National Garden Clubs, Inc.
2015-2017 President's Project - The Frightened Frog
Amphibian Awareness Lesson Plan for Elementary School Children
National Science / Life Science Education Standards K-4

Key Concepts In Lesson Plan

1. Introduce the characteristics. (what makes an animal an amphibian?)
2. How are amphibians grouped? (orders & characteristics)
3. What are the structures and functions of each part of the life cycle? (example organism: Frog)
4. What are the important functions of amphibians in the ecosystem and to man?
5. What are the threats to extinction of amphibians?
6. What are some things you can do to help save amphibians?

Activities For Students

ACTIVITY 1 - IDENTIFYING CHARACTERISTICS OF ORGANISMS

1. Using photographs, or if possible life organisms, for demonstration: show characteristics of the three orders
2. Have students identify, on a diagram using matching (for younger students) visible differences (e.g. 4 legs, rough warty skin, smooth skin, external eardrum (tympanic membrane), parotid glands, no legs, external segmentation)
3. Using a matching worksheet, or cut and paste labels, have students put names on a toad, salamander, frog and caecilian.

ACTIVITY 2 - EXPLORE LIFE CYCLES OF ORGANISMS

1. If possible use life organisms for demonstration. Show pictures of tadpoles, adult frog, toad, mud puppy and salamander.
2. Using worksheet diagram of circular lifecycle: Color the stages of the lifecycle.
3. Have students cut out labeled diagram of life cycle and paste on white paper in the order they occur (egg, tadpole with legs, adult).
4. Show salamanders with external gills and describe how they can live in water and sometimes reproduce as a larval stage.

ACTIVITY 3 - ORGANISMS AND THE ENVIRONMENT

1. Make a list with the students of the reasons frogs and other amphibians are important to the environment (they may need coaching).
2. Have students look at a paper divided with the following images: a farmer spraying crops; someone filling in a pond with a bulldozer; someone gigging frogs; a pet frog in a tank. Ask students how each of these activities could endanger frog populations.
3. Work out a maze that shows how a tadpole can become a frog if he avoids the troubles on the maze.
4. Have students make posters or signs that explain the frogs problems and the student's feelings.
5. Read stories about frogs and toads or other organisms who are threatened by extinction.
6. Small groups might get together to go to another class to tell about the plight of these organisms.
7. Go over some animals that have gone extinct long ago, and recently. Be sure they understand it's a loss.
8. Remind them what the word STEWARDSHIP means, and ask them how each day they might do one thing that would make them good stewards of the Earth.

EVALUATION: DIAGRAMS, MATCHING EXERCISES, POSTERS, MAZE, CUT AND PASTE

Three Orders of Amphibians

Class: AMPHIBIA, 6000 species (approximately), Amphibia meaning "Double Life":
1/2 on land, 1/2 in water (with some exceptions).

Order *Anura* (without a tail) : **Frogs & Toads**
- Frogs have smooth, moist skin
- Toads have dry, bumpy skin
- Frogs have longer legs and more tapered bodies
- As adults, Toads return to water only to reproduce

Order *Urodela* (visible tail): **Salamanders and Newts**
- Are often brightly colored and vary in length from a few centimeters to about 1.5 meters
- Long body, long, tail and two pairs of legs. Some remain aquatic their entire life cycle by maintaining gills and are able to reproduce from the larval stage depending upon their environment.

Order *Apoda* (no legs): **Caecilians**
- Blind, burrowing animals, smooth skin, no limbs
- Look like earthworms but have vertebrae like other chordates
- Reside in S. America, Africa and Southeast Asia
- About 30 cm in length

Characteristics of Amphibians

1. Unshelled Egg: mostly jelly, most lay in water, some on land. Some lay eggs in leaves over water in rainforests: they hatch and fall into the water. In terrestrial species, metamorphosis occurs in the egg before hatching. Some have adapted to staying in the larval stage and can reproduce: mud puppies are an example of this characteristic.
2. Permeable Skin: substances move across it easily. Caecilians (a legless amphibian) have some scales. Most are aquatic in nature or dry out. Some have fatty secretions that help to keep from drying out. Some live in the desert and can form a cocoon underground to protect themselves from drying out. Some salamanders, like the Hellbender, spends its life in water.
3. Carnivorous Adults: Some tadpoles and larval salamanders are filter feeders that eat plants. All adults are carnivores. Most eat spiders, insects, earthworms, and some small vertebrates. Bullfrogs and bigger frogs eat snakes, fish, rodents and other frogs.
4. Great Diversity: They are found in many regions: Central and South America, West Africa and the Southern United States are very rich in fauna.
5. Courtship Rituals: All species have these. Some males call, females do not. Salamanders do not vocalize but many have complex dances and rituals.
6. Poikilothermic: They are unable to control their body temperature internally, so they match the temperature of their environment. They use basking in the sun and burrowing to help. Some people refer to animals of this type by the term “cold blooded”.

Examples of Amphibians

FROG	TOAD
	
SALAMANDER	CAECILIAN
	

Amphibian Life Cycle

Metamorphosis: Change in Structure from Larva to Adult

Some toads can complete their entire metamorphosis in 8 days. Bullfrogs can take two to three years to go through the change. **The average is somewhere between 6 and 21 days**.

Fertilization In Frogs and Toads Is External

Stage 1 - Eggs

- **Fresh laid eggs look like a mass of tapioca pudding.** They are mostly jelly and covered in a gelatinous substance that not only helps protect the egg but also provides some nourishment.

- **Most frogs and toads do not protect eggs**. They are eaten by fish, snakes and birds.

- **However, some do guard their eggs.** The poison arrow frog lays her eggs in the rainforest. When they hatch, the tadpole wiggles up onto her back and she carries it to water. The female Australian gastric-brooding frog swallows her eggs which develop in her stomach. Her digestive system shuts down, and 5 weeks later froglets emerge. The Asian tree frog secretes a small amount of fluid which she whips into a foam, and lays her eggs in a foam nest that hangs from a tree. When tadpoles hatch, the foam disappears and the tadpoles fall into the water below.

Stage 2 - **Larvae**

- **Eggs hatch into Tadpoles**. Depending upon the species and the environment it may take a few days to years for this to happen. The tadpole is adapted to living in the water. It has gills and a small hole on the side of the face to allow water to pass in and out through it called an “operculum”. It also has a lateral line system, like a fish, to detect changes in the surrounding water. It has a snout appendage on its face to eat plant matter and plankton.

- **Changes in development are triggered by a hormone called thyroxine**. Genes in the frog make it sensitive to the thyroxine at the appropriate times.

- **As the larvae develops its tail is absorbed.** The lateral line system disappears. The back two legs form followed by the front legs. As the front legs form, the “operculum” (hole in the face) closes and the gills form. The mouth becomes less beak-like, and the digestive tract shortens to change from herbivore to carnivore. The two chambered heart becomes three chambers. Eyelids develop to protect the eye. Caecilians are blind, but they can tell dark from light - they just can’t see images.

- **Some aquatic salamanders remain in the larval stage**. They maintain gills and are able to reproduce without maturing into an adult first. This is called Pedomorphosis. The mud puppy of the southeast United States has both gills and lungs.

- **Some salamanders have different stages in development but are the same organism**. The red spotted newt and the red eft salamander are different stages of the same species. The newt spends most of its life in water, but becomes terrestrial during the mating season.

Stage 3 - Adulthood

- Frogs and toads have powerful leg muscles for movement. Toads have shorter legs and hop shorter distances.
- Salamanders move from side to side like a fish. They are very good swimmers due to their long tails.
- Caecilians have no legs and burrow (and move) like earthworms.

Frogs and toads **absorb oxygen** from their lungs, skin and the roof of their mouth. They all **need to stay moist**: toads have a dryer skin. Amphibians can **secret mucous from their skin**. It protects them from drying out and is often **poisonous to predators**. People who eat frogs must remove the skin first.

Frogs and toads hear very well. They have large tympanic membrane on the side of their head and can **hear very well both above and below water**. Male frogs have pouches in their throat to make **calling sounds**. Salamanders do not make calls, but make **squeaky sounds** instead.

Frogs and salamanders return to the same body of water every year to reproduce. This often involves a very **strong homing instinct** triggered by their response to the Earth's magnetic field and polarized light from the sun.

How Frogs Protect Themselves Naturally

- They are slimy or slick, making them hard to catch or hold onto
- They secrete substances that make them taste bad
- They secrete poisonous substances
- They use camouflage and blend into their environment
- They swim very well - however, they're not very mobile on land
- They use aposematic coloration to warn predators of poisons in their body

Ecological Significance

Amphibians have been around since the Devonian period (the Carboniferous period is known as the Age of the Amphibians). They have overcome major ecological changes and still managed to carry on. Normally an amphibian is lost to extinction 1/500 years. The rate now has gone to the loss of 200 species in 35 years. EXTINCTION IS FOREVER. If not protected, the genetic makeup of an important species will be forever gone.

Important Functions Of Amphibians In The Ecosystem

1. Their skin is permeable and works as a lung and a kidney. They are susceptible to environmental changes and are known as BIOINDICATORS or ECOLOGICAL INDICATORS.
2. They are an important ally in the control of insects. Many of their prey destroy crops or carry diseases. Grasshoppers, crickets, mosquitos, biting flies, etc.
3. They are important in both freshwater and terrestrial ecosystems. They remain an important food source for snakes, birds, monkeys, fish and humans.
4. They have provided a long list of medical advances. Maganin from the African clawed frog is a natural antibiotic and is used to treat diabetic foot problems. The chemistry of the waxy monkey frog was used in the development of Dermaseptin which treats antibiotic resistant Staphylococcus. Caerin is a drug from White's tree frog that blocks HIV transmission. Bradykinin , which is used to lower blood pressure, comes from the Fire Bellied toad and works by enlarging blood vessels as well as relaxing smooth muscles. Epibatidine is a painkilling substance developed from poison dart frogs that is 200 times more potent than morphine. Their poisons show promise as muscle relaxants and stimulants as well as appetite suppressants.

Threats to Amphibian Populations World Wide

Pollution
Frogs need clean water to extract oxygen. They are sensitive to chemical changes in the water because their skin is so permeable. Thermal pollution is a problem: their internal temperature is controlled by their environment. In the United States near agro-ecosystems we are experiencing Eutrophic Conditions in the water sources: higher ph, higher water temperature, un-ionized ammonia. All of these things can lead to frog embryo mortality and malformations. Herbicides and pesticides have a dramatic effect on frog mortality. Atrazine, a commonly used herbicide, is especially damaging as it interferes with hormone function, leading to a variety of malformations and death.

Habitat Loss
This is a serious issue world wide. The world's population is growing. There are more people who need and to live on and grow food. This is a serious problem for frogs. Their environmental needs are very specific and they can't just move somewhere else. The recent drought in California and the southwest United States has hurt the amphibian populations.

Climate Change
The ozone hole has increased in size allowing for more ultraviolet radiation in the environment. This effects the developing embryos in the egg.

Invasive Species
Introducing organisms that fed on amphibians. Example: There were lakes in the mountains with no trout. The state introduced trout to the lakes. There was a large population of yellow legged frogs. The trout ate the eggs, tadpoles and adults. The population dropped by an estimated 90%. They removed the fish from the environment.

Road Mortality
This comes with habitat loss. Expanding road systems to give people better access to aquatic ecosystems.

Overharvesting
Eating frogs has been a part of cultures for centuries. However, with expanding populations, the same aquatic systems can't supply the people with organisms. Amphibians are often collected for the pet trade. This collection is putting added stress on an already troubled group of organisms.

Chytrid Fungus: Batrachochytrium dendrobatidis (BD)
It is a pandemic. This fungus is found all over the world, attacking the skin cells making the skin thick and heavy. Frog skin is a very important organ allowing the frog to absorb water and oxygen. It regulates salts and wastes through it's skin. This is a fatal infection. "Worse infectious disease over recorded in Vertebrates". (Gascon et al, 2007)

What We Can Do To Help

1. When using chemicals on the garden, be aware of runoff patterns. Do not use more than the recommended amount on the package. Be aware of wind patterns. Don't put old medicines on the ground or in situations where they could become part of the water source. Be aware of climate changes: if a drought occurs in your area for a short time, they will recover. However, if you find tadpoles or eggs in a drying puddle, you might move them to a safer place.
2. Don't move amphibians from one ecological place to another. They carry diseases to new populations. It's better to protect them where they are living.
3. Don't capture amphibians for pets. They have very specific needs for their skin and food source. They become stressed and that can lead to disease.
4. Support conservation groups. Tell your friends about the problems of the frog.
5. Stop eating frog legs. They are disappearing in the wild and the ones that are commercially grown in wetlands help spread frog disease. Support groups who are doing research on an antidote to Chytrid fungal infections. Antibiotics are being studied as is the genetics of small resistant populations

You and I have a responsibility to care for all we are given.

