a stream are easier to sample and have a greater diversity of macroinvertebrates. The target habitats, in order of preference, are the following:

1. rocky areas with flowing water
2. exposed tree roots in the water along the side of the stream
3. logs or branches in the water

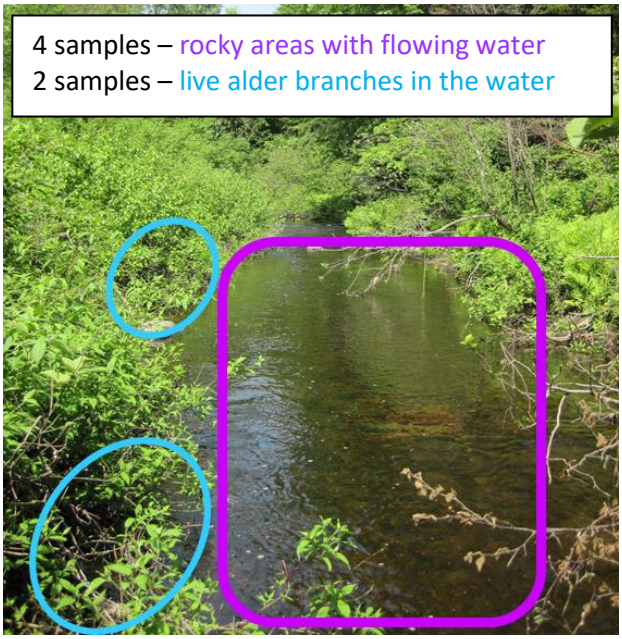
4. plants growing in the water

Look around to see which of the target habitats are most common in your stream. In general, you want to allocate the samples among those target habitats based on their order of preference (listed above) and how common they are at your location. If possible, collect most of your samples (4 to 6) from the highest priority habitat, such as rocky areas with flowing water. If the highest priority habitat is uncommon, then allocate more samples in the next highest priority habitat. For example, if your stream only has a small area of rocks but has a lot of tree branches in it, then you would allocate more samples to the branches. Do not stress out when deciding what to sample. Use your best judgment and mark down the number of samples collected in the different habitat types on the field sheet.

Examples of streams with a variety of habitats and what to sample

	Habitat at the site	What should you collect
Stream 1	Stream has a rocky bottom in areas of flowing water. The stream also has tree roots in the water where flowing water has undercut the stream bank. The stream also has some plants growing in the water along the edge.	4 samples where there are rocks in flowing water, 1 sample at the undercut bank with the tree roots, and 1 sample in the plants growing in the water
Stream 2	The stream has a mix of rocky and sandy substrate. The stream has some large branches but no exposed tree roots or plants growing in the stream.	4 samples where there are rocks in flowing water and 2 samples where there are logs and branches in the water
Stream 3	The stream has a sandy bottom. It has some logs and branches in the water. It also has a small area with an undercut bank and tree roots.	4 samples where there are logs and branches in the water and 2 samples at the undercut bank with the tree roots in the water
Stream 4	The best available habitat is mostly rocky areas in flowing water. There are a few branches but not many.	5 samples where there are rocks in flowing water and 1 sample where there are branches in the water
Stream 5	The stream has equal amounts of rocks, branches, and exposed tree roots.	2 samples where there are rocks in flowing water, 2 samples where there are branches in the water, and 2 samples where there are undercut banks and tree roots in the water
Stream 6	The stream is mucky and difficult to walk in. There are some branches and plants growing in the water.	Don't collect samples. The sampling protocol does not work well for this kind of stream.

More examples of where to collect samples



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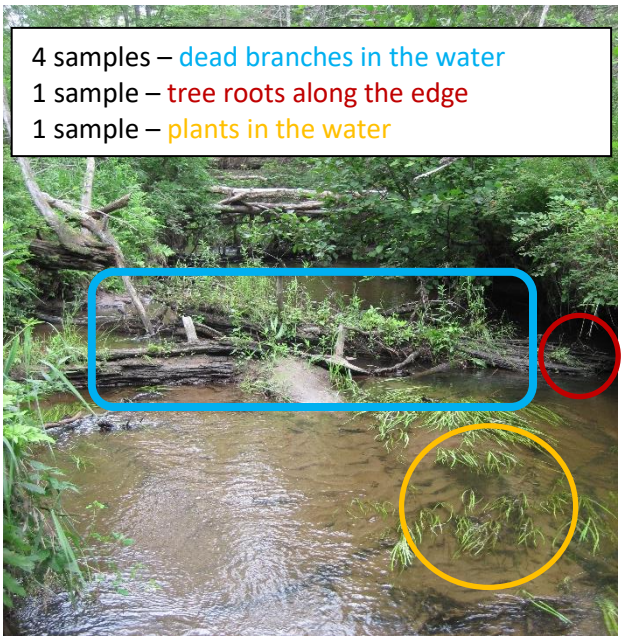

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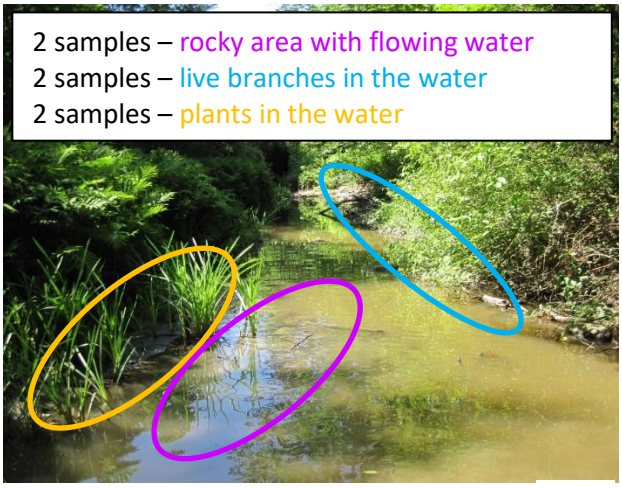

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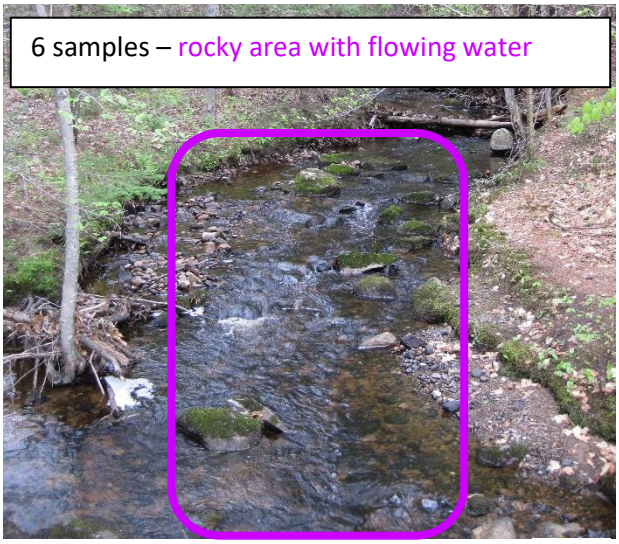

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Sampling rocky areas with flowing water

1. Place the net in the water with the opening of the net facing upstream
2. Place the net downstream of rocks small enough to be picked up and cleaned by a second person (try to avoid getting too much sand)
3. Sample an area extending approximately 18 inches upstream of the net
4. The second person picks up one rock at a time, holds it in the front of the net, and wipes off all sides of the rock so stuff on it floats into the net
5. Set the rock off to the side and do the same thing with other rocks in your sample area
6. After cleaning all rocks in the sample area, gently massage and agitate the stream bottom with your fingers (avoid getting too much sand and silt, however… skip this step if you see too much sand and silt getting into the net)
7. Repeatedly scoop your net through the water to concentrate the animals into the bottom of the next
8. Wash off and remove branches and large leaves
9. Transfer the contents of the net to a tray with about an inch of water in it
10. This process usually takes 2-3 minutes

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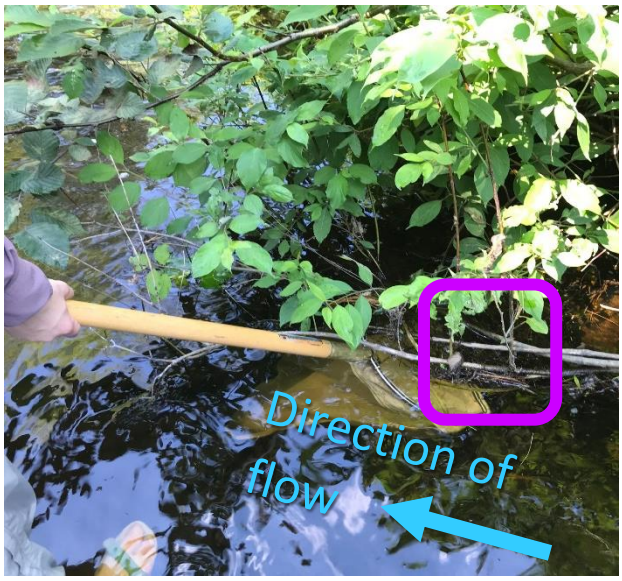
Sampling underwater roots



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1. The first person places the net downstream of the roots in the water
2. If possible, position the net so the roots are in the net
3. Sample an area extending approximately 18 inches upstream of the net
4. If the water is flowing there, then hold the net at an angle so water flows into the net and animals dislodged from the roots will fall into the net
5. If the water is not flowing much there, then hold the net facing up so animals that are dislodged from the roots will fall into the net
6. The second person gently massages and agitates the roots with hands or with a whisk broom
7. You may need to reposition the net several times to sample all parts of the roots
8. Repeatedly scoop your net through the water to concentrate the animals into the bottom of the next
9. Wash off and remove twigs and large leaves from the net
10. Transfer the contents of the net to a tray with about an inch of water in it
11. This process usually takes 2-3 minutes

Sampling branches and logs in the water

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1. The first person places the net in the water downstream of the branches with the opening facing upstream so animals dislodged from the branches will float into the net
2. Sample an area extending approximately 18 inches upstream of the net
3. If possible, position the net so the branches are inside the net
4. The second person gently rubs the branches with hands or a whisk broom to remove animals from them
5. You may need to reposition the net several times to sample all parts of the branches

6. If the branches are positioned horizontal to stream flow, then sample 18 inches of the branches while slowly moving the net sideways to collect animals dislodged from the branches
7. Repeatedly scoop your net through the water to concentrate the animals into the bottom of the next
8. Wash off and remove twigs and large leaves from the net
9. Transfer the contents of the net to a tray with about an inch of water in it
10. This process usually takes 2-3 minutes

Sampling plants or moss in the water

1. The first person places the net downstream of the plants or moss with the opening of the net facing upstream
2. Sample an area extending approximately 18 inches upstream of the net
3. If possible, position the net so the plants are inside the net
4. The second person gently rubs or agitates the plants or moss with hands or a whisk broom to remove animals from them
5. You may need to reposition the net several times to sample all parts of the plants or moss

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6. Rub clean any large leaves or plant parts in the net, then remove them from the net
7. Repeatedly scoop your net through the water to concentrate the animals into the bottom of the next
8. Transfer the contents of the net to a tray with about an inch of water in it
9. This process usually takes 2-3 minutes

Picking macroinvertebrates from the sample

Place 2 samples in each of the three trays. Let the water sit in the white tray for a couple minutes to let the debris settle and allow the animals to become active again. Look carefully at one section of the tray for moving animals. Many macroinvertebrates are small, and many are camouflaged to protect themselves from predators. Be prepared to look for very small creatures. Some will be as small as grains of rice or even poppy seeds. Use the magnifying lenses provided in the kit to look at small creatures. Collect the macroinvertebrates with the spoons or pipettes provided in your kit. It sometimes is helpful to use a brush to get macroinvertebrates into the spoon. After capturing a macroinvertebrate, transfer it to a petri

dish or ice cube tray cell filled with water. The following tips may be helpful when looking for macroinvertebrates in the trays:

- Sort the macroinvertebrates while you collect them, putting similar ones together in the same petri dish or ice cube cell. Be careful, some large ones may try to crawl out.
- Gently stirring water in a section of the tray can sometimes reveal macroinvertebrates. Look for anything not moving in the same direction as the swirling debris, whether swimming or sticking in place.
- Pick up and examine rocks, chunks of wood, or large plant parts that are in the tray. Some macroinvertebrates will try to hide on these items. Clean these items and place them back in the stream or temporarily in a clean container.
- Your eyes will focus first on large and active macroinvertebrates. It is naturally more challenging to find small macroinvertebrates and cryptic kinds that have good camouflage. To balance out what you collect try this challenge… **For every large or active macroinvertebrate that you find, try to search for and collect two or more small, cryptic, or hard to find macroinvertebrates.**

Keep track of how long you spend searching for and sorting macroinvertebrates in the tray. You should spend at least 60 minutes finding, sorting, and identifying macroinvertebrates. You are encouraged to spend more time identifying macroinvertebrates if you are having fun.

Identifying macroinvertebrates

Use the keys and information provided in this guide to identify the macroinvertebrates. Please use magnifying lenses, field scopes, or other means of magnification to help see the creatures. It is very difficult to see some of the diagnostic features without using some form of magnification. After you identify something, try to take a picture of it with a camera or phone. If your camera or phone does not have a macro feature, then get as close as you can without causing the image to become blurry. People with steady hands also could try to hold a magnifying lens between the macroinvertebrate and the lens to magnify the image. One strategy is to take a picture of half of the ice cube tray and another picture of the other half. You will undoubtedly see some macroinvertebrates that are not on the Maine Stream Explorers field sheet. The keys and write ups in this guide only include common kinds. If you recognize some of the other macroinvertebrates, then please write them down in the comments section of the field sheet. Take pictures of these creatures too.

Filling out the field sheet

Fill out the information about the stream including its name, town, and description. If possible, please record the coordinates of the sample location with latitude and longitude. If possible, please take pictures of the sample location facing upstream and downstream. It would be helpful to take pictures representing the different habitats that you sampled. Write down the name of the team leader and other stream explorers. Record the total time spent at the stream and amount of that time spent sorting and identifying macroinvertebrates. Write down the number of samples in each of the four habitat types.

After you sort and identify macroinvertebrates, write down the abundance code for each kind that you found underneath the picture of the macroinvertebrate. The abundance

codes are Few (F) for 1-5 found, Common (C) for 6-25, and Abundant (A) for more than 25 found. Once that is done, count the number of *different kinds* of "sensitive" macroinvertebrates on the field sheet and write that number in the space provided on the back of the form. Do the same thing for the "moderately sensitive" and "tolerant" macroinvertebrates.

Pictures

Please take pictures of the sample location looking upstream and looking downstream. Please take representative pictures of each kind of macroinvertebrate you find. Please label pictures with the stream name, date, and description. For example, if you took a picture of a *Glossosoma* at the Northwest River on July 22, 2020, the picture name would be **Northwest_River_07_22_2020_Glossosoma.jpg**. E-mail pictures to Hanna Young with Maine Audubon (pkeefe@maineaudubon.org). Although it may be time consuming to label all images, this step is very helpful and allows the project coordinators to double-check identifications, help you improve your identification skills, and improve future training sessions.

Cleaning up

When you are done, please return all samples to the stream. Wash the net and pick off any debris. Wash the trays, spoons, ice cube trays, and petri dishes with stream water. Dry them off and pack them up. Please return all items in the sample kit by the time indicated by the program coordinator when you reserved or picked up the sample kit. If something is lost or damaged, then please let the program coordinator know so it can be replaced.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates have one of three basic life cycles. Becoming familiar with these life cycles will help you recognize macroinvertebrates. First, some animals hatch from an egg and are tiny versions of their adult form. For example, baby crayfish and snails look like tiny versions of the adults and are called "immature". Immature crayfish and other crustaceans molt their exoskeletons periodically as they grow. Like lobsters, they have a "soft shell" phase after molting, which allows them to increase in size before hardening again. In contrast, snails increase the size of their shells as they grow.

The terms "larvae", "nymphs", and "naiads" are sometimes used interchangeably in books and other resources, which can cause confusion.

The second life cycle type is called "complete metamorphosis" (Figure 1). Like the monarch caterpillar, these animals have four life stages: egg, larva, pupa, and adult. Most aquatic macroinvertebrates with complete metamorphosis have larvae that live in the water. Animals in this group include beetles, caddisflies, blackflies, and a wide diversity of flies. All the larvae look different than the adults. The larvae undergo metamorphosis in the pupal stage. In the pupa, the cells rearrange and transform the larva into the adult form.

The third life cycle type is called "incomplete metamorphosis" (Figure 2). These animals have three life stages: egg, nymph/naiad, and adult. Young insects in the group are called nymphs or naiads based on how they obtain oxygen. Naiads have gills to get oxygen from water while nymphs breathe air. Young dragonflies and damselflies primarily get oxygen from the water and are called naiads. In contrast, young water striders and water boatmen breathe air and are called nymphs. The nymphs and naiads look somewhat like the adults but do not have wings. For example, dragonfly naiads and adults have a head, a thorax with three sets of legs, and an abdomen. The basic body structure is similar, but the naiad does not have wings and it is adapted to breathe water instead of air. Dragonfly naiads start off tiny and molt their exoskeletons as they grow. Depending on the species, they may molt 8 or more times. After molting several times, they start to grow wing pads on their backs. The wings develop inside the wing pads. When they naiads are ready to turn into adults, they crawl out of the water and molt one last time. After molting, they pump up the wings and fly away.