Leap Into Action!

The Vanishing Frog

Title	Save My Species
Grade Level	3rd – 5th
Lesson Duration	2 - 3 class sessions. Time outside of class
Curriculum Focus	Science, Social Studies, Language Arts, Visual Arts, Technology

STUDENT OBJECTIVES

- Investigate the current situation and reasons behind the global amphibian crisis.
- Draw conclusions, summarize, and present important information about the plight of amphibians.

MATERIALS

- Computer with access to the Internet
- Four signs, each with one of the following phrases: climate change, pollution, disease, and habitat loss.
- Tape
- Flip chart (optional)

PROCEDURES

Note: Before the lesson, place four signs (see above) in different corners of the room.

1. As students enter the room, tell them you need their help solving a mystery. Read or ask a student to read aloud the statement below:

Do you know that the world's frogs are mysteriously disappearing? Frogs have been around since the days of the dinosaurs. That's more than 360 years. They've lived through many events and changes but something is making them disappear. In the past few decades, as many as 130 species of frogs and other amphibians may have been wiped out. Right now, almost one half of the world's amphibian species are threatened with extinction. That would be the largest mass extinction since the disappearance of the dinosaurs! Why are the frogs disappearing?

2. Explain to students that there are four signs around the room. (See above.) On each sign is written a reason why the frogs might be disappearing. Have students read the signs aloud. Then challenge them to get up and stand by the sign that they think represents the reason why frogs are disappearing.

3. Once students are standing by the sign that represents their guess, encourage them to justify their choice.

4. Congratulate all students because they are all correct! All four explanations help to explain why frogs are disappearing. But that answer alone can't help to fix this problem for the frogs.

5. Have students return to their seats. Ask how they feel about the frogs disappearing. Do they know what role frogs play in our world? How might the disappearance of frogs impact their lives? Would they want to help the frogs if they could?

6. Explain that scientists, researchers, ecologists and many others all over the world are trying to save the frogs. One of the ways that scientists help is by asking and answering questions that start with "who, what, where, why and how."

7. Challenge the class to brainstorm as many "who, what, where, why and how" questions as they can about this alarming situation. Record the questions on the board or a flip chart.

The Vanishing *Frog*

Questions could include:

Who?
Who are the frogs that are disappearing?
Who is trying to save frogs?
What?
What are scientists and others currently doing to help the frogs?
What role do frogs play in our ecosystem?
What do frogs need to survive?
What are the dangers of the extinction of frogs?
What is the name of the disease that is killing the frogs?
Where?
Where are the frogs disappearing?
Where can frogs go to be saved?
Where can I find more information?
Why
Why are the frogs disappearing?
Why is this a global crisis?
Why are climate change, pollution, habitat destruction and disease killing the frogs?
How?
How do frogs help our environment?
How can we help the frogs?
How many frogs have disappeared?
How does the plight of the frogs impact me?

8. Divide students into groups. Then tell students to imagine that they have been asked by the Governor of their state for a briefing about the plight of the frogs. Once he or she receives this briefing, a decision will be made whether to include information about the crisis in the annual State of the State address. You may want to share with students that Governors use this annual speech to report to the state legislature and the people about important national and global issues that have an impact on their state. From these issues, new laws are and initiatives are and public support is gained for new programs.

9. Ask student groups to select 3-5 questions from the list they've developed. They must include questions from at least three different questioning categories. (If possible, have each group select unique questions so that no question is repeated). Encourage groups to use the Internet as well as any other available research resources. A list of useful Web sites is below.

10. Once students have answered their questions, challenge them to summarize and present the information into a three minute presentation for the "Governor!"

DISCUSSION QUESTIONS

1. Discuss the differences between extinct, endangered and threatened species.
2. All living things in an ecosystem depend on each other for survival. How does the plight of the frog likely impact the entire ecosystem in which they live?
3. Do students know of any animals or species that are threatened or endangered in your community? What things do students think they can do to help these animals? What other things can students do to help the environment?

4. Scientists say that the plight of the frogs is a warning sign for the environment. Why might this be?
5. Ask students if they think it's our responsibility to help endangered animals? Why or why not?
6. One way that people can help the frogs is to donate to groups that are trying to help them. How might donations help? Would students consider donating their own money to help the frogs?
7. How do students feel about frogs? What frogs can they name from stories, songs or television shows?

ADAPTATION/EXTENSION

Have students observe a local ecosystem such as a pond, creek, wooded area or even a puddle. Have them list the living and non-living things that make up the ecosystem and create a chart that shows the interactions between them. Have them imagine how the ecosystem would change if one of the organisms died or was removed.

ASSESSMENT

You can evaluate your students using the following three-point rubric:
Three points: Students use sound reasons to justify what is killing the frogs; work cooperatively in groups; accurately research answers to the questions they've chosen; develop and present a well-written
summary.
Two points: Students use somewhat sound reasons to justify what is killing the frogs; work somewhat cooperatively in groups; accurately research most answers to the questions they've chosen; develop and present an adequate summary.
One point: Students are unable to use sound reasons to justify what is killing the frogs; need assistance to work cooperatively in groups; accurately research some answers to the questions they've chosen; develop and present an adequate summary.

VOCABULARY

Amphibian
Definition: Any of the class of cold-blooded vertebrates such as frogs, toads and salamanders intermediate between fishes and reptiles; they have gilled aquatic larva and air-breathing adults.
Context: Frogs and toads are amphibians because they spend part of their lives in water and part of their lives on land.
Ecosystem
Definition: A system formed by the interaction of a community of organisms with their environment
Context: Amphibians are a very important part of the ecosystem.
Endangered
Definition: Threatened with danger or extinction.
Context: The bald eagle is classified as an endangered species.
Extinct
Definition: No longer in existence; died out.
Context: When a species is extinct, that means there are no longer any animals of that kind on the Earth.

The Vanishing Frog

Fungus
Definition: Any of a large group of thallophytes which are parasites on living organisms or feed upon dead organic material.
Context: The chytrid fungus threatens the world's amphibians.
Habitat
Definition: The place or environment where a plant or animal naturally lives and grows.
Context: A frog's habitat is usually a swampy wetland area.
Plight
Definition: A dangerous situation
Context: Scientists are working around the clock to uncover clues on the frogs' deadly plight.
Population
Definition: The total of organisms inhabiting a particular locality.
Context: A decline in the world's frog population is a warning sign for the environment.

ACADEMIC STANDARDS

This lesson plan may be used to address the academic standards listed below. The standards listed are drawn from the National Education Science Standards.
Grade Level: K-4
Content Standard: Science as Inquiry: Understandings about Scientific Inquiry
Benchmarks: Scientists use different kinds of investigations depending on the questions they are trying to answer.
Grade Level: 5-8
Content Standard: Science as Inquiry: Abilities to do Scientific Inquiry
Benchmarks: Think critically and logically to make the relationships between evidence and explanations.
Grade Level: K-4
Content Standard: Life Science: The characteristics of organisms
Benchmark: Organisms have basic needs; the behavior of individual organisms is influenced by internal cues and external cues.
Grade Level: K-4
Content Standard: Life Science: The life cycles of organisms
Benchmarks: Plants and animals have life cycles that include being born, developing into adults, reproducing and eventually dying; many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interaction with the environment.
Grade Level: 5-8
Content Standard: Life Science: Structure and Function in Living Systems
Benchmarks: Disease is a breakdown in structures or functions of an organism.
Grade Level: 5-8
Content Standard: Life Science: Diversity and Adaptation of Organisms
Benchmarks: Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.
Grade Level: K-4
Content Standard: Science in Personal and Social Perspective: Changes in Environments
Benchmarks: Changes in environments can be natural or influenced by humans; some environmental changes occur slowly, and others occur rapidly.

WEBSITES: www.amphibianark.org
http://animal.discovery.com/tv-shows/other/videos/vanishing-frogs.htm

The Vanishing *Frog*

Title	Save My Species
Grade Level	6th – 8th
Lesson Duration	2-3 class sessions
Curriculum Focus	Science, Social Studies, Language Arts, Visual Arts, Technology

STUDENT OBJECTIVES:

- Research an endangered or threatened amphibian species.
- Identify strategies for saving one amphibian species.
- Persuade others to take action to save the species.

MATERIALS:

Computer with access to the Internet

- Downloaded photographs of Endangered Amphibians (ex. Panamanian golden frog, Wyoming toad, Corroboree frog, Kihansi spray toad, etc.) http://www.amphibians.org/amazing-amphibians OR http://www.iucnredlist.org/initiatives/amphibians
- *Endangered Amphibian* cards
- *Amphibian Investigation* Student Activity Sheet
- Books, magazines, journals with information about amphibians
- Materials specific to chosen presentation, i.e., technical equipment for video presentation, access to computer for Power Point presentation, art materials for poster, etc.

PROCEDURES:

Note: Before the lesson, download copies of endangered amphibian photographs. Hang them in an area where students can see them.

1. Have students view the photographs of Endangered Amphibians and ask them to guess what the animals in the photographs have in common. Students may identify that all are frogs or amphibians. They may not realize, however, that all of the animals in the photographs are in danger of becoming extinct.
2. Ask students what it means when an animal becomes extinct. Why might this occur? What other extinct species can students name?
3. Give students time to explore the *Amphibian Ark* site (www.amphibianark.org) where they will learn about the current plight of the world's amphibians. Have students share their thoughts and feelings about the current situation.
4. Discuss:
    a. How does the plight of the amphibians impact students?
    b. Why should it matter to us that amphibians are becoming extinct?
    c. Whose responsibility is it to help save the amphibians?
5. Have students generate a list of ideas that could help save amphibians around the world. Their list could include raising or donating money, writing letters, raising awareness, habitat & wetland restoration, bringing a species to a zoo or safe place, researching a cure for chytrid fungus, volunteering at a zoo, etc. Review each idea and have students identify those that they would personally do to help save the amphibians. Which strategies seem most realistic for students to implement?

6. Divide students into teams of three or four. Tell teams that they will study one endangered amphibian species and design specific strategies to help save it.
7. Fold and place the *Endangered Amphibian* cards into a box or container. Have each team choose a card that will reveal which amphibian they will help save.
8. Once all teams have chosen their cards, explain that each team's first step is to learn as much as they can about the amphibian they've chosen. Distribute and review the *Amphibian Investigation* student activity sheet with the class.
9. Point out that the final stages of their research include a justification for saving their amphibian and specific strategies that can help save it.
10. Distribute research resources and give students computer access to complete their research. A list of helpful Web sites is below. Students likely will need one to two class sessions to complete the student activity sheet.
11. Once students have completed their research, have each team discuss the strategies and solutions that could help save their amphibian. Then challenge them to create a project, based on one of these solutions, to help save their amphibian. (Project ideas include a persuasive letter or presentation to Congress or potential corporate or individual donors; fundraising action plan; public service announcement, commercial; poster; brochure; newspaper editorial, research or Web site. Their project should include compelling reasons why their amphibian should be saved.
12. Have teams present their projects to the rest of the class.

EXTENSIONS:

• Organize a group of faculty, community leaders or parents to serve as a judging panel to determine which student presentation is most compelling. Have the class work together to implement an idea that can actually help save the winning team's amphibian.

• Many endangered amphibians are right in our backyard. Have students go to http://cgee.hamline.edu/frogs/science/Threatened.pdf where they will find a list by state of endangered amphibians. Encourage them to brainstorm ideas to help endangered amphibians in your local area. (PDF may not be kept up to date)

• Take a habitat walk to a local stream. Observe the plants and animal life in and around the stream as well as the environmental factors that affect both. Have students draw conclusions about their observations.

ASSESSMENT:

You can evaluate your students using the following three-point rubric:
3 points: Student teams collect sufficient and accurate data about their endangered amphibian; design appropriate strategies to help save their species; transform their data into a well-designed project to save
their species; share compelling and accurate reasons why their species should be saved.
2 points: Student teams collect some data about their endangered amphibian; draw somewhat appropriate conclusions about projects to save their species; create an adequate project to save their species; share some reasons why their species should be saved.
1 point: Student groups collect inadequate or incomplete data about their endangered amphibian; are unable to create strategies to help save their species; are unable to transform their data into a project to save their species; share some reasons why their amphibian should be saved.