Figure 1. Example of Complete Metamorphosis with the Tortoise-shell Caddisfly (*Glossosoma*)

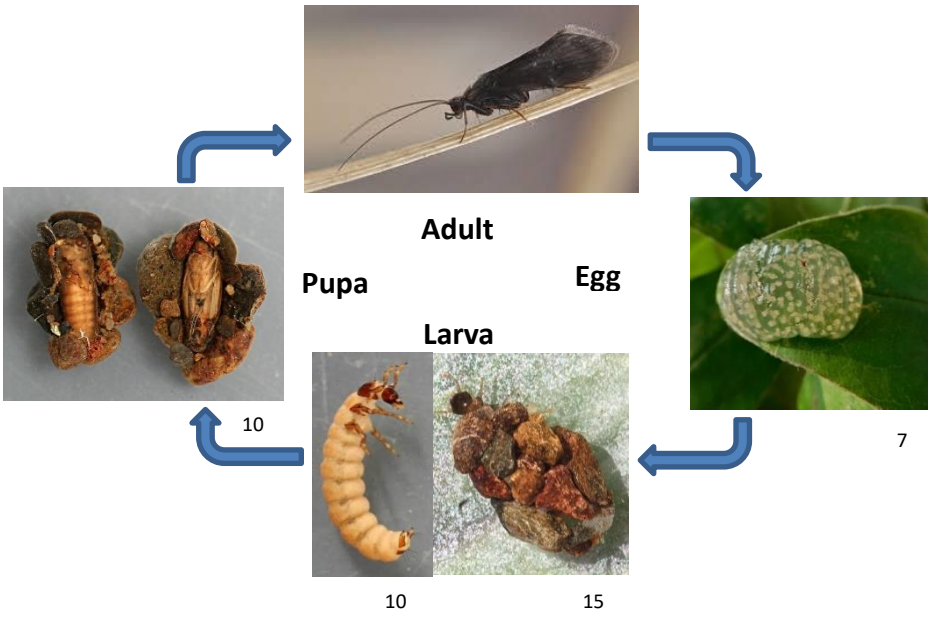
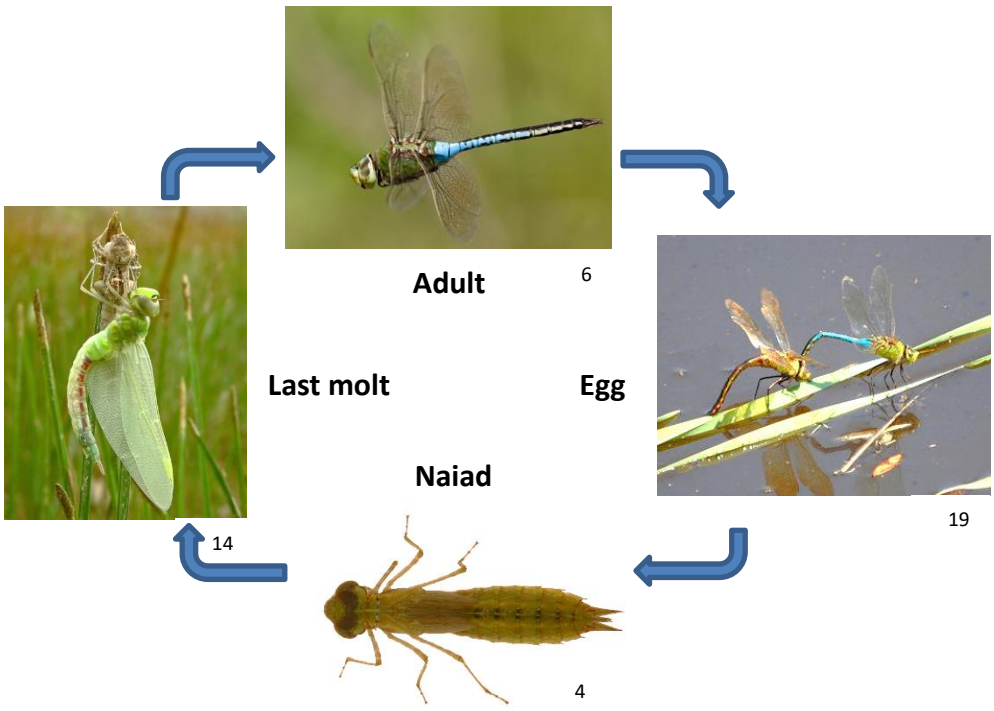


Figure 2. Example of Incomplete Metamorphosis with the Green Darner Dragonfly (*Anax junius)*



Some immature aquatic insects live in streams for only a few weeks before turning into adults, such as some kinds of non-biting midges. In contrast, some dragonfly naiads and dobsonfly larvae may live in streams for several years before leaving the water. After leaving the water, most adult caddisflies, dragonflies, and other insects have wings and can fly. Some may live for only a few days and do not eat as adults. For example, some mayfly adults live for a few days. Many mayflies, stoneflies, and caddisflies do not eat as adults. Some eat nectar or plants. Some adult insects may live for several weeks and eat a variety of foods. For example, adult dragonflies eat flying insects and some may live for several months. In comparison, adult crane flies eat nectar. As an adult, their main purpose is to find a partner, mate, and lay eggs. Many live in the forest and marshes that border the streams. If the forests next to the streams are cut down or otherwise damaged, then some adult insects will not have a place to live and may not be able to reproduce. Therefore, it is important to keep healthy forests and native plants next to our streams.

Maine is fortunate to have many streams with excellent water quality. Maine has water quality standards to keep our streams healthy, which include four classes: Class AA, Class A, Class B, and Class C. Class AA and A share the same environmental expectations, but Class AA have more restrictions on human activities. For example, dams and discharges of pollution are not allowed in Class AA streams. Since Class AA and A share the same environmental expectations, they will be grouped together as Class A for the remainder of this document. Each stream in the state has been assigned to one of these four classes by the State Legislature. DEP biologists collect and analyze samples of macroinvertebrates and algae from streams to determine if a stream attains biological criteria of its designated class (A, B, or C). DEP has collected more than 2,200 samples since the 1980s and has identified more than 1,400 different kinds of macroinvertebrates. Obviously, that is way too many kinds for volunteers to identify, so we had to narrow the list.

For the Stream Explorers project, we took the DEP sample results and grouped all species observations to the genus level. For example, if a sample had more than one species of it in the genus *Baetis*, then those species counts were added together in that sample. For each genus, we counted how many samples had that genus. Our next step was to remove uncommon genera from the list. We only included commonly seen macroinvertebrates in the Stream Explorers project. Finally, we grouped macroinvertebrates that have similar appearance and would be difficult to identify in the field. The resulting list of macroinvertebrates included some genera, some families, some groups of families, and some orders. For example, there is a kind of flatheaded mayfly, called *Epeorus*, that has a distinctive appearance by having only 2 tails compared to the other kinds of flatheaded mayflies that have 3 tails. It was worthwhile to keep *Epeorus* separate from the other flat-headed mayflies because it tends to occur in clean, cold streams and some of the other flat-headed mayflies are somewhat more tolerant of pollution.

Taxonomy of the *Baetis* mayfly

Kingdom – Anamalia, animals
Phylum – Arthropoda, arthropods
Class – Insecta, insects
Order – Ephemeroptera, mayflies
Family – Baetidae, small minnow mayflies
Genus – *Baetis*
Species – (examples) *B. bicaudatus*, *B. pluto*, *B. tricaudatus*

In contrast, all isopods collected in Maine streams were grouped to the Order level, Isopoda, because they have similar appearance and tolerance to pollutants.

After selecting the macroinvertebrates for this project, DEP biologists grouped them as being "sensitive", "moderately sensitive", or "tolerant" of pollution, habitat degradation, and poor water quality. Macroinvertebrates that were most common in streams that attain Class A water quality standards were put in the "sensitive" group. Macroinvertebrates that were most common in streams that attain Class A or B water quality standards were put in the "moderately sensitive" group. Finally, macroinvertebrates that were most common in streams that did not attain Class A or B water quality standards were put in the "tolerant" group. *Tolerant macroinvertebrates are not bad*. They can be found in the highest quality streams along with sensitive and moderately sensitive macroinvertebrates. Tolerant macroinvertebrates are simply tough. They have adaptations that allow them to survive in streams with poor water quality. For example, some of them reproduce several times each year and can recolonize streams after disturbances. Some of them have adaptations that allow them to live in warm water that contains little oxygen. For example, some midges (Chironomidae) have hemoglobin that helps them extract oxygen from the water, like the hemoglobin that helps our red blood cells carry oxygen. Other macroinvertebrates are tolerant of water that has been contaminated by road salt.

The way that we assigned macroinvertebrates to the "sensitive", "moderately sensitive", and "tolerant" groups is not perfect. It is common to have related species show a range of tolerance to pollution. For example, there are several kinds of net-spinning caddisflies. Many of the net-spinning caddisflies are moderately sensitive but some are tolerant of pollution and nutrient enrichment, such as *Cheumatopsyche*. A great abundance of *Cheumatopsyche* caddisflies can be an indicator of pollution. However, it is difficult to distinguish different kinds of net-spinning caddisflies in the field and we ended up keeping them all together in the "moderately sensitive" group.