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Ecosystem
Definition: A system formed by the interaction of a community of organisms with their environment
Context: Amphibians are a very important part of the ecosystem.
Endangered
Definition: Threatened with danger or extinction.
Context: The bald eagle is classified as an endangered species.

Extinct Definition: No longer in existence; died out. Context: When a species is extinct, that means there are no longer any animals of that kind on the Earth.

Threatened
Definition: Likely to become endangered or extinct if not protected.
Context: Many of the world's amphibians are currently threatened.
Habitat
Definition: The place or environment where a plant or animal naturally lives and grows.
Context: A frog's habitat is usually a swampy wetland area.
Plight
Definition: A dangerous situation
Context: Scientists are working around the clock to uncover clues on the frogs' deadly plight.
Population
Definition: The total of organisms inhabiting a particular locality.
Context: A decline in the world's frog population is a warning sign for the environment.

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Benchmarks: Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.

ENDANGERED AMPHIBIAN CARDS

MISSISSIPPI GOPHER FROG	BARTON SPRINGS SALAMANDER	TITICACA WATER FROG
HOUSTON TOAD	PANAMANIAN GOLDEN FROG	MOUNTAIN YELLOW-LEGGED FROG
PUERTO RICAN-CRESTED TOAD	CORROBOREE FROG	WYOMING TOAD
SPINY GIANT FROG	ETHIOPIAN SHORT HEADED FROG	KIHANSI SPRAY TOAD
GOLDEN MANTELLA FROG	WHITE-BELLIED FROG	THE BLEEDING TOAD

The Vanishing *Frog*

Amphibian Investigation Student Activity Sheet

Common Name of Amphibian:

Scientific Name:

IUCN (International Union for the Conservation of Nature) Status:

Description (color, weight, etc.)

Distinguishing Features:

Location:

Habitat:

Diet:

Major Threats:

Reason(s) why this amphibian should be saved:

Specific solutions/strategies that could help save this amphibian:

The Vanishing *Frog*

Title	Save My Species
Grade Level	9th -12th
Lesson Duration	23 class sessions. Time outside of class
Curriculum Focus	Science, Social Studies, Language Arts, Service Learning

STUDENT OBJECTIVES

- Debate critical issues about the current global plight of the amphibians.
- Identify specific strategies that could help save the amphibians.
- Create an action plan for applying service to their own community.

MATERIALS

- Computer with access to the Internet
- *Plight of the Amphibians: How Much Do You Know?* student activity sheet (one for each student)
- *Leap to Serve: Making a Difference in My Community* planning sheet (one for each student)
- Local newspapers
- List of local organizations that welcome student volunteers

PROCEDURES

1. Write the following headline on the board, *"Breaking News: World's Frog Population Extinct."*
2. Ask students to react to this headline. Do they think it's true? Do they think it could be true? Justify answers.
3. Explain that scientists around the globe are fearful that this headline could one day be true. Have students share what they know, if anything, about the current situation that faces the world's amphibians.
4. Distribute the *Plight of the Amphibians: How Much Do You Know?* student activity sheet. Individually or in groups, challenge students to answer the questions to the best of their ability.
5. Then direct them to www.amphibianark.org where they can research the answers to these questions and learn more about the current situation and what is being done to help.
6. Review the correct answers (see below).
7. As a class or in small groups, discuss the following with students:
    a. Who is responsible for saving the amphibians? What would happen if no one felt responsible?
    b. In what ways do humans positively and negatively impact the amphibians?
    c. Should students care about the plight of the amphibians? Why or why not?
    d. In what way(s) can students help save the amphibians?
8. Challenge students to create a list of ideas for how they could actually help the world's amphibians (donate money, raise money, raise awareness, change their lifestyle, etc.) and survey students to see which they would actually do.

9. Ask students what they think their role or responsibility is in helping to impact or solve problems globally, nationally and in their own community? Do students think they have the power to make a difference in their own communities? Do students currently do anything to positively impact the community? If so, what?
10. Share with students the results of a recent survey that more than 10 million students between the ages of 12-18 participate in community service through their schools. What do students think the benefits are to students of doing community service? What about benefits to the community? The nation as a whole? In what ways might students like to serve their community?
11. Ask students to review several issues of their local newspaper to learn more about current problems or challenges in the community. Create a class list of these issues. Have students use prior knowledge and interviews with parents, community leaders and other citizens to add to their list.
12. Based on this list, have students develop a list of categories where they could serve their local community. Service categories could include:

a. Animals
b. Community development/beautification
c. The Environment
d. Health Issues
e. Children
f. Seniors
g. Special Needs (disabilities, homeless, illiteracy)
h. Politics

13. Have students check off the categories that most interest them. Then encourage students to form groups based on areas of common interest.
14. Distribute the *Leap to Serve: Making a Difference in My Community* student planning sheet.
15. Have each group review the list of community problems they've created along with their areas of interest. Challenge each group to identify one problem/area of interest on which to focus, a solution or way they can serve their community and positively impact that issue, and an action plan. Students may need time outside of class to learn more about local service opportunities and realistic solutions. Links to volunteer opportunities are below.
16. Have students present their completed planning sheets to the class. They should be able to share what community problem they want to impact, their idea for impacting it, how their idea will impact it and how they plan to implement their idea.
17. If time and logistics allow, have students implement their plans.
18. Finally, have students reflect on the following:

a. What should be the role of young people in serving the community?
b. What did you learn about your community and yourself through this activity?
c. How does community service benefit you, your family, your community and your world?
d. What would you tell other people your age about community service?

ADAPTATION/EXTENSION

- Have students implement their service action plans.
- Have students organize a community service day at your school where all students can learn about and sign up for service opportunities.
- Have the class work together to implement one or more strategies that can help save wildlife or positively impact the local environment.

ASSESSMENT

You can evaluate your students using the following three-point rubric:

Three points: Students accurately research answers to the worksheet questions; actively participate in the class discussion; identify a problem or challenge in the local community; devise a logical, realistic solution to how they can impact that problem; thoughtfully reflect on their role and responsibility in the community.

Two points: Students somewhat accurately research answers to the worksheet questions; participate in the class discussion; identify a problem or challenge in the local community; devise a somewhat logical, realistic solution to how they can impact that problem; reflect on their role and responsibility in the community.

One point: Students need help researching answers to the worksheet questions; do not participate in the class discussion; have difficulty identifying a problem or challenge in the local community; devise a solution to how they can impact that problem; have difficulty reflecting on their role and responsibility in the community.

The Vanishing Frog

VOCABULARY

Community
Definition: A social group of any size whose members reside in a specific locality, share government and often have a common cultural and historical heritage.
Context: There are many opportunities within every community for people to serve and volunteer.

Endangered
Definition: Threatened with danger or extinction.
Context: The bald eagle is classified as an endangered species.

Extinct
Definition: No longer in existence; died out.
Context: When a species is extinct, that means there are no longer any animals of that kind on the Earth.

Plight
Definition: A dangerous situation
Context: Scientists are working around the clock to uncover clues on the frogs' deadly plight.

Service
Definition: An act of helpful activity; help; aid
Context: Students across the country make community service a part of their lives.

The Vanishing *Frog*

ACADEMIC STANDARDS

This lesson plan may be used to address the academic standards listed below. The standards listed are drawn from the National Education Science Standards and the National Civics Education Standards

Grade Level: 9-12
Subject: Science
Content Standard: Life Science: The interdependence of organisms
Benchmark: Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

Grade Level: 9-12
Subject: Science
Content Standard: Life Science: The behavior of organisms
Benchmark: Organisms have behavioral responses to internal changes and to external stimuli.

Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.

Grade Level: 9-12
Subject: Civics
Content Standard: What are the basic values and principals of American Democracy?
Benchmarks: Understands roles of voluntarism and organized groups in American social and political life

Grade Level: 9-12
Subject: Civics
Content Standard: What are the Roles of the Citizen in American Democracy?
Benchmarks: Understands how participation in civic and political life can help citizens attain individual and public goals; understands the importance of political leadership, public service, and a knowledgeable citizenry in American constitutional democracy.

Web sites: www.amphibianark.org
Information about Youth/Community Service
http://servicelearning.org/youthsite
www.learningtogive.org
Service/Volunteer Opportunities
www.volunteermatch.com
http://www.nationalserviceresources.org/topics/service-activities

The Vanishing *Frog*

The Plight of Amphibians: How Much Do You Know?

(Answers in bold)

1. How long have amphibians lived on the Earth?
a. 360 years
b. 360,000 years
c. 360 million years
d. 360 billion years

2. Which of the following statements is NOT true?
a. Frogs and amphibians may become extinct in our lifetime.
b. The plight of the frogs may be a sign of a larger environmental problem.
c. Amphibians are vital components of their ecosystems.
d. Amphibians' thick skin protects them from most environmental changes.

3. What percentage of amphibian species could go extinct in our lifetime?
a. 10%
b. 25%
c. 30%
d. 50%

4. How many amphibian species have become extinct in recent years?
a. 30
b. 60
c. 130
d. 240

5. Amphibians help us by providing compounds that help treat which disease:
a. HIV
b. Cancer
c. Alzheimer's
d. All of the above

6. What does it mean that amphibians are like "canaries in the coal mine?"
a. They make loud noises.
b. They serve as warning signs of dangers in the environment.
c. They can live in any habitat.
d. They come in many different colors.

7. Which is NOT considered a reason why amphibians are disappearing?
a. Climate Change
b. Disease
c. Habitat Destruction
d. Zoo closings
8. What is chytrid fungus?
a. A disease that amphibians help to treat.
b. A disease that is killing amphibians.
c. A disease that is killing plants that amphibians eat.

9. **True** or false: Chytrid fungus is currently unstoppable and untreatable.

The Vanishing *Frog*

Leap to Serve: Making a Difference in My Community

Team Member(s):

Service Category of Interest:

Existing community problem we'd like to positively impact:

What do you and your group members already know about the issue you've selected?

What would you like to learn (and who can help?)

What are some ways that you can help to impact the problem you've identified?

Our goal to impact this issue, need or problem is:

This will benefit our community by:

To help us reach our goal, we will do the following: (you may want to chart this out on a calendar)

Task	Who Will Do	By When

Resources and Materials we will need:

WILDLIFE ON THE MOVE

Teaching Guides

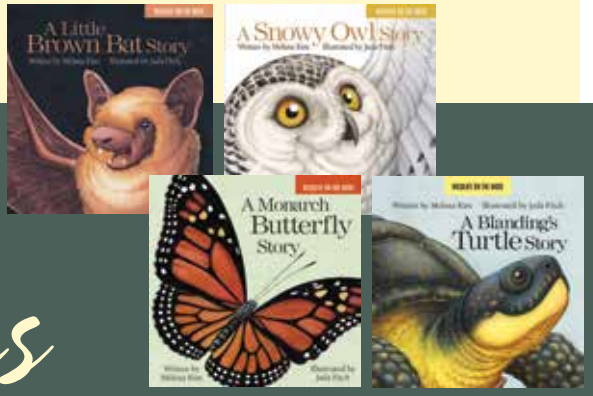

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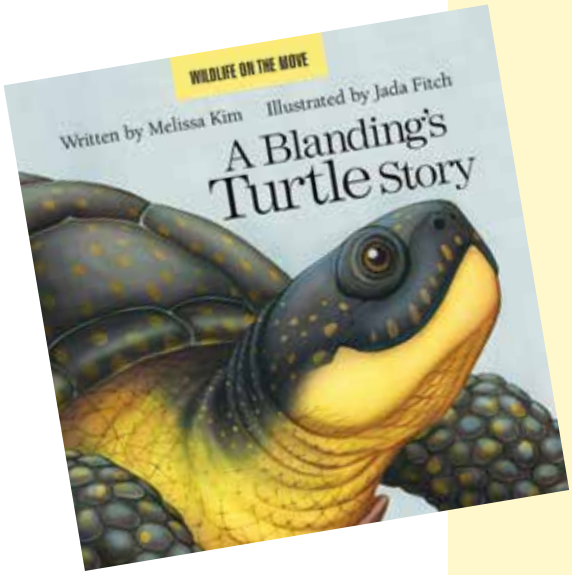
TABLE OF CONTENTS



Introduction

ABOUT MAINE AUDUBON

Maine Audubon is building a community of people who understand that when Maine's wildlife thrives, Maine thrives. Since 1843, we have been connecting people to nature through a science-based approach to conservation, education, and advocacy. The largest Maine-based wildlife conservation organization, Maine Audubon has eight wildlife sanctuaries, 10,000 members, and serves 50,000 people annually.

We work with children, adults, families, and educators to foster environmental literacy and stewardship through science-based and experiential education programs.

ABOUT WILDLIFE ON THE MOVE

Wildlife On the Move started with a great story. In January 2014, a Snowy Owl got stuck in an abandoned building in downtown Portland, Maine, and Maine Audubon staff were called on to assist. Both on scene that day and in the days following, we saw a fantastic opportunity in this front page story to explain basic wildlife ecology, why animals venture far from home, and what positive human intervention looks like. Our friends at Islandport Press agreed, and together we set to work developing a series of books that would help introduce and expand upon these important themes for families and classrooms in Maine and beyond. Not only did the trapped Snowy Owl get a happy ending, but we hope that her and other stories will live on to benefit and inspire generations of young naturalists and conservationists to come.

Why these species? The species chosen for the Wildlife on the Move project are iconic, charismatic, and most importantly, representative of the challenges facing Maine's wildlife. Even students who have never seen a Snowy Owl, for example, are able to relate to the experience of living in Maine. Though the story of each species is unique, they explore similar themes of animal movement, human interactions with wildlife, animal adaptations, seasonal changes, and habitat requirements.

Why this format? The Wildlife on the Move books are written for preschool-aged children through second graders, with simple prose supported by a strong foundation of scientifically accurate content and illustrations. This allows educators, aided by these curriculum guides, to dig deeper into the underlying scientific concepts and to challenge older students to take on a greater load of the cognitive work. The smaller board books allow students of all ages to explore the books at their own pace and practice reading skills, while the large teacher editions allow for large group reading and discussion while inviting further interaction with the detailed illustrations.

HOW TO USE THIS GUIDE

Like the books in the Wildlife on the Move series, these companion teaching guides can be used in multiple ways. It is certainly possible to choose a standalone unit or lesson from one teaching guide, or to use them to provide context and background information to inform your own usage of the Wildlife on the Move books.

However, we hope that your interactions with this book series will go deeper than that. Taken as a whole, the Wildlife on the Move series provides an opportunity to explore multiple themes related to ecology, geography, and stewardship throughout each season and from multiple angles. This seasonal focus also provides an excellent starting point for incorporating outdoor exploration and field work into your teaching. You'll find tips for that in this guide, too.

Finally, we are proud to have put together a set of books that truly speak to a wide range of ages—from preschool to second grade. If you have the opportunity to work with multiple age groups, we hope you'll take advantage of this by spiraling back to the Wildlife on the Move books as your students grow. Not only will they be glad to revisit these familiar stories, but you'll be prepared to help them delve deeper into the ecological themes contained within the books.

Acknowledgments Maine Audubon and the Wildlife On The Move project have benefitted from many partners and collaborators. These guides include contributions from teachers at Portland Public Schools and Opportunity Alliance, and were funded by the Jane B. Cook 1992 Charitable Trust and Edward H. Daveis Benevolent Fund. We especially thank Melissa Kim at Islandport Press for her tireless support.

In each guide, you'll find these sections:

Background information This section will give you the context and background knowledge necessary to teach these books confidently! It's certainly not necessary to have all of the answers, but knowing where to look for more information is important. If this section doesn't answer all of your (or your students') questions, the resources listed at the end of the guide should point you in the right direction.

Discussion Questions Part of what makes these books work for a wide range of ages is their careful balance between scientific accuracy and conciseness. This gives educators the opportunity to highlight certain ideas and themes in the books by asking well-chosen open-ended questions before, during, and after a read aloud. This section contains examples and ideas for all three.

Lessons and Activities We've provided a range of lessons and activities in each guide organized around several themes and guiding questions. Though each works as a standalone, we think that they work best when bundled. This allows you to explore a topic in different ways, address multiple learning styles, and incorporate other subjects.

Standards Addressed For the purpose of these teaching guides, we've chosen to focus on the Next Generation Science Standards (NGSS). The reason for this is twofold; first, while many of the lessons and activities in this guide integrate multiple subject areas, we believe that it is their accurate and accessible science content that sets the Wildlife on the Move books apart.

Secondly, the NGSS align with Common Core State Standards for Math and English Language Arts. These Common Core connections are listed for each NGSS performance expectation and accessible on the NGSS website.

We have also taken the Maine Early Learning Developmental Standards into account for those educators working with preschoolers. You'll find a list of the science standards most relevant to this guide in the Appendix.

Objectives The importance of firsthand observation and hands-on, sensory experiences in nature cannot be overstated, especially for young children. Throughout this guide, you will notice that many of the lesson objectives reflect that by going beyond knowledge and skills to include experiences and actions.

Extensions Each lesson includes extension options and ideas for incorporating other subjects, specialties, and areas of your classroom. These are just a starting point—consider working with other teachers at your school or parents to fully integrate Wildlife on the Move themes into other areas.

Take Learning Outside Research has shown that students are happier, healthier, and more engaged when they are given opportunities to play, learn, and explore outside. Authentic experiences in nature support students' learning, but also their social, emotional, and physical growth and development.

Focusing on the seasonal themes of each Wildlife on the Move book can be a great springboard for taking your students outside, and many of these lessons include outdoor exploration and observation components. Consider allowing extra time outdoors for students to explore and play on their own, too. Unstructured time in nature often leads to unexpected teachable moments and gives your students a chance to relate to you—and each other—in new and positive ways.

Take Action The final part of this section describes ways that you and your students can take meaningful action to help wildlife. We know that time and resources vary from school to school and we have included projects that vary accordingly. Maine Audubon is committed to helping schools take action, so let us know if we can be of help.

Appendix In this section are the following resources:

- Maine Early Learning and Development Standards
- Book lists, including children's books, teacher resources, and classroom-friendly field guides
- Songs and fingerplays
- Reproducibles, including graphic organizers and graphics used in lessons

Access online resources at maineaudubon.org/WOTM.

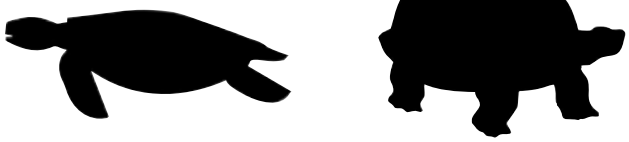
Background Information

WHAT MAKES TURTLES SPECIAL?

Turtles are reptiles with shells. This distinguishing feature provides excellent protection from predators and is made up of two halves that are fused together. The upper half is called the carapace, and the lower half of the shell is the plastron. Although a turtle can withdraw into its shell if threatened, it cannot leave it as its ribs and spine are fused to the inside of the carapace. The shell itself is made of bone and covered with plates, called scutes, that are made of keratin.

Turtles, like other reptiles, are cold-blooded. This means that unlike mammals and birds, which can generate their own body heat, their body temperature is dependent on ambient temperatures. It is common to see turtles basking on logs, rocks, or in shallow water on days when the air temperature is warmer than the water.

TURTLE OR TORTOISE?*



	TURTLES	TORTOISES
Appearance	Streamlined with a low shell profile. Webbed feet or flippers.	Sturdy legs and high domed shells. Feet are not webbed.
Habitat	Aquatic or semi-aquatic	Terrestrial
Diet	Omnivorous	Herbivorous

**Technically, all shelled reptiles are considered turtles! Tortoises are a separate category within that larger group.*

BLANDING'S TURTLE LIFE HISTORY

Appearance A Blanding's Turtle can be distinguished by its bright yellow throat, spotted head and shell, and helmet-shaped carapace, which grows up to 10 inches long.

Diet Blanding's Turtles are mostly carnivorous, although they have been observed eating some aquatic plants as well. They mainly feed in the water and eat invertebrates including snails, aquatic insects, and small crustaceans. Blanding's Turtles will also eat tadpoles and fish, although they tend to scavenge on dead fish rather than catch live ones.

Range and Habitat Blanding's Turtles are found throughout the northern U.S. from Minnesota to Maine, but their populations tend to be fragmented, especially in the Northeast. Most of the Blanding's Turtles in New England are found in Massachusetts, and their range in Maine extends only into southern Maine.

Blanding's Turtles inhabit vernal pools and a variety of wetland habitats and frequently move between these areas throughout the active season. Suitable aquatic habitats must also be near potential nesting sites, which often include residential and agricultural areas, under power lines, or road edges.

Reproduction

Blanding's Turtles are slow to mature, often not breeding until they are between 14 and 20 years old. They mate in late spring and early summer and females typically lay eggs in June or July. They can travel more than a mile in search of a suitable nest site and often lay eggs in residential areas where ambient heat helps the eggs develop.

Like other reptiles, the sex of a Blanding's Turtle embryo is not genetically determined. Instead, it is the nest temperature that determines sex, with cooler nests resulting in mostly male hatchlings and warmer nests resulting in female

hatchlings. The eggs will not hatch at all if temperatures are below 22 degrees Celsius, which is probably what restricts their range to southern Maine.

Average clutch size is between 10 and 12 eggs, and both nests and hatchlings are extremely vulnerable to predation by raccoons, skunks, crows, foxes, and other opportunistic predators. When the turtles hatch in August or September, they are less than 1.5 inches long and their soft shell offers little protection. Those that survive usually overwinter in wetlands.

Brumation Just as some mammals conserve energy during the winter by reducing their body temperatures and metabolic rates in a state called hibernation, many cold-blooded animals enter brumation. Blanding's Turtles brumate under the water (and often ice) of deeper pools. Their metabolism is so slow during this time that they do not even need to breathe and can meet their reduced oxygen needs by absorbing dissolved oxygen in the water through specialized blood vessels in their cloaca (the opening through which they eliminate waste and lay eggs).

CONSERVATION STATUS

The Blanding's Turtle is listed as endangered under the Maine Endangered Species Act. Its federal status is under review and a decision is expected in 2023.

Blanding's Turtles can live to be more than 70, and in theory this long lifespan should balance out their relatively late sexual maturity and low breeding success. However, human development has put undue pressure on them in several ways. First, the wetland habitat they rely upon is becoming increasingly degraded and fragmented. Adult turtles are frequently killed while crossing roads as they move between wetlands or to potential nest sites. Lastly, many of the predators that prey on turtle nests and hatchlings thrive in more developed areas.

GLOSSARY

Carapace: the upper half of a turtle's shell

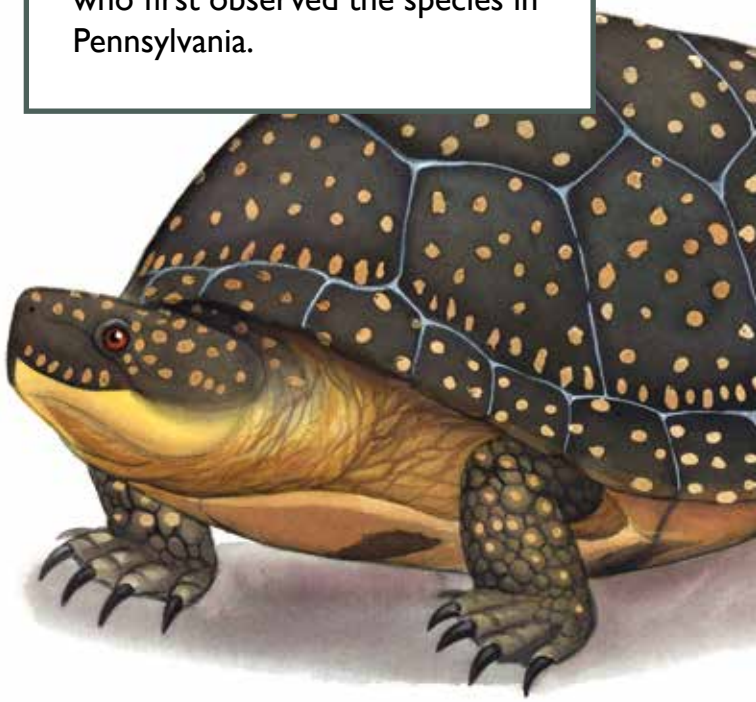
Plastron: the bottom half of a turtle's shell

Cold-blooded: having a body temperature that changes with that of the environment (ectothermic)

Brumation: the hibernation-like state that cold-blooded animals enter to conserve energy in cold weather

Who was BLANDING?

The Blanding's Turtle gets its name from Dr. William Blanding (1773-1857), the doctor and amateur naturalist who first observed the species in Pennsylvania.