Most macroinvertebrates in a healthy Maine stream will be sensitive or moderately sensitive. In addition, there will be several kinds of sensitive macroinvertebrates (Figure 3). Tolerant macroinvertebrates live in the nice streams too, but they will be less abundant than the sensitive and moderately sensitive kinds. High-quality streams often have low abundance of macroinvertebrates because upstream areas are mostly forested and nutrients in the water are scarce. Streams with upstream sources of nutrient enrichment often have a lot of macroinvertebrates, but still have many sensitive and moderately sensitive kinds (Figure 4). Streams that are overly enriched with nutrients will have an extreme abundance of macroinvertebrates, often with a great abundance of moderately sensitive or tolerant midges and caddisflies that obtain food by filtering water with nets that they construct. In contrast, severely polluted streams may have low overall abundance with no sensitive macroinvertebrates (Figure 5).

Figure 3. Macroinvertebrates from a stream with good water quality (Image credits: 20)

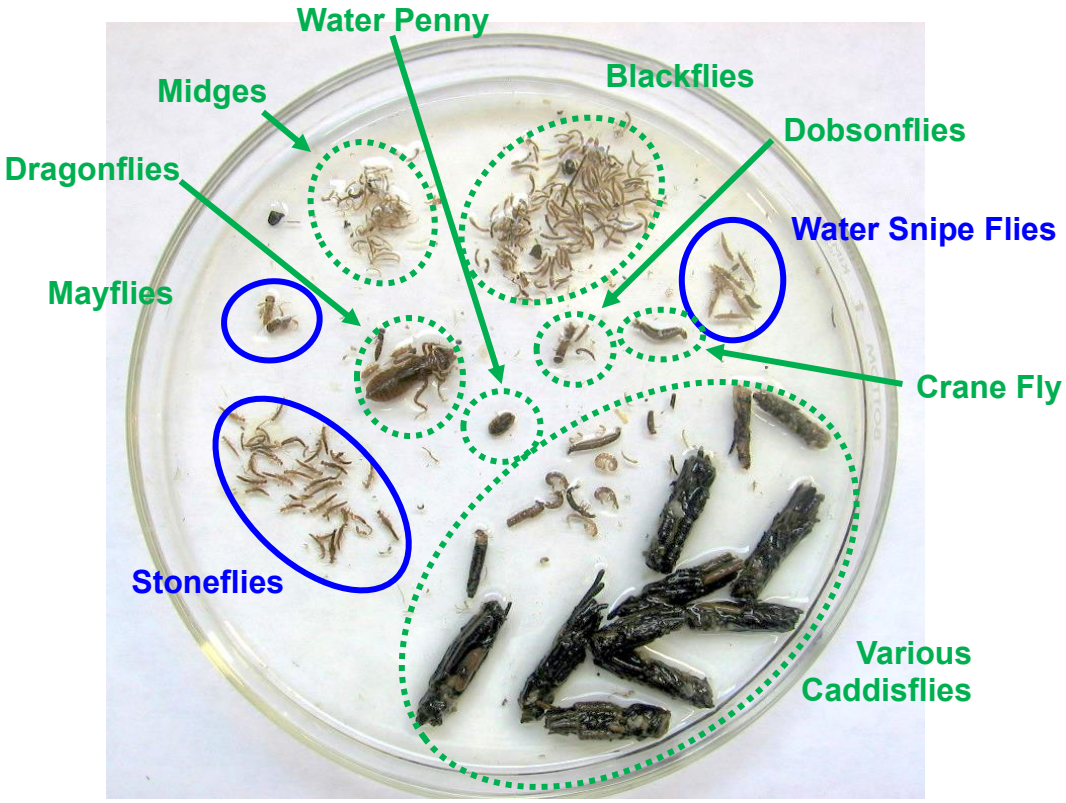


Figure 4. Macroinvertebrates from a stream that is moderately enriched with nutrients

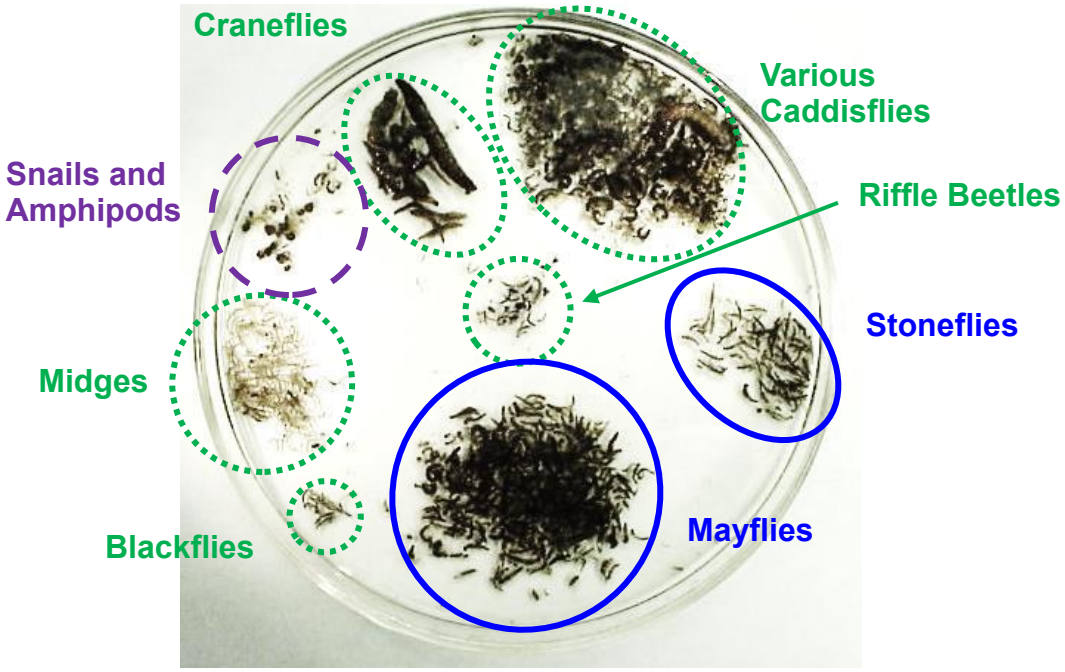
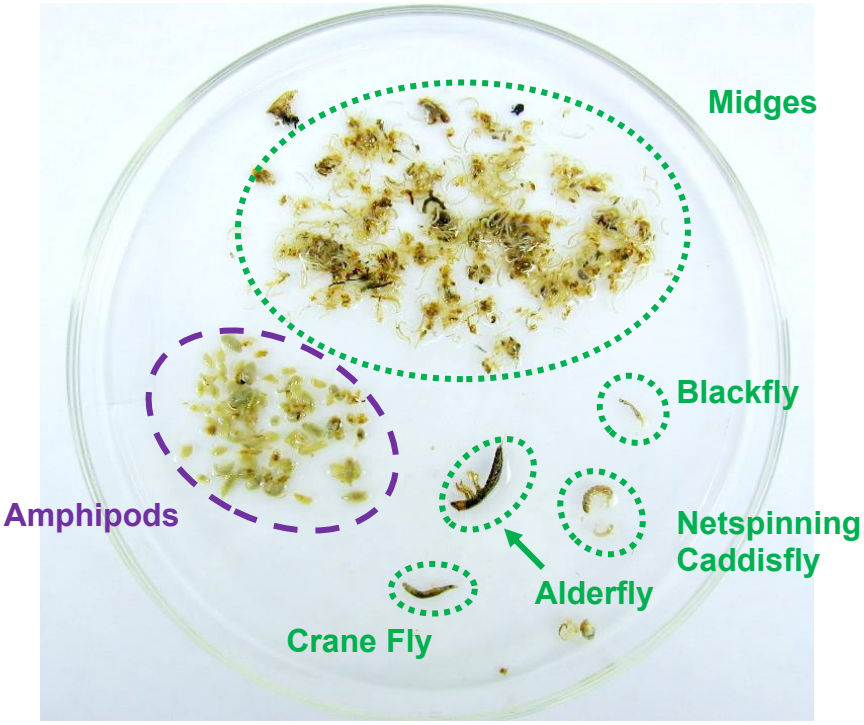


Figure 4. Macroinvertebrates from a severely polluted stream



Macroinvertebrate Descriptions

The taxonomic keys are restricted to the macroinvertebrates in this guide. There are many other macroinvertebrates not included in the keys or guide. The keys are designed for volunteers and are not as complex as those used by professionals. The pictures of macroinvertebrates in this guide are representative examples. Macroinvertebrates in the same group can come in many shapes, sizes, and color variations. Also, some of the specimens shown in this guide were preserved and may have different color than live organisms. The scale bars shown on the macroinvertebrate descriptions later in this guide show the range in the size of mature specimens. Young specimens are tiny and are smaller than the scale bars.

Most aquatic insects in Maine streams are naiads or larvae. It is helpful to become familiar with the basic body structures to use this guide. A larva has 1) a head, 2) a thorax comprised of three segments, and 3) an abdomen with 8-11 segments, depending on the species (Figure 5). Some larvae have a pair of segmented legs on all three thoracic segments. Some larvae have various bumps, prolegs (false legs), gills, and filamentous projections on the abdomen. Caddisfly larvae have hardened shields on the back of some or all thoracic segments. Some larvae have hooks on their rear end. Naiads have similar body structure but develop one or two pair of wing pads on thoracic segment 2 or segments 2 and 3 (Figure 6).