Discussion Questions

Before Reading

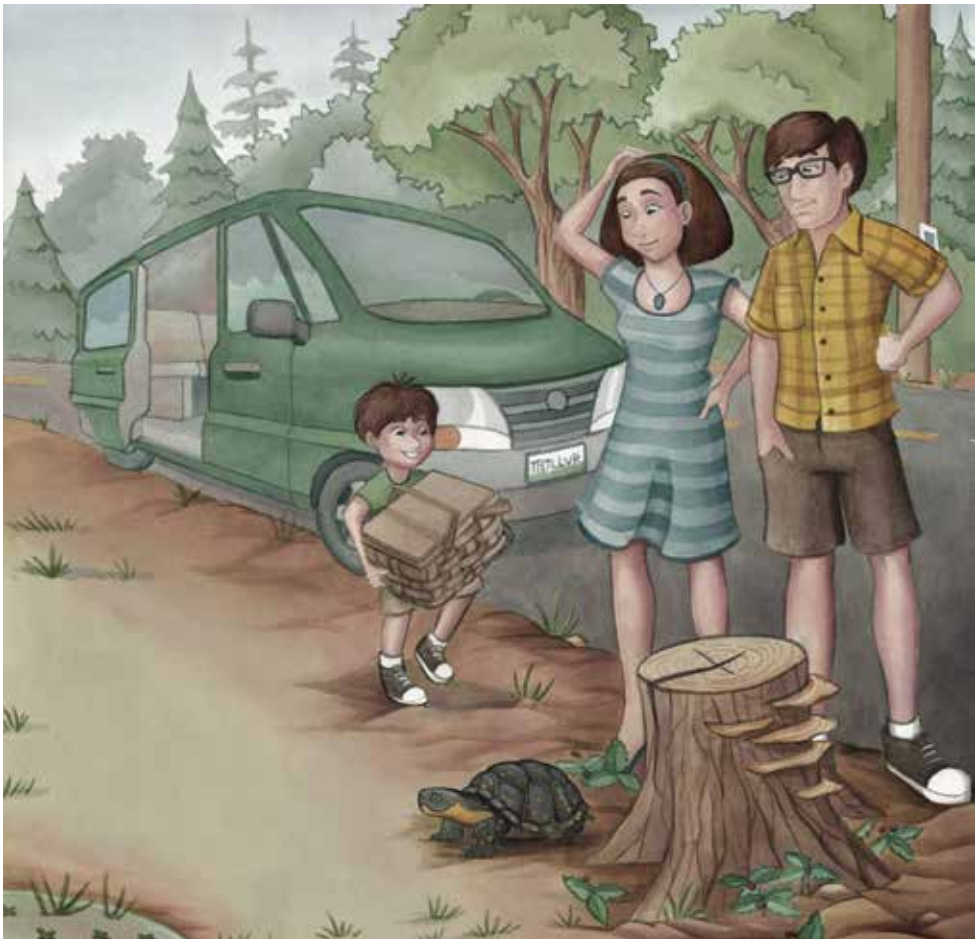
- What do you already know about turtles?
- Why might a turtle be "on the move?"

During

- What different habitats does the turtle visit? What does she do in each?
- There is a lot to notice on the last page. What does the sign the boy created say? What predators do you see that might want to eat the baby turtles?

After Reading

- What should the family have done when they first saw the turtle? What if she had been in the middle of the road?



Lessons & Activities

Unit I: Turtle Adaptations and Life Cycle

GUIDING QUESTIONS

How do turtles grow?
What do turtles need to survive?

NGSS Performance Expectations

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Turtles, sea turtles, and tortoises, oh my!

Objectives: Students will be able to describe the physical characteristics that distinguish turtles, sea turtles, and tortoises and how those characteristics relate to the animal's behavior.

Materials: pictures of turtles, sea turtles, and tortoises (see appendix), "design a turtle" worksheet (see appendix)

Procedure:

1. Show students at least one picture each of a freshwater turtle, sea turtle, and tortoise. What do they have in common? How are they different? Use a 3-part Venn diagram or other graphic organizer to capture students' ideas.
2. Connect these observations to each animal's life history. Where do sea turtles live? Why would they need flippers? Which animals have a streamlined shell for swimming quickly? Which have a domed shell that offers extra protection from predators?
3. Give each student a copy of the "design a turtle" worksheet and ask them to create their own creatures. Once they have answered the questions about where their animal lives, how it moves, and what it eats, they should use those answers to draw the animal. Encourage creativity and attention to detail! What will they call their new species?

Extension: There are many weird and wonderful turtle species around the world that have unique adaptations for staying camouflaged, catching prey, or breathing while remaining mostly underwater. Have students choose a species to research and share their findings with the class.

Turtle Shells

Objectives: Students will compare the shape and patterns of different turtles' shells, sort them according to different attributes, and create artwork that depicts a shell of their own design.

Materials: turtle and tortoise photographs (see appendix), turtle shell templates (see appendix), crayons, watercolors, paint brushes

Procedure:

1. Begin by introducing some of the vocabulary used to describe a turtle's shell:
   a. Carapace: the top half of the shell
   b. Plastron: the bottom half of the shell
   c. Scutes: the plates that cover both halves of the shel
2. Although all turtles have shells, the appearance of those shells can vary greatly. Divide the class into small groups or pairs and give each group a set of photographs. Give them some time to look closely at the photos, then ask them to sort them into two or more groups. They may sort according to color, texture, shape, or something completely different!
3. When a group has finished sorting, have them show you and describe their categories. Record their thoughts and have them work together to create new categories.
4. Allow enough time for each group to repeat the sorting process several times, then debrief as a large group. Read back the list of categories/attributes that you recorded earlier, asking students to show examples of each. Was there anything they noticed that was surprising? Why might the shells differ so greatly?

5. Give students a chance to create a shell of their own design using watercolor resist. Have them use crayons to draw a design in the shell portion of the turtle template. When that's completed, they can paint over the design using watercolors. The wax from the crayon will resist the watercolor, so the design will still show through.

Extension: Turtle tag is a fun way to reinforce the idea that a turtle's shell protects it from predators. Find an area with plenty of room to run around and designate one or two students as potential predators. What might like to eat a turtle? (Raccoons, foxes, herons). Everyone else is a turtle, and they need to avoid being eaten. They can do so by avoiding the predators, or by hiding in their shells (crouching down and covering their heads). Play for a while, switching up roles as predators get tired. Do they succeed in eating any turtles?

The Race to Raise Young

Objectives: Students will understand that animals differ in how long they live and how old they are when they begin to reproduce.

Materials: animal "passports" and four season station signs (see appendix), at least 3 dice, writing implements

Setup: Create four stations around the perimeter of the room. Each should have a table or flat surface and one of the station signs. Place one or more dice at each of the fall, winter, and spring stations, and some writing implements at the summer station.

Procedure:

1. Begin by asking the students how old they think the turtle in *A Blanding's Turtle Story* is. How long do they think Blanding's Turtles can live? Blanding's Turtles do not begin breeding until around age twenty, and can live to be over seventy. This is not the case for many of the animals we encounter in our day-to-day lives.
2. Shuffle the animal passports and give one to each student. Explain that the number of boxes on the passport represents the number of years that that species lives, and that the boxes with Xs in them are years that the animal is alive but not reproducing.
3. The goal of each animal in this game is to survive long enough to have babies, which they can attain by doing laps around the room. Each lap represents one year, but there are some times when they will be in danger. What dangers might their animals face? (predation, cars, hunters, etc.) To represent these dangers, as they pass each of the first three stations, they should roll one of the dice at the table. If they roll 1 through 4, they survive and can move onto the next station. If they roll 5 or 6, they don't survive and should take a seat (there will be a chance to rejoin the game momentarily).
4. When they reach the "summer" station, they have made it through the year and should color in one of the boxes on their passport. If it's a box that does not have an X in it, they have also successfully reproduced! If there are any students sitting out at this point, they can invite one of them to rejoin the game as their "baby" and that student should be given a passport for the corresponding animal.
5. As you continue to play, some of the robins and deer may fill their passports and reach the end of their lifespans. They should take a seat and can rejoin the game in the same way as described in the previous step. Allow enough time for this to happen, and for any surviving turtles to have young.
6. Debrief the game by asking students about their experiences. What made it easy or hard to be a particular animal?

Extension: Something not addressed in the game above is the fact that not all animals have the same number of young each year, and not all of those young survive. Some animals have just a few young and care for them intensely, while others have many young (or lay many eggs) and leave them to fend for themselves. Have students think of an example of each and research that species. How many young does it usually have? What dangers do they face?

Lessons & Activities
Unit II: Turtle Habitat

GUIDING QUESTIONS

What makes good turtle habitat?
Where do turtles lay their eggs?

NGSS Performance Expectations

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to fit their needs.

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.

Aquatic Explorations

Objectives: Students will explore an aquatic habitat in their community by scooping or searching for creatures, making and recording observations, and analyzing their findings.

Materials: clear containers, thermometers, measuring tools, nets, binoculars, field guides, paper, clipboards, writing utensils

Procedure:
This lesson includes three different approaches to exploring and observing an aquatic habitat. Depending on the needs and abilities of your students, as well as your schedule and situation, you may choose to focus on only one exploration, combine elements from each, or continue to visit the same habitat and add a new layer of exploration each time.

Focus on: Water

1. You can tell a lot about what kinds of plants and animals will live in an aquatic habitat just by looking at the characteristics of the water. For example, would a sea turtle live in a freshwater pond? What would happen to an insect that's a weak swimmer in a fast-flowing river?
2. Begin by collecting and observing some of the water in a clear container. Is is cloudy or clear? What is its temperature?
3. Move on to observing the body of water as a whole. Is the water moving or still? Try tossing in leaves or other small natural objects that float to observe water currents. If the water is moving, are there some places where the current is stronger than others? If you can, measure the depth.
4. Based on your findings, what animals would you expect to find living here? Continue onto the next exploration to see if your predictions are correct!

Focus on: Biodiversity

1. Biodiversity refers to the variety of plant and animal species in a given area. In this exploration, you'll be challenging students to measure biodiversity by finding and identifying as many different plants and animals as they can.
2. If you will be using nets to scoop, make sure to go over a few guidelines beforehand:
3. Students should kneel when scooping so that they don't lean too far over the water
4. If they catch something, have them gently move it to a container of water for observation. Be prepared to assist students with the transfer.
5. Avoid handling frogs and tadpoles—the oils on our hands can be harmful to them.
6. Remind students to look both in the water and around it, and that they may need to look closely and carefully to see some of the smaller aquatic insects.
7. Provide field guides and help students try to identify what they've found. Keep a list of plants and animals observed. Was there anything surprising? Anything you expected to find that you didn't?

Focus on: Turtle Habitat

What do animals need in their habitat? (food, water, shelter). What would those elements look like for a turtle? Come up with a list of things to look for that might indicate that a body of water could be a good habitat for a turtle.

Assess your chosen aquatic habitat by looking for the things on your list. Is there anything missing? Did you observe any turtles? What about potential predators?

Extension: Continue to explore your chosen aquatic habitat throughout the year. How does it change with each season? Explore the life cycles of some of the creatures you see there. How do they change and grow?

Turtle Maps

Objectives: Students will demonstrate knowledge of the two habitat types that Blanding's Turtles need (aquatic and suitable nesting sites) and will imagine the journey a turtle might need to make between the two habitats.

Materials: long strips of paper, turtle and turtle crossing cutouts (see appendix), drawing implements, glue sticks

Procedure:

1. Show students the inside cover pages of *A Blanding's Turtle Story*. What do they see? What does the dotted line represent? The turtle in the story is on a quest to find a place to lay her eggs, which means she needs a place with soft or sandy soil where she can dig. What does she encounter along the way?
2. Have students create their own "turtle map" on a long strip of paper. They can glue a cutout of a turtle at the beginning of the strip, and should then imagine and draw the places and things the turtle will encounter along her journey. Remind them to include a nest at the end, and if their turtle crosses any roads, they can add a "Turtle Crossing" sign, too.
3. Give students a chance to share their maps and the accompanying story with partners or in small groups.

Extension: Continue to imagine turtle journeys by adding plastic turtles and other related props to sand/water or block play for younger students, or by asking older students to write a story from the perspective of the turtle in their map.

Habitat Hop

Objectives: Students will experience the need for habitat connectivity and discuss the effects of fragmentation.

Materials: Carpet squares, hula hoops, or some other material that can be used to create designated areas for students to stand in/on, music player

Procedure:

1. Begin by reviewing the components a habitat must include to meet an animal's basic needs (food, water, shelter). What happens if an animal cannot meet those needs?
2. Create a large circular path using the hula hoops or carpet squares, which represent wetland habitat for Blanding's Turtles. Explain to the students that they are Blanding's Turtles and that although they can travel fairly long distances over land, they need to be able to return to wetlands to feed or brumate. When the music is playing, they should follow the circular path. When it stops, they should freeze.
3. Practice starting and stopping the music a few times, then begin to take away some of the habitat. You can explain that the wetlands in these areas were replaced with new buildings. Continue to play for several rounds, taking away more habitat each time. If students find themselves out of the designated areas when the music stops, they are out.
4. When the remaining habitat gets crowded to the point of becoming uncomfortable, or many of the turtles are "out," pause the game to debrief. What happens when the turtles have to travel very long distances between habitats? How might this happen in real life?
5. Finish by brainstorming some ways to restore or protect the habitat that was lost. Maybe a town can create a wildlife sanctuary or a conservation group can work to restore habitat. Return the squares and allow the turtles to play another round or two with more available habitat.

Extension: Blanding's Turtles can walk more than a mile to find a place to lay their eggs. Visit a track, or better yet, a nature trail, and see how long it takes to walk one mile. How long do you think it would take a turtle?

Lessons & Activities

Unit III: People and Turtles

GUIDING QUESTIONS

How can people help turtles?

NGSS Performance Expectations

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to fit their needs.

K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

SS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

K-2-ETS1-1. Ask questions, make observations, and gather information about a new situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Wildlife Crossings

Objectives: Students will compare the steps people take to be safe when crossing roads with the challenges faced by animals that need to cross roads, and will design road crossings for an animal of their choice.

Materials: photos of wildlife road crossings (see online resources), paper, drawing implements

Procedure:

1. Begin by reviewing how to safely cross the street (look both ways, cross at a crosswalk, etc.). What else helps keep people safe when crossing? (signs, bright clothing, flags, etc.). Can animals do or use those things?
2. Look at the two pictures in *A Blanding's Turtle Story* that show the turtle crossing the road. What do you notice? Make sure to point out the "Turtle X-ing" sign on pages 3-4. Pages 7-8 show a special crossing tunnel for reptiles and amphibians. Turtles won't go into dark tunnels, so they need a tunnel that lets in sunlight. A fence on either side funnels them towards the safe crossing.
3. Show students pictures of other wildlife road crossings and discuss the features that make them unique and suited for the animals that use them. Have students choose an animal that might need to cross the road and design a crossing for that animal. Encourage them to think about how that animal moves, when it would need to cross the road, and what might motivate or deter it.
4. Give students time to share their designs with others in pairs or small groups.

Extension: Use the crossings that students designed in step 3 as blueprints and try to build them! Provide blocks, Legos, clay, play dough, or other building materials, along with plastic animals and even some cars or train tracks.

Turtles in our Town

Objectives: Students will work together to draw a map of an imaginary town that meets the needs of a family, a store owner, and a Blanding's Turtle

Materials: "Turtles in our Town" role cards (see appendix), large paper for each group of three, drawing implements

Procedure:

1. Divide the class into groups of three. Explain that each group of three will include a family, a store owner, and a Blanding's Turtle, and that they all need to work together to create a town. Each person will get a card that explains their role and the three things that they need in the town. For example, the family needs a place to live (house, apartment, etc.), a school, and a playground. They will need to work together to create a town that works for the whole group.
2. Give the students time to discuss and draw their town plans. Make sure they remember to connect the buildings with roads, and encourage them to name their towns and add detail.
3. Have each group give the rest of the class a "tour" of their town. How did different groups approach meeting the needs of each group member?

Extension: Can turtles usually speak for themselves? What other animals might wish to have a say in the town's plans? Work together to create a list of their needs and try to incorporate them into the towns.

Spread the Word about Turtle Crossings

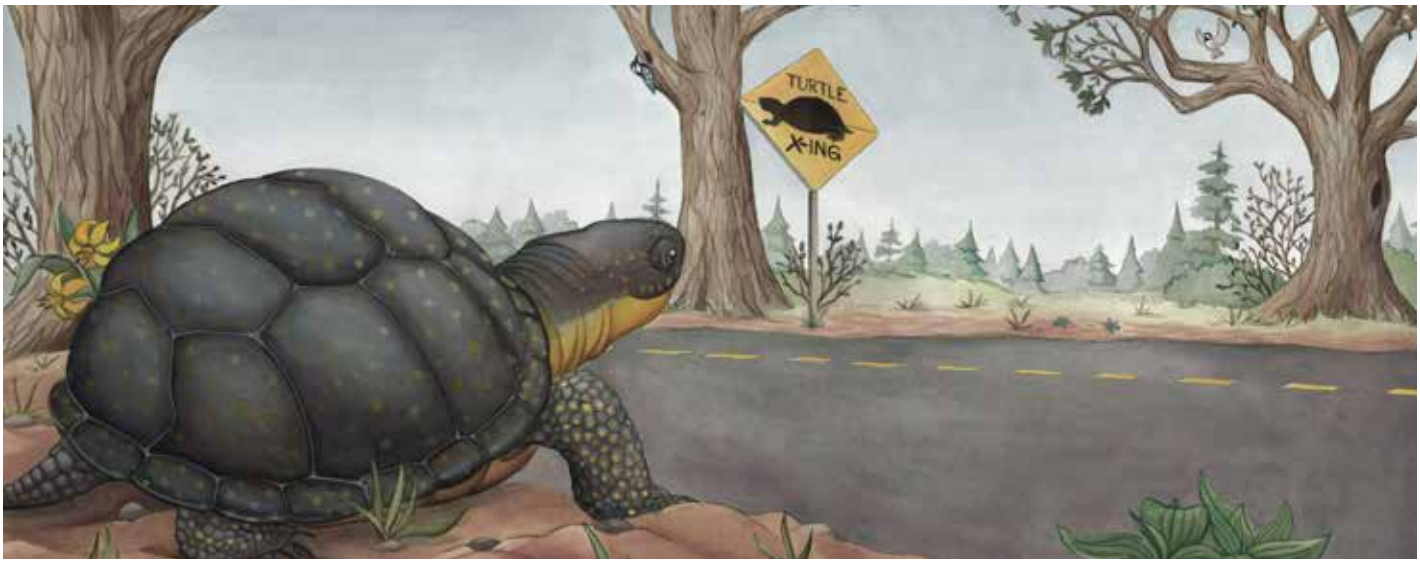
Objectives: Students will research the turtle species found in their community and will create posters or other displays to increase community awareness of these animals along roadways

Materials: poster board, writing and drawing implements, field guides or other resources

Procedure:

1. Use the field guides to figure out which species of turtles are found in your area. Although Blanding's Turtles only live the southernmost parts of Maine, most turtles found in the state face similar challenges with respect to fragmented habitat and road crossings.
2. Have students choose one or more of the species they learned about in the previous step and create posters that share important information about the turtles, and what to do if you see a turtle in the road (see the Take Action section for more information).
3. Display the posters in a public space, such as your school's corridors or the public library.

Extension: How else could you spread the word? See the Take Action section for more ideas.



Take Action

Watch for wildlife! Maine Audubon's Wildlife Road Watch is a citizen science project that compiles map-based data on attempted road crossings by wildlife. Visit maineaudubon.org/projects/road-watch/ to view a map of observations or to input your own.

Spread the word about slowing down. Work with your town, school, or community to encourage safe driving for the sake of wildlife and pedestrians! In addition to posters, students could write letters to the editor of a local newspaper, plan and host a road safety education event, or create PSAs that cover what to do if you find a turtle in the road.

Protect and restore habitat. Contact Maine Audubon or check with other conservation organizations in your area to see if there are opportunities to help with invasive species removal, litter cleanup, or restoration projects.

Help on the Big Night! Vernal pools are temporary pools of water that form in the spring. Many amphibians lay their eggs in vernal pools because there are no fish to prey on the eggs, although there may be hungry Blanding's Turtles! The first warm and rainy spring night is often called the Big Night because droves of these amphibians move from their overwintering places to vernal pools. If there is a vernal pool in your community, consider joining or organizing a volunteer effort to help escort amphibians across the road during this important migration event.

What to do if you see a

TURTLE IN THE ROAD

If you spot a turtle in the road or along the side of the road and can safely stop to check on it, you'll want to keep in mind the following:

1. That turtle knows where it wants to go! If it's in the road or about to cross, help it cross safely in the direction it was already going.
2. If you need to move the turtle, hold it by encircling the shell with both hands. Never pick a turtle up by its tail!
3. However, if the turtle is a snapping turtle, do not try to pick it up. Instead, you can "herd" it out of harm's way by walking behind it or gently nudging it with a stick.
4. Lastly, please report your encounter to Maine Audubon's Wildlife Road Watch project at maineaudubon.org/projects/road-watch/

Take Learning Outside

To extend your study of turtles and their habitat to the outdoors, try some of these ideas:

Fall

- Animals that hibernate or brumate are busy eating as much as they can before winter! Watch for woodchucks feasting on fallen apples or turtles and frogs snapping up insects. How are other animals getting ready for winter?

Winter

- Watch for ice to form on ponds and lakes. What's happening underneath the ice?
- Turtles are cold-blooded, so their body temperatures decrease along with air and water temperatures in the winter. However, warm-blooded animals that remain active need to eat high-energy food to maintain their body temperatures. Try putting out a suet feeder for the birds and watch to see who visits it.

Spring

- Lengthening days and warmer air and water temperatures mean it's time for turtles to emerge from brumation. What other signs of spring can you observe?
- Birds, reptiles, and amphibians are busy laying their eggs. Watch for birds engaging in courtship and nesting behavior like singing, defending territories, or carrying nesting material. Visit a pond or wetland to look for amphibian eggs, and keep an eye out for turtles on the move!

Summer

- Warm summer sunshine brings many turtles out of the water to bask in the sunshine. Look for turtles on logs or swimming near the surface of a pond near you.
- Blanding's Turtles eat a variety of aquatic creatures, including insects, snails, and tadpoles. Summer is a great time to scoop for these creatures.

The BENEFITS

The benefits of taking your students outside are multifold. Getting students moving and exploring in different settings offers physical benefits and gives them a chance to recharge. Connecting what you do outside with what happens in the classroom provides opportunities for students to excel and engage in different ways. Perhaps most importantly, it also provides a framework of shared experiences from which you can all work. Young children learn best from firsthand experience, but may not have ever looked under a fallen log or followed a bee from flower to flower.

These benefits are magnified if you make outdoor learning a regular habit. Going outside and, if possible, visiting the same location throughout the year will highlight seasonal changes and spark lines of questioning that link to bigger ecological concepts. For example, hibernation and migration make much more sense if you've noticed insects and flowering plants getting scarcer and felt temperatures getting colder throughout the fall. Furthermore, as you and your students become more comfortable with the routines and expectations associated with outdoor learning, it will get easier and you'll be better able to take advantage of teachable moments as they arise.

The ideas here are only a starting point. At Maine Audubon, we want all educators to feel confident and supported in creating these types of experiences for their students. We provide this support through classroom visits that can serve to introduce content, field trips and field studies at our sanctuaries or local parks, curricular coaching, teacher workshops, and rentable materials through our Educator Resource Center. Visit maineaudubon.org for more information.