Figure 5. Body structure of a caddisfly larva (view from the side)

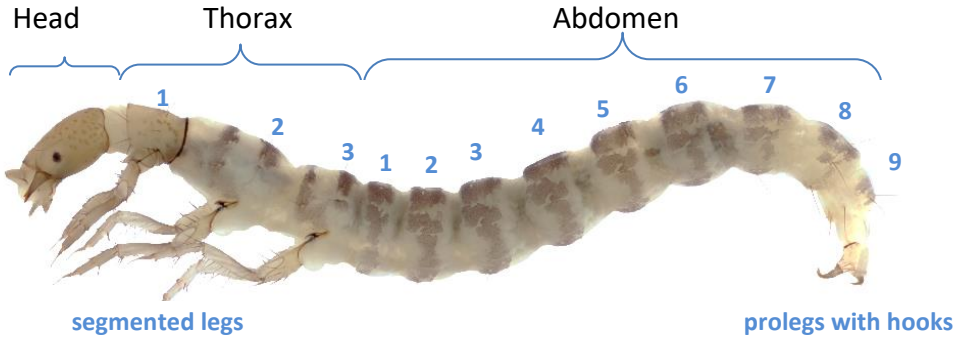


Figure 6. Body structure of a stonefly naiad (view from the top)

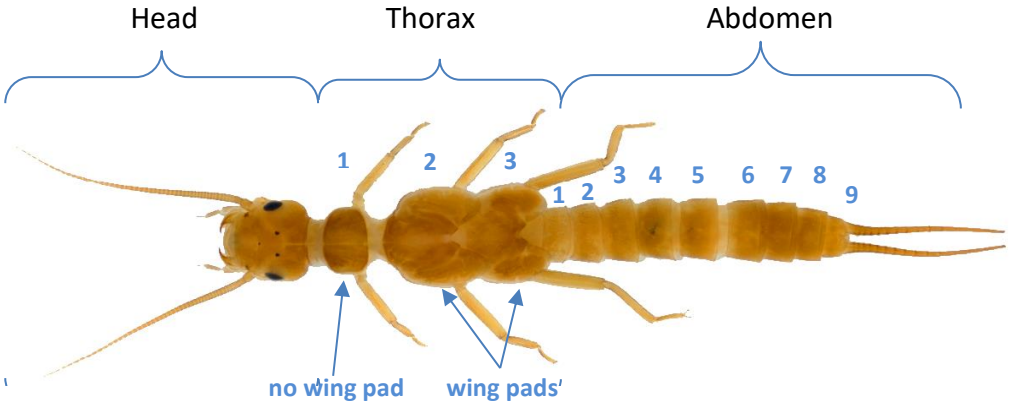


Image credits: 1

What do they look like as adults?

Here are some examples of adult forms of insects that live in streams as larvae or naiads. Each group may have a wide variety of shapes, sizes, and colors.

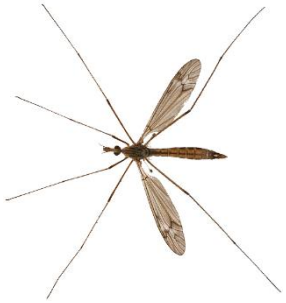
Alderfly [3]

Aquatic Dance Fly [12]

Blackfly [18]

Caddisfly [21]

Crane Fly [18]



Damselfly [17]

Dobsonfly [18]

Dragonfly [8]

Mayfly [18]

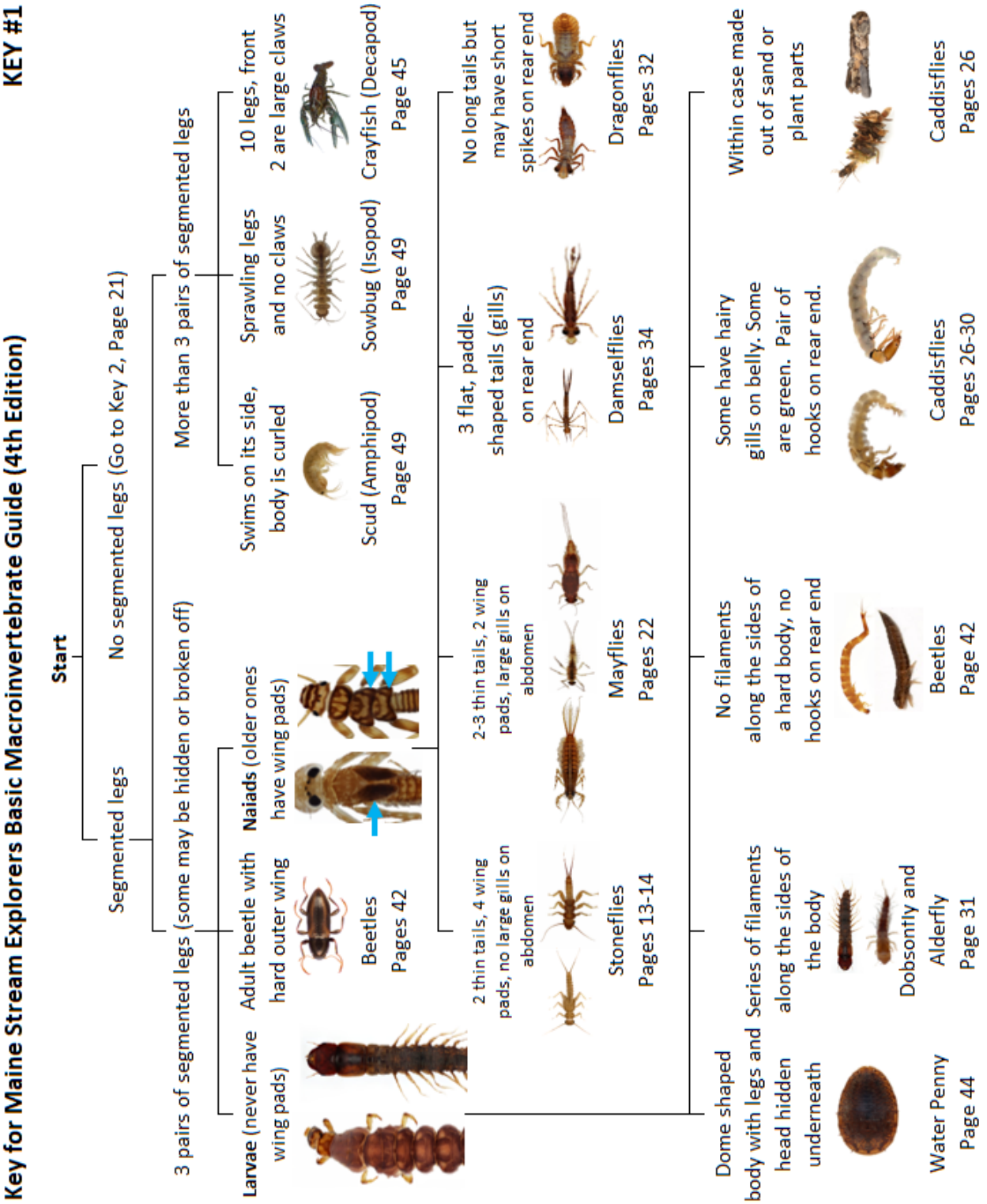
Non-biting Midge [21]

Stonefly [18]