Appendix

Maine Early Learning and Development Standards

Earth Science:

Demonstrates, through observation and investigation, an understanding that human action impacts the earth (i.e., use of resources and recycling, the process from cutting trees to recycling paper)

Life Science:

- Uses senses to observe and describe properties of familiar plants and animals
- Uses vocabulary for naming plants and animals moving beyond generic labels (e.g. "bug") to names of specific creatures (e.g. "ant," "beetle") and uses symbols or icons to identify where they see such creatures
- Develops plans, based on observations and guided inquiry, to care for plants and animals in the classroom and surrounding area
- Observes and describes animals in his/her immediate environment to learn what they need to live
- Uses nature journals, tally sheets and resource materials, with support, to summarize observations (e.g., make connections between the types and numbers of birds coming to a feeder in summer or winter by counting and categorizing)
- Listens to accounts and discusses pictures found in fictional or non-fictional books or media to enhance vocabulary and concept knowledge of living things and their environments
- Identifies problems affecting the lives of plants and animals (including themselves) and generates possible solutions
- With teacher support, creates drawings or models for possible solutions
- Compares tools or solutions and reflects on what works well
- Designs and creates materials to change the behavior or incidence of creatures (e.g. bird feeders, butterfly gardens) in places

Book Lists: Children's Books

- *A Turtle's Life* by Nancy Dickmann: very simple text paired with photos that describe a Box Turtle's life cycle.
- *All Eyes on the Pond* by Michael J. Rosen: each two-page spread includes a rhyming couplet that describes a different pond animal's unique perspective
- *Big Night for Salamanders*: not about turtles, but a good introduction to "big night" and vernal pools
- *Box Turtle at Long Pond* by William T. George: a Box Turtle searches for food and interacts with many other animals interested in eating the same things along the way
- *Follow the Moon Home: A Tale of One Idea, Twenty Kids, and a Hundred Sea Turtles* by Philippe Cousteau: an inspiring story of a class in South Carolina that mobilizes a town to take action to help Loggerhead Sea Turtles; includes a "letter to young activists" at the end
- *Melvin and the Boy* by Lauren Castillo: a boy who wants a pet has high hopes when he takes a Box Turtle home from the park, but instead decides to return the turtle and visit it in its own habitat; the charming illustrations help make the point without being too didactic
- *My Little Book of Painted Turtles* by Hope Irvin Marston: a year in the life of a group of Painted Turtles, accompanied by plenty of action and sound words that make for a fun read aloud
- *Scoot!*, *Turtle Splash*, and *Pond Babies* by Cathryn Falwell: an engaging trio of books that look at a pond and the creatures that live there; each book features lovely collage-style illustrations and extra information, activities, and projects
- *Turtles and Snails: A Scholastic First Discovery Book*: detailed illustrations and text that highlight the diversity and life cycles of these two groups of animals that use shells for protection
- *A Place for Turtles* by Melissa Stewart: Lovely illustrations and includes many different species, including Blanding's; this book touches on a huge array of threats that humans pose to turtles and while it does include solutions, could be discouraging unless framed carefully and paired with direct action

Book Lists: Field Guides and Reference

- *National Audubon Society Field Guide to North American Reptiles and Amphibians:* includes a section of color photographs that are easy to flip through, along with species profiles that include range maps, descriptions, and other information about habitat and habits
- *Maine Amphibians and Reptiles*, edited by Malcolm L. Hunter, R., Aram J.K. Calhoun, & Mark McCollough: a comprehensive account of each species found in Maine; includes a CD of frog and toad sounds

Adult Resources

- *Balanced and Barefoot: How Unrestricted Outdoor Play Makes for Strong, Confident, and Capable Children* by Angela Hanscom: written by a pediatric occupational therapist (and founder of TimberNook), an easily accessible description of the developmental benefits of outdoor play. A good one to recommend to parents
- *Nature Preschools and Forest Kindergartens: The Handbook for Outdoor Learning* by David Sobel: engaging accounts from existing programs along with guidance on everything from curriculum development to risk assessment
- *Hug a Tree* and Other Things to Do Outdoors with Young Children by Robert Rockwell, Elizabeth Sherwood, and Robert Williams: a classic compilation of outdoor activities for young children
- *Project Seasons: Hands-on Activities for Discovering the Wonders of the Natural World* by Deborah Parrella: a compendium of seasonal activities

Songs and Fingerplays

I'm a Little Turtle (to the tune of "I'm a Little Teapot")

I'm a little turtle with a shell
I have four legs, a head, and a tail When I get so scared that I want to hide I pull my head and my legs inside

I'm a little turtle, look and see When the sun's out on a rock I'll be Soakin' up the sunshine and warming my toes But if something scares me, SPLASH, I'll go

Rock-a-bye Turtle (to the tune of "Rock-a-bye Baby")

Rock-a-bye turtle, in a white egg
When the time comes, your white egg will crack
When the egg cracks, you must be real quick
Run to the water (ocean) quicker than this!

Here is My Turtle (fingerplay)

Here is my turtle (*form fist and extend thumb*)
He lives in a shell (*put thumb inside fist*)
He likes his home very well (*nod*)
He pokes his head out (*pop out thumb*)
When he wants to eat (*move thumb around*)
And pulls it back in (*put thumb back in*)
When he wants to sleep

TURTLES


Common Snapping Turtle


Common Musk Turtle

Photo: Laurent Laboise/Flickr


Painted Turtle


Spotted Turtle

Photo: arcole2010/Flickr


Wood Turtle

Photo: USFWS


Blanding's Turtle

TURTLES

Eastern Box Turtle

Photo: Vernon R. Martin/WikipediaCommons

Leatherback Sea Turtle

Photo: USFWS

Loggerhead Sea Turtle

Photo: Natasa Stuper/Flickr

Kemp's Ridley Sea Turtle

Photo: National Park Service

Galapagos Tortoise

Photo: Daniel Ramirez/Wikipedia Commons

Radiated Tortoise

Photo: AtOMiCNebulaFlickr

DESIGN A TURTLE

Species name: _____

Where does your turtle live? _____

_____

How does it move? _____

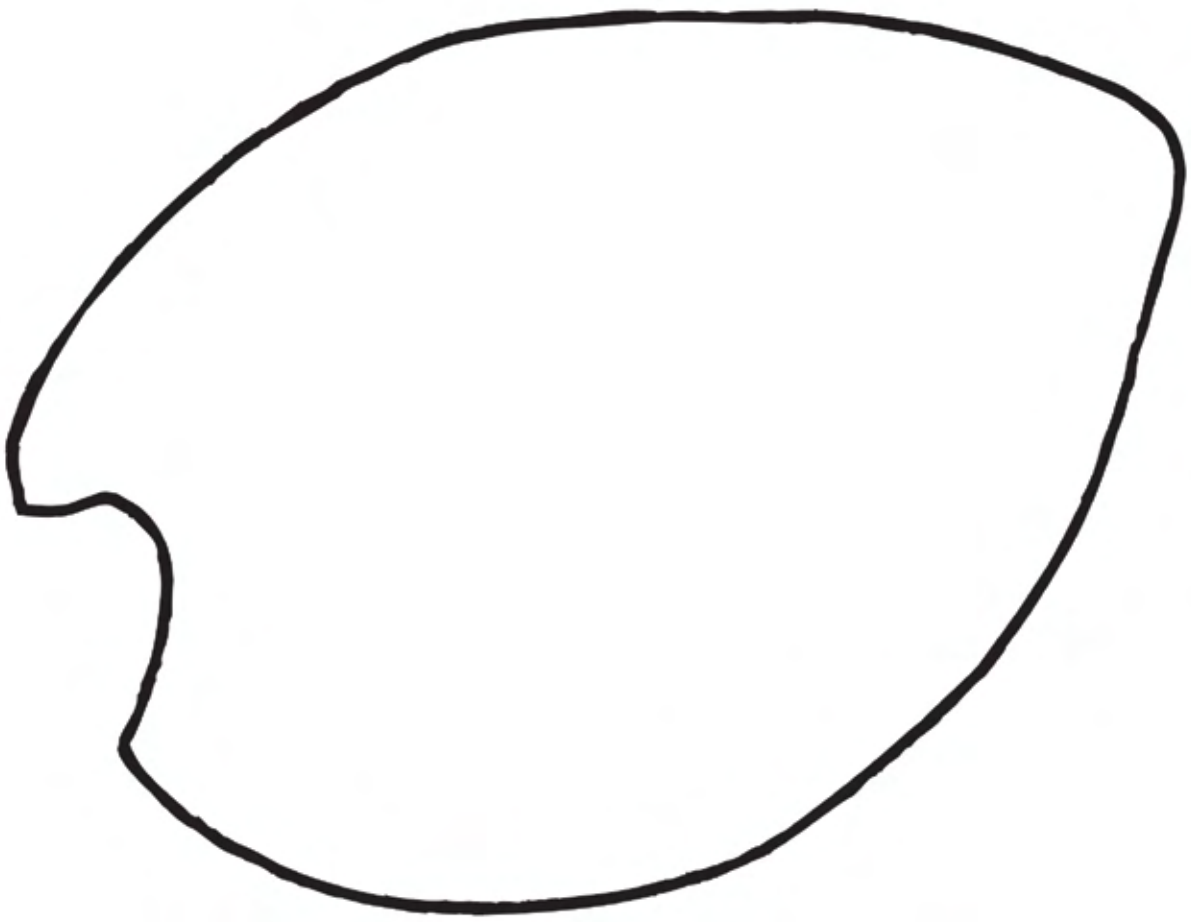
_____

What does it eat? _____

_____

Draw your turtle:

TURTLE SHELL TEMPLATE



RACE TO RAISE YOUNG

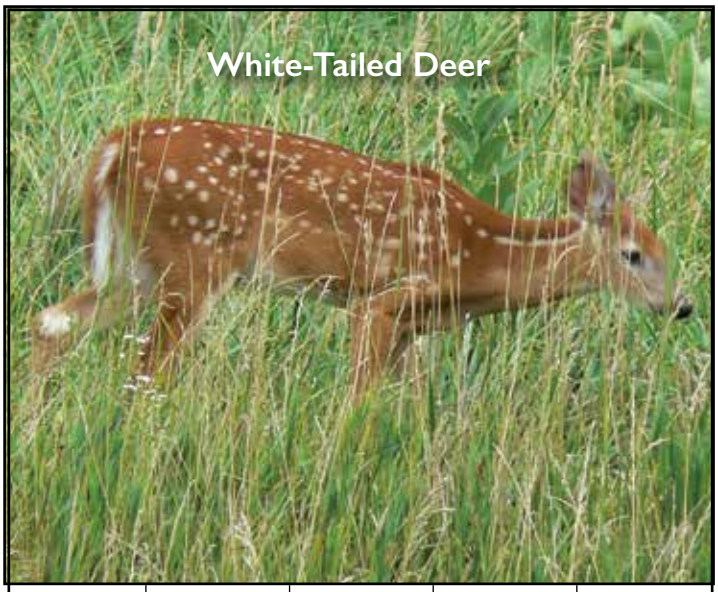


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Photo: Andrew Cannizzaro/Wikipedia Commons

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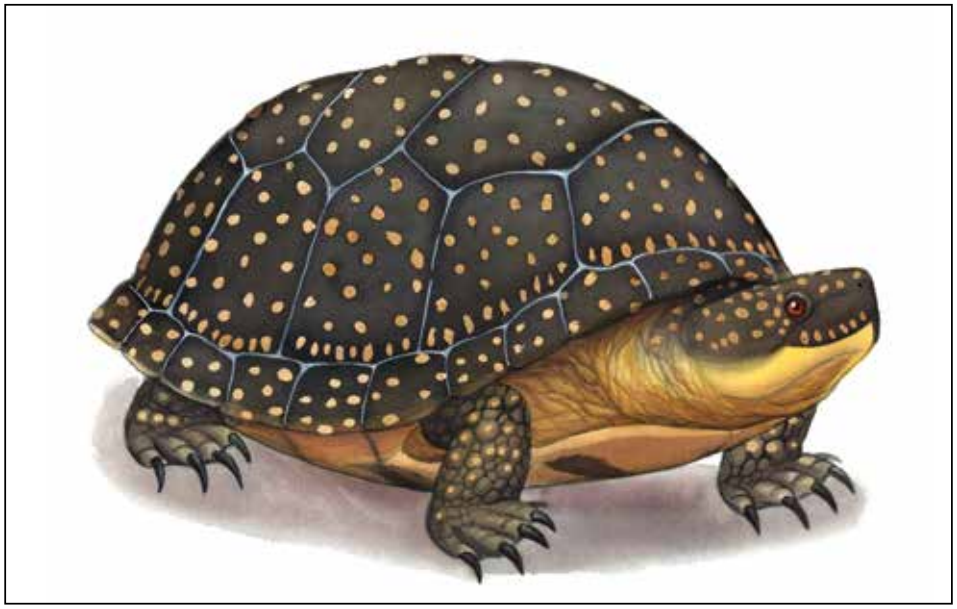
FALL

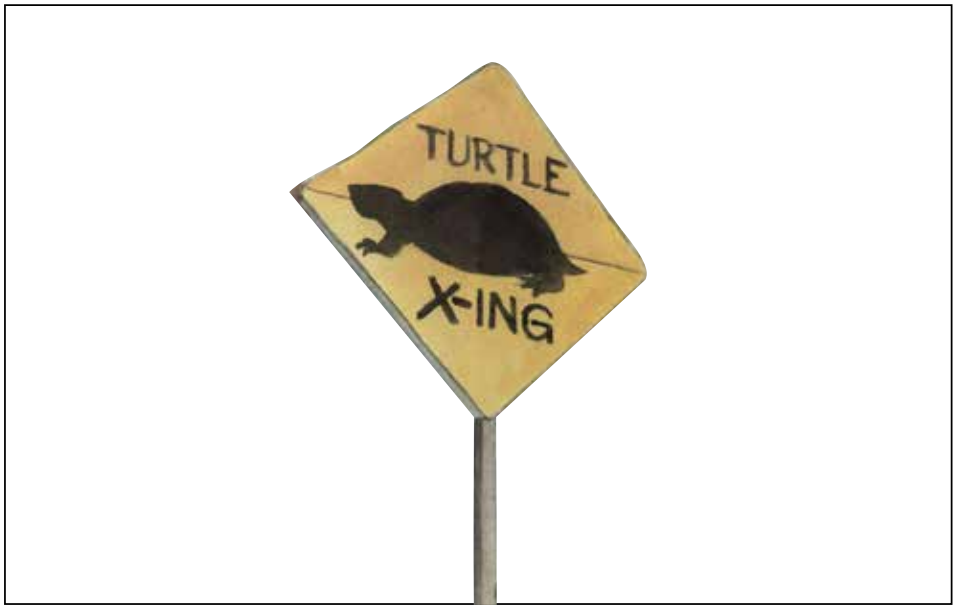
WINTER

SPRING

SUMMER

CUTOUTS FOR TURTLE MAPS





TURTLES IN OUR TOWN: ROLE CARDS

We need a:

- **place to live**
- **school**
- **playground**

Photo: Kiadrinkos.com

I need a:

- **store**
- **parking lot**
- **farm**

I need a:

- **vernal pool or pond**
- **marsh**
- **place to lay eggs**

BUILDING A BOX TURTLE SHELL

An Elementary Science Lesson Plan
Designed For Group Inquiry
Based On The 5E Inquiry Model

GRADE LEVEL: 7th Grade

SCIENCE CONCEPT (the Main Idea or Enduring Understanding): Box turtles have unique shells which help them survive in the wild. Each shell is different and variations among box turtle shells can determine a turtles, species, gender, and age (ARKive.org).