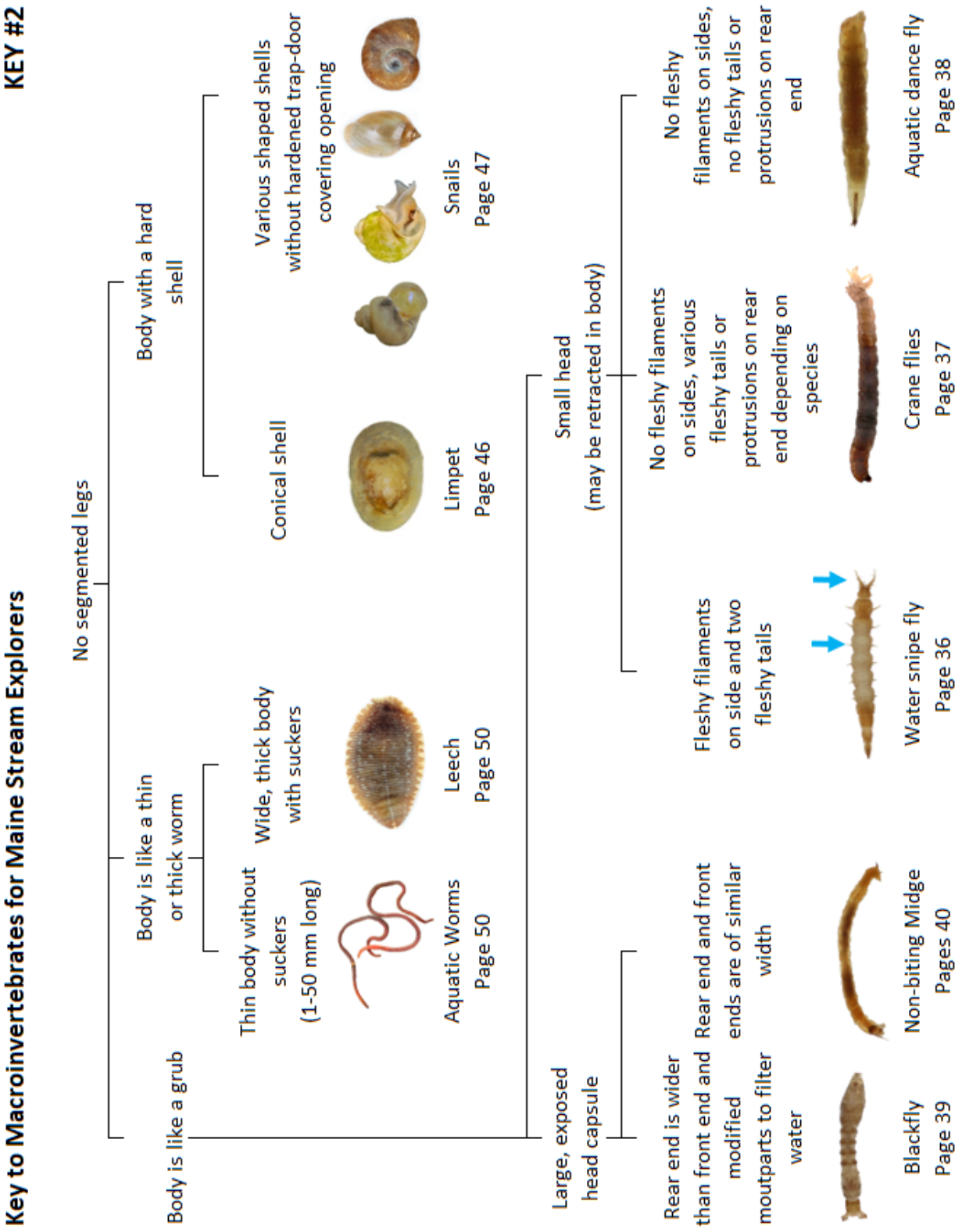
Water Penny [3]

Taxonomic Keys

Taxonomic Key #1 – Start



Taxonomic Key #2 – No Segmented Legs



SENSITIVE
(Most sensitive to pollution)

Taxonomy: Order Ephemeroptera

Mayfly

View from above

View from the side

Diagnostic characteristics

1. Has clearly distinguishable head, thorax with 6 legs, and abdomen
2. One pair of wing pads on the back of older larvae
3. Each leg ends with a single claw
4. Gills on the abdomen (some are shaped like leaves, some are covered by protective plates, and some our branched)
5. 3 thin tails (a few species have only 2 tails)

Behavior

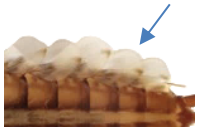
- Different species eat algae, detritus, and/or invertebrates
- Some are good swimmers with an up-down motion, like a dolphin

Environmental Sensitivity

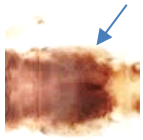
- Mostly occurs in clean, cold streams with good habitat
- Prefers streams with rocks
- Prefers moderate to swift flowing water
- Some kinds with gill covers are thought to be better able to live in turbid water

Variety of gills…

Shaped like a paddle or a leaf



Covered by a plate



Branched

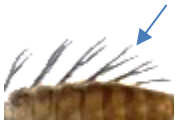


Image credits: 1

Length: 8-20 mm, excluding tails

Variety of Mayflies

1

Image credits: 1

SENSITIVE
(Most sensitive to pollution)

Taxonomy: Order Plecoptera

Stonefly

View from above

View from below

Diagnostic characteristics

1. Has clearly distinguishable head, thorax with 6 legs, and abdomen
2. 2 pairs of wing pads on back
3. Each leg ends with two claws
4. 2 tails
5. No gills on abdomen
6. Some have hairy gills in “armpits”

Stoneflies are among the most sensitive macroinvertebrates.

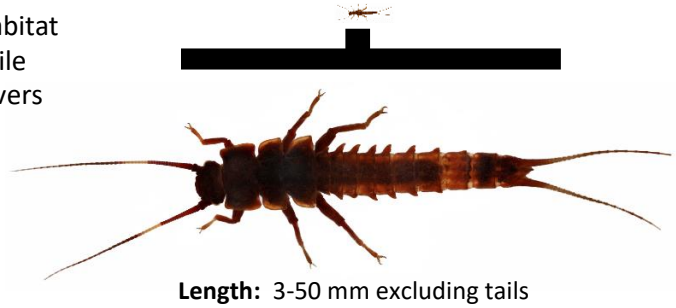
Finding stoneflies in a stream or river is a signal of good water quality.

Behavior

- Some kinds love to chew on dead leaves
- Some are predators

Environmental Sensitivity

- Mostly occurs in clean, cold streams with good habitat
- Some kinds are mostly found in small streams while others are most common in larger streams and rivers



Length: 3-50 mm excluding tails

Image credits: 1

Variety of Stoneflies

Image credits: 1

Taxonomy: Order Plecoptera

SENSITIVE
(Most sensitive to pollution)

Casemaking Caddisfly

Brachycentrus **(top view and case)**

Micrasema **(side view and case)**

Diagnostic characteristics

1. Has a head, thorax with six legs, and abdomen
2. Abdomen is soft and usually thick
3. Most have a pair of hooks on their rear end
4. Some have sparsely scattered filamentous gills on abdomen

Behavior

- They spin silk and use the silk to create cases made of rocks, sand, sticks, or plants
- They eat detritus, algae, and/or small invertebrates

Environmental Sensitivity

- Mostly occurs in clean, cold streams with good habitat
- Prefer moderately or swiftly flowing water
- Prefer streams with rocks, sticks, or plants

Image credits: 1

Length: 6-12 mm

Variety of Casemaking Caddisflies

9

Image credits: 1, 9

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Trichoptera

Netspinning Caddisfly

View of *Neureclipsis* (Polycentropodidae) from the side

Diagnostic characteristics

1. Has a head, thorax with six legs, and abdomen
2. Last abdominal segment has a pair of hooks on fleshy bumps
3. **The pair of bumps (prolegs) with the hooks are well developed**
4. **Areas between abdominal segment not deeply constricted**
5. **Usually pale cream to yellow bodies**
6. **No armor on the back of thoracic segments 2 and 3**
7. **No armor on the underside of last abdominal segment**

Environmental Sensitivity

- Occur in streams with good water quality but are often more abundant in nutrient-enriched streams
- Prefer rocky substrates
- Prefer streams with moderately or swiftly flowing water

Behavior

- **Spin nets with silk on the tops and sides of rocks (fine mesh)**
- Catch animal and plant matter in nets
- Will abandon nets when stressed

Neureclipsis makes a large silken net that is shaped like a cornucopia. Nets can be several inches long.

Netspinning caddisflies range in color from cream, to grey, brown, and lime green (they do not taste like limes, however).

They sometimes fight to take over nets or defend nets from interlopers (they make scraping vibrations to

Length: 10-25 mm

Image credits: 1, 20 (net)

Variety of Netspinning Caddisflies (Some are green)

9

Image credits: 1, 9 (larva in net)

SENSITIVE
(Most sensitive to pollution)

Taxonomy: Order Trichoptera

Freeliving Caddisfly

View from above (These are often green)

View from the side

Diagnostic characteristics

1. Looks like a caterpillar
2. Has a head, thorax with six legs, and abdomen
3. Last abdominal segment has a pair of hooks on fleshy bumps
4. **The pair of bumps with the hooks are well developed (prolegs)**
5. **Deep constrictions between abdominal segments**
6. **No armor on the back of where the 2nd and hind legs join the body (thoracic segments 2 and 3)**
7. **Armor on the back of the first thoracic segment**
8. **No gills underneath abdomen**

Mature people may compare them to the "Michelin Man" and younger folks have no idea what they are talking about.

They are sometimes a pretty blueish-green color.

Behavior

- **Do not spin webs or make cases**
- Active predators of other invertebrates
- Are more mobile than most caddisflies

Environmental Sensitivity

- Mostly occurs in clean, cold streams with good habitat
- Prefer clear water

Length: 11-18 mm (sometimes longer)

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Megaloptera
Family Corydalidae
Sialidae

Dobsonfly and Alderfly

***Nigronia* (Dobsonfly)**

above below

***Sialis* (Alderfly)**

above below

Diagnostic characteristics

- Has a head, thorax with six legs, and abdomen
- Abdomen has a series of well-developed filaments on their sides
- Head has large mouthparts
- **(Dobsonfly) abdomen ends with pair of prolegs, each with a pair of hooks**
- **(Alderfly) abdomen ends with a single, long tail**

Behavior

- Active predators of other invertebrates
- Dobsonflies are most common in rocky streams with moderately or swiftly flowing water
- Fishflies are most common in sandy and silty streams with deposits of wood and detritus

Environmental Sensitivity

- Usually live in clean streams but are somewhat tolerant of organic enrichment and warmer water
- Dobsonfly larvae take three years or more to mature before pupating and turning into an adult. (It is a good sign to see a dobsonfly in a stream!)

If you were as small as a blackfly, the sight of a dobsonfly approaching would be truly frightening.

They mostly breathe through their skin but they also can breathe air (a little). The filaments on their sides help them absorb oxygen from the water.

They rarely bite fingers but only when handled roughly.

Length: 25-90 mm (dobsonfly)
10-25 mm (alderfly)

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Odonata

Dragonfly

Boyeria

from above

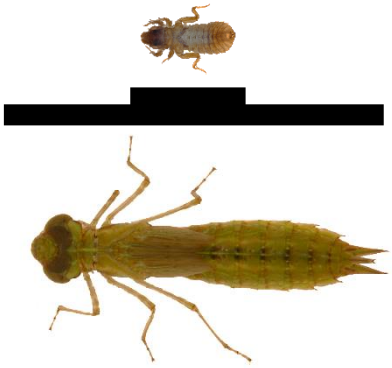
from below

Diagnostic characteristics

1. Has a head, thorax with six legs, and abdomen
2. 2 pairs of wing pads on back of older naiads
3. No visible gills (they are on the inside)
4. Their mouthparts are hinged and can extend forward
5. Lower lip of mouth (labium) is large and flat

Behavior

- These predators extend their hinged mouthparts to grab their prey (lightening quick!)
- Naiads will eat insects, small fish and amphibians
- Adult *Hagenius* dragonflies are known as dragon hunters because of their habit of eating other dragonflies (wow!)



Environmental Sensitivity

- Different species prefer rocky substrates or sandy substrates
- The larvae of some species spend more than a year in the water

Image credits: 1, 4 (*Anax*)

Length: 15-50 mm (up to 65 mm)

Variety of Dragonflies

Dragonfly mouthparts are hinged and extend to grab prey. The picture to the left shows the extended mouthpart.

4

Dragonflies can suck in water through their mouth and shoot it out of their rear end to jet forward (fart propulsion!)

Image credits: 1, 4

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Dameslfly

Taxonomy: Order Odonata
Family Calopterygidae
Broad-winged Damselfly
Genus *Calopteryx*

View from Above

View from Below

Diagnostic characteristics

1. Has a head, thorax with 6 legs, and abdomen
2. Has 2 pairs of wing pads on back
3. Their mouthparts are hinged and can extend forward
4. Long, slender bodies
5. 3 leaf-shaped gills that may look like tails

Behavior

- These predators extend their hinged mouthparts to grab their prey (lightening quick!)
- They eat other macroinvertebrates
- Poor swimmers, move with side-to-side motion
- They crawl on plants, tree roots, and between rocks in search of food
- Adults lay their eggs on aquatic plants, sometimes even going underwater to lay the eggs

Environmental Sensitivity

- Mostly occurs in streams with good water quality
- Are somewhat tolerant of warmer water

Adults jewelwings have shiny, metallic green, blue, and gold bodies depending on the species and the angle of the sun. There are three species in Maine. The most common is the ebony jewelwing which has a greenish/blue body and black wings.

Image credits: 1

Length: 20-29 mm, excluding gills (tails)

Variety of Damselflies

view from above

view from below

21

Image credits: 1, 21

SENSITIVE
(Most sensitive to pollution)

Watersnipe Fly

Taxonomy: Order Diptera
Family Athericidae
Watersnipe Fly
Genus ***Atherix***

View from Above

View from the side

Diagnostic characteristics

1. Does not have segmented legs
2. Small head that can be partially retracted into body
3. Abdomen has pairs of prolegs (not true legs) which help them hold on to rocks in fast current
4. **Abdomen has a series of pointy, fleshy filaments on the sides and two larger ones with hairs on the rear end**

Behavior

- These predators eat other macroinvertebrates
- They crawl between rocks in search of prey

Environmental Sensitivity

- They inhabit cold, clean streams with good habitat
- Are intolerant of warmer water
- They prefer streams with moderate current

Adults lay eggs on plants that hang over the stream. When the eggs hatch, the larvae fall into the water.

Aquatic dance flies look similar but do not have the filaments on the side or rear end.

Image credits: 1

Length: 10-18 mm

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Diptera
Families Limoniidae
Pediciidae
Tipulidae

Crane Flies

Antocha **(Limoniidae)**

Dicranota **(Pediciidae)**

Tipula **(Tipulidae)**

Diagnostic characteristics

1. Does not have segmented legs
2. Head is often retracted into body
3. Grub-like body
4. **Various projections and breathing parts on their rear ends**
5. **Do not have filaments on the side of the body**
6. **Some have prolegs, some have bumps, some have neither**

Adult craneflies look like giant mosquitoes with extra long legs.

The adults are peaceful vegetarians and do not bite, thankfully.

Behavior

- Most species are omnivores that eat detritus, algae, and small invertebrates
- *Dicranota* is a predator
- Most species are somewhat secretive because fish would find them quite tasty
- Some specialize on chewing on dead leaves and can be found in leaf packs
- Tipulidae are the largest crane flies (both larvae and adults)

Environmental Sensitivity

- Mostly occurs in streams with good water quality
- Are somewhat tolerant of warmer water
- They prefer streams with moderate current

Image credits: 1

Length: 10-25 mm but some Tipulidae can be more than 50 mm long

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Aquatic Dance Fly

Taxonomy: Order Diptera
Family Empididae
Aquatic Dance Fly
Genus ***Hemerodromia***

View from the side

View from below

Diagnostic characteristics

1. Does not have segmented legs
2. **Grub-like body with thin neck and small head**
3. **Several short projections on their rear ends**
4. **Do not have projections on the side of the body**
5. **Series of short prolegs on underside of body**

Behavior

- Predators of other invertebrates
- Prefer rocky streams with swift current
- Adults have an erratic flight pattern of twisting and turning above the water ("dancing")
- Some larvae will form pupa in blackfly cocoons after eating the blackfly (some house guest!)

Environmental Sensitivity

- Mostly occurs in streams with good water quality

In comparison, crane flies do not have prolegs on the underside of their bodies.

Watersnipe flies have filaments on the side of their bodies and two longer projections on their rear ends.

Length: 2-20 mm

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Diptera
Family Simulidae
Blackfly

Blackfly

View from above

View from side

View from below

Diagnostic characteristics

1. Grub-like body with head and no legs
2. **Has a small proleg below the head**
3. **Large, fan-like mouthparts**
4. **Swollen rear end**
5. **Rear end has a ring of tiny hooks that helps them attach to rocks and plants**

Behavior

- They anchor themselves to rocks and plants
- They filter water and catch food with their fan-like mouthparts (algae, detritus, tiny invertebrates)
- They can move around with an inchworm movement

Environmental Sensitivity

- Mostly occurs in streams with good water quality
- Are somewhat tolerant of warmer water
- They prefer streams with moderate current

They spin silken threads and can anchor safety lines to where they are located. If a dobsonfly, common stonefly, or other predator comes too close, they can let go of the rock and float downstream. The safety lines prevent them from floating away until they can find something to grab on to.

Length: 3-8 mm

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Diptera
Family Chironomidae
Non-biting midge
Chironomid (midge)

Non-biting Midge

Orthocladius
(from the side)

Tanytarsus
(from the side)

Diagnostic characteristics

1. Grub-like body with head and no legs
2. **Both ends of body have similar width**
3. **Pair of prolegs beneath head**
4. **Pair of prolegs on rear end (sometimes hairs too)**

Close to 400 kinds of midges have been collected from Maine streams, rivers, ponds, and wetlands. Almost all streams in Maine have some kind of midge living in them.

Behavior

- They sometimes wriggle on the bottom of collection pans
- Some make tube-shaped retreats out of silken threads can be found on rocks or in sediment
- Most eat algae, plants, and detritus but a few are predators
- Some make nets out of silk to catch food in flowing water
- They range in color from white to yellow

Environmental Sensitivity

- Species range from sensitive to tolerant
- Red midges (page 63) are tolerant of low dissolved oxygen concentrations

Length: 5-20 mm

Image credits: 1

TOLERANT
(Tolerant to pollution)

Taxonomy: Order Coleoptera

Red Non-biting Midge

Chironomus
(from the side)

Diagnostic characteristics

1. Grub-like body with head and no legs
2. **Both ends of body have similar width**
3. **Pair of prolegs beneath head**
4. **Pair of prolegs on rear end**
5. **Red or orange body color**

Behavior

- They sometimes wriggle on the bottom of collection pans
- They burrow and make silken tubes in sand and mud
- Most eat algae, plants, and detritus
- They range in color from orange to bright red

Environmental Sensitivity

- Tolerant of low oxygen concentrations

Red and orange midges have a substance like the hemoglobin in our blood, which makes our blood red. It helps them extract oxygen from the water, allowing these midges to survive in habitats where oxygen is scarce.

Length: 10-20 mm

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Coleoptera

Beetle

Views of a *Dubiraphia* adult

Dubiraphia larva

Macronychus larva

Diagnostic characteristics (Adult)

1. Head, thorax with 6 legs, and abdomen
2. Outer wing is a hard shell

Diagnostic characteristics (Larvae)

1. Head, thorax with 6 legs, and abdomen
2. No wing pads on back
3. Some have projections on the side of the body

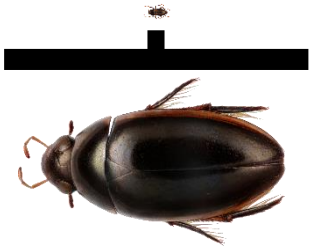
Behavior

- Most beetles are predators
- Some beetles eat algae and detritus
- Some kinds prefer fast flowing water and rocky substrates
- Some kinds prefer slow flowing water or ponds

Environmental Sensitivity

- Mostly occurs in streams with good water quality
- Some occur in urban streams with poor water quality but abundant oxygen and detritus to eat

Many adults have millions of tiny hairs on their bodies that trap a thin layer of air. They breathe the air from this bubble. Some adults swim to the surface to get fresh air. Some rely on oxygen transferring from the cold water to their air bubbles.



Length: 2-8 mm (adults) and up to 16 mm (larvae)

Image credits: 1

Variety of Beetles

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Water Penny

Taxonomy: Order Coleoptera
Family Psephenidae
Water Penny
Genus *Psephenus*

View from above

View from below

Diagnostic characteristics

1. **Distinctive flat, elliptical shape**
2. Head, thorax with six legs, and abdomen with gills (as seen from below)

Behavior

- Prefer rocky streams with moderately or swiftly flowing water
- Move around on top of rocks grazing on algae
- The streamlined body shape helps them stick to the top of rocks in fast currents and makes it harder for fish to eat them
- Adult beetles live on land near streams

Environmental Sensitivity

- Mostly occurs in streams with good water quality
- Somewhat tolerant to nutrient enrichment

It can be challenging to spot these in collection pans at first. Pick up any rocks or plants that are in the collection pan to see if the water pennies climbed on to them

Swirl water in the pan and look for the contrast of the swirling material and these beetles stuck to the bottom of the pan

Length: 3-10 mm

Image credits: 1

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Decapoda
Family Cambaridae
Crayfish, Crawdads

Crayfish

Spiny cheek crayfish (*Faxonius limosus*)

- Patch of spines on cheek, which are easy to feel and see
- Brown body and claws
- Some have reddish brown spots along center of their tail and silvery eyes

Northern Crayfish (*Faxonius virile*)

- Light-colored bumps on cheek and single spines on neck but not a patch of spiky spines on the cheek
- Blueish-green claws with orange tips and yellowish bumps
- Brown body
- Has a few spines on head

Rusty Crayfish (*Faxonius rusticus*)

- Non-native and invasive
- Prominent dark, rust colored spots on either side of the carapace
- Greenish-reddish claws with black bands at the tips

Behavior

- These species occur in a variety of stream habitats, from rocky to muddy
- They are opportunistic feeders that will eat almost anything, even live fish if they can catch them
- They can survive out of water for short periods of time if their gills remain wet
- They make burrows under rocks and in the mud
- Rusty crayfish are aggressive

Crayfish will flick their tails to swim backwards. They sometimes flick their tails when being held, which can startle people.

The best way to hold them is to pinch behind their claws on their carapace.

Environmental Sensitivity

- They mostly occur in streams with clean water but they can tolerate poor water quality to some degree
  - They are somewhat tolerant of warm water

Image credits: 16

Length: Up to 100 m

MODERATELY SENSITIVE
(Moderately sensitive to pollution)

Taxonomy: Order Basommatophora
Family Ancylidae
Limpet
Genus *Ferrissia*

Limpet

View from the side

View from above

Diagnostic characteristics

1. **This snail's unique shell is flattened with a wide opening that points down and a spire that points up and to the rear**
2. Its tentacles, eyes and mouth are located under the shell

These non-descript snails have both a an air bubble in the shell that functions like a primitive lung and gill-like structure to obtain oxygen from the water.

Behavior

- Grazes algae from rocks, logs, and plants
- The streamlined body shape helps them stick to the top of rocks in fast currents and makes it harder for fish to eat them
- Although easily overlooked because of their small size, limpets are widespread in Maine streams, lakes, and ponds
- Limpets have 1-2 generations per year
- Air is stored in a cavity inside the shell near the pointy end and functions as a "lung"

Environmental Sensitivity

- Mostly occurs in streams with good water quality but is somewhat tolerant of warm water and nutrient enrichment
- Can be found on rocks, logs, and mud

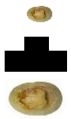


Image credits: 5

Length: 3-7 mm

TOLERANT
(Least sensitive to pollution)

Taxonomy: Order Neotaenioglossa
Family Hydrobiidae
Mud Snail

Snail

***Amnicola* (closed)**

***Amnicola* (open)**

Diagnostic characteristics

1. The shell opens to the right when held with the pointy end up and the opening facing toward you
2. Spiraled shell that is widest by the opening

Behavior

- Graze on algae and detritus plants, rocks, and mud
- Some have gills for obtaining oxygen from water
- Some breath air and carry an air bubble within their shells

Environmental Sensitivity

- Some streams with good water quality but is somewhat tolerant of warm water and nutrient enrichment
- They can be abundant in streams with a little nutrient enrichment
- Can be found on rocks, logs, and mud

It can be challenging to spot these in collection pans at first

Pick up any rocks or plants that are in the collection pan to see if they climbed on to them

Swirl water in the pan and look for the contrast of the swirling material and these snails stuck to the bottom of the pan

Length: 3-5 mm

Image credits: 5

Variety of Snails

Image credits: 5

TOLERANT
(Least sensitive to pollution)

Taxonomy: Order Amphipoda
Side-swimmer, Scud

Amphipod

Diagnostic characteristics

1. **More than 10 legs**
2. Some resemblance to shrimp
3. Legs are designed for swimming
4. It swims on its side

Behavior

- Eats algae, plants, and detritus
- Several generations per year allows it to recolonize after disturbance

Environmental Sensitivity

- Some species are tolerant of warm water
- Some species are common in urban streams
- Most common in sandy and mucky streams with plants or decaying organic matter

Image credit: 2

Length: 3-5 mm

TOLERANT
(Least sensitive to pollution)

Taxonomy: Order Isopoda
Isopod, Sowbug

Isopod

Asellus

Diagnostic characteristics

1. **More than 10 legs**
2. Legs are designed for crawling
3. Pair of appendages on rear end

Behavior

- Eats algae, plants, and detritus
- Several generations per year allows it to recolonize after disturbance

Environmental Sensitivity

- Some species are tolerant of warm water
- Some species are common in urban streams
- Most common in sandy and mucky streams with plants or decaying organic matter

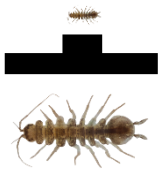


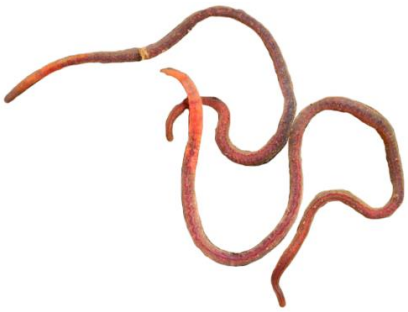
Image credits: 1

Length: 5-20 mm

TOLERANT
(Least sensitive to pollution)

Taxonomy: Order Tubificida
Aquatic oligochaete worm

Aquatic Worm



Diagnostic characteristics

1. **Long, thin, delicate segmented body**
2. Some have hairs on them
3. Grey to pink coloration

Behavior

- Eats detritus
- Several generations per year allows it to recolonize after disturbance

Environmental Sensitivity

- Some species are tolerant of warm water
- Some species are reddish because they contain hemoglobin
- Some species are common in urban streams
- Most common in sandy and mucky streams

Length: 1-30 mm

TOLERANT
(Least sensitive to pollution)

Taxonomy: Order Hirudinida
Leech

Leech

Placobdella

Diagnostic characteristics

1. **Thick, segmented body (A)**
2. Mouth adapted for sucking (B)
3. Sucker on rear end (B, C)
4. Range in color from cream to dark grey and brown
5. Bodies can stretch and contract like an accordion

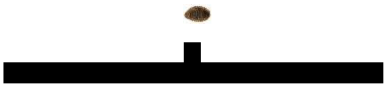
Erpobbdella

Behavior

- Most are predators and scavengers
- Some suck blood from animals
- Several generations per year allows it to recolonize after disturbance

Environmental Sensitivity

- Some species are tolerant of warm water
- Some species are common in urban streams



Length: 5-20 mm in Maine streams
(some pond leeches are larger)

Image credits: 1, 13 (*Erpobdella*)

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MAINE STREAM EXPLORERS

A treasure hunt to find healthy streams in Maine.

For information on how to volunteer, please contact Phillip Keefe with Maine Audubon at 207-781-2330, ext. 219 or pkeefe@maineaudubon.org

For help identifying macroinvertebrates, please contact Tom Danielson with the Maine Department of Environmental Protection at thomas.j.danielson@maine.gov