RELATIONSHIP TO CALIFORNIA SCIENCE CONTENT STANDARDS: 7.7 d. Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

LEARNING OBJECTIVES:

1. Students will identify/ label all the parts of a box turtle shell by creating a box turtle shell model.

EVALUATION IDEAS:

1. formative:
    - The teacher will check students rough shell draft and assess for foundational understanding; correctness of parts and variations.

2. summative:
    - Teacher will collect the final box turtle shell models; check for correctness of parts and variations.

CONCEPTUAL BACKGROUND: Box turtle shells are unique in structure. ""The shell is made up of bony plates, or scutes, which are patterned with yellow lines radiating from the centre. The scutes on the lower shell (plastron) also bear this pattern. ..The plastron is hinged and can be closed completely against the carapace, allowing the turtle to completely withdraw its head and feet and enclose them within a protective 'box'". (ARKive.org)

LESSON IMPLEMENTATION PLAN:

ENGAGE –

1. Students will touch and feel a real box turtle shell. (The ornate box turtle and/ or shells are available for rent at SERC).
2. The teacher will ask students to write down at least 5 observations they have made about the shells.

EXPLORE –

1. Students will share their observations out loud to the class and the teacher will write them on the board.
2. The teacher will divide the students into groups of four, then assign them a topic/ observation that was written on the board.
3. The groups will research the topic more in-depth using turtle websites (see references and suggested reading list).

EXPLAIN –

1. Each group will share their findings to the class and explain the important components of the turtle shell. This should include an explanation of shell features and variations.

ELABORATE –

1. Students will take notes and compile a list of shell characteristics. They will illustrate a shell draft and label the parts.
2. The teacher will assess students' progress, to check if all of the labeled parts are correct. On the labels, student will also include the descriptions (for example, Scute- because this is an older turtle).

EVALUATE –

1. The students will use an up-side-down plastic bowl to create their turtle shells. The teacher will provide art supplies such as construction paper, glue and makers for students to be creative with their design.

(a) summative –teacher will collect turtle shell models and assess if all of the parts are included. Also, noting consistency with correctness and descriptions.

(b) formative – teacher will check for correctness as the students draft their designs; labeled parts and descriptions.

DIFFERENTIATION PLANS:

Behavioral for Student A-:

- This student can be closely supervised by the teacher during observation time.

Cognitive for Student B;

- Guided notes/ outline can be given during note taking time.

Cognitive for Student C:

- Graphic organizes can be used to collect data instead of writing research.

Affective for Student D:

- This student can choose to work with a group or one-on-one with the teacher during shell construction time.

Language Demands for Students E, F, G

- When compiling a list of shell characteristics, they can use illustrations instead of words.
- The teacher can provide sentence strips to provide a structure during research time.
- The teacher can model the steps of creating a turtle shell for them to follow.

LIST OF MATERIALS (PER GROUP):

- plastic bowls
- construction paper
- glue, scissors
- makers
- paper
- tape.

DIRECTIONS OR SPECIAL INSTRUCTIONS; SAFETY CONCERNS, ETC.

Pets in the Classroom Lesson Plan 1st Grade

Objective:

Students will observe different turtle structures and create a model off of one of those structures to solve a human problem.

Standards (NGSS - Next Generation Science Standards 2013):

1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Hook:

Live turtles or if you do not have access to live turtles, You Tube clips-
Box turtle: https://www.youtube.com/watch?v=sjhMpVNFu2A
Water turtle: https://www.youtube.com/watch?v=RH_wZ3xjqpw or various pictures off of which the students can make observations.
Another option might be to contact your local turtle rescue and see if they could bring live animals to your classroom.

Lesson:

DAY 1 (45 min. period)

Have the turtle(s) on display for the students. Have them make written/drawn observations about the structures they see on the turtle: top and bottom shell, camouflage coloring, claws, beaked mouth, eyes, tail, ability to hide in shell (if box turtle), webbed feet (if water turtle).

Share the 2 objectives with them and go over the rubric*.

In teams of 2 have them brainstorm a list of things that could be designed based off of one aspect of the turtle. After 10 minutes have them share their ideas.

Show them the materials. So their creations don't get too big, you might have the design confined to a lunchroom tray. This also makes storing easier if they have several class periods to work on this.

DAY 2-3 (45 min. period)

Finish designing and building the prototype. Have them complete the sheet*.

Share the projects.

Assessment:
The model and the accompanying sheet

Rubric:

	4	3	2	1
Model	The model is age appropriate and is carefully constructed	The model is age appropriate and is fairly carefully constructed	The model is age appropriate but is fairly messy	The model is not age appropriate and has been hastily constructed
Prototype	Students can accurately explain what part of the turtle inspired the prototype	Students can fairly accurately explain what part of the turtle inspired the prototype	Students aren't sure what part of the turtle inspired their design	Students built something that does not relate to any part of the turtle
Problem	Students can explain with confidence what human problem this prototype is solving	Students can explain with some confidence what human problem this prototype is solving	Students aren't sure what problem their design is solving	Students have made a prototype that does not solve a human problem
Cooperation	The group required less than 1 teacher interventions	The group required less than 2 teacher interventions	The group required less than 3 teacher interventions	The group could not cooperate

* Included documents

If live turtles are used, please use appropriate handling techniques and make sure that all individuals thoroughly wash their hands after touching the turtles.

Turtle Project

Names:

What is the problem you are trying to solve?

From what part of the turtle are you copying your prototype?

Sketch and label your design.

Box Turtle Interview

Goals:
Students learn all about box turtles and then conduct an imaginary interview with a box turtle.

Grade Level: 3-8

Subject Areas:
science

Materials Needed:
- Copies of the Box Turtle Interview Worksheet
- Copies of the "Turtle in a Box" article

Time to Complete:
30 minutes

Students should read the article "Turtle in a Box" (starts on the following page) and then imagine that they are interviewing a real box turtle about its life. Students can use the information in the story and/or online resources to help them write the turtle's responses to the questions.

From Ranger Rick Educator's Guide, June 2009, National Wildlife Federation
www.nwf.org/nationalwildlifeweek **email: educators@nwf.org**

Box Turtle Interview

Turtle in a Box

By Gerry Bishop

Who's looking at you? It's an amazing little creature called a box turtle. You may have seen one in a nearby woods—or maybe even in your own backyard. But how much do you really know about box turtles? Read on!

How did they get the name "box turtle"?

The answer is a simple one. They're among the few turtles in the world that can completely close up their shells—like a box.

A box turtle first pulls in its head, legs, and tail. Then it shuts two hard flaps on its bottom side. In an instant, it's all boxed up in a tough suit of armor.

The turtle holds its flaps shut so tightly that they're almost impossible to pry open. That's why most predators, including the weasel, are no threat to a grown-up box turtle. (But staying safe is a very different story for the babies, as you'll soon find out.)

Where do you find box turtles?

Two species—the eastern box turtle and the western box turtle—live in the United States. Two other species live only in Mexico, and ten species live in Asia. (This story is about the U.S. species only.)

Other kinds of turtles spend lots of time in the water, but eastern and western box turtles spend almost all of their time on land. You might find a box turtle walking around in almost any woods or meadow.

What do they eat?

Box turtles will eat just about anything they can find. Some of their favorite foods are insects, earthworms, slugs, berries, and mushrooms—even the kinds that are poisonous to people. Box turtles will also munch on flowers, roots and dead animals.

How can you tell a male from a female?

There are different clues you can look for, but these two are the easiest ones:

Eye Color: A female's eyes are usually dull orange or brown; a male's are usually red or bright orange.

Shell Shape: The bottom side of a female's shell is flat, while the bottom of a male's is slightly curved in.

How do box turtles have babies?

Like all other turtles, box turtles are egg-layers. After mating, a female finds some soft soil in a sunny place and starts digging with her hind legs. Into the hole she lays four to six eggs. Then she covers the eggs with soil and walks away, never to return.

As the summer sun warms the nest, the little turtles grow inside their eggs. After a couple of months, the babies break through their shells. In cold climates, the hatchlings stay underground until the next spring. But in warm ones, they dig up and out of the ground right away.

Baby box turtles are on their own right from the start. They hatch knowing how to find food. But they still have a hard time surviving. Their tiny shells are soft and bite-sized for skunks, raccoons, minks, weasels, snakes, and other hungry animals. The little turtles are careful to keep themselves hidden under fallen leaves on the forest floor. Even so, very few of them live to see their first birthday.

How long can box turtles live? What's the record?

A box turtle's shell doesn't completely harden until the animal is about seven years old. If it survives that long, it may enjoy a very long life. It's no big deal for a box turtle to live to be 30 or 40 years old. A few reach the age of 100, and one—the oldest on record—made it to 138!

If you find a box turtle, you may be able to figure out how old it is: Look closely at one of the big scales on its top shell. Then, starting at the center, count the number of rings. Like a tree, a box turtle adds a new ring of growth every year. (After about 20 years, a turtle grows so slowly that the rings are too close together to count.)

Where do the turtles go in winter?

Like all reptiles, box turtles are "cold-blooded." That means their body temperature varies with the temperature of the surroundings. That's not a problem in summer, because the warm sun keeps the turtles at a comfortable temperature. But the only way for box turtles to survive during cold weather is to find a sheltered place and hibernate.

In the fall, a box turtle digs down into soft soil or a thick bed of leaves until completely covered. Its breathing and heartbeat slow way down,

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Box Turtle Interview

and its temperature drops. Parts of its body may become completely frozen!

Then, months later, the box turtle pokes its head out into the warm spring sun. It won't waste a minute in marching off to find something to fill its empty belly!

Are they endangered?

The good news is that box turtles are not in danger of becoming extinct. The bad news is that they're not doing all that well, either.

Their biggest problem? The loss of habitat—the places they need for finding food and shelter and for laying their eggs. When people turn woods and meadows into towns and shopping centers, it's big trouble for box turtles. The turtles are not only robbed of their homes, but also many are killed by bulldozers and mowers. And every road that's built can become a box-turtle death zone.

When people move in, so do lots of raccoons. The raccoons thrive on the garbage people create. When the raccoons aren't eating garbage, they may be digging up turtle nests to chow down on the eggs.

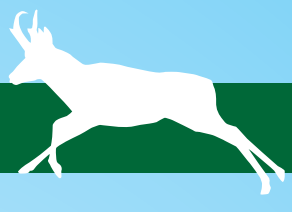
Turtle thieves are still another problem. People who find box turtles often take them home as pets. Others collect turtles to sell to pet stores. Either way, this can wipe out box turtles in many places.

How can kids help box turtles?

1. Never take a box turtle home as a pet or buy one from a pet store. Box turtles belong in their natural habitat.
2. If you see a turtle in the road, move it to where it was heading. Always be careful of traffic, and always wash your hands afterward.

From Ranger Rick, June 2009, p. 6-12.

Box Turtle Interview



Box Turtle Interview Worksheet

After you read the article "Turtle in a Box" imagine that you are interviewing a real box turtle about its life. Use the information in the story to help you write the turtle's responses to your questions.

You: Hello, turtle! Thanks for coming out of your shell to answer some questions for me. First, what's your name, and how old are you?

Box Turtle: _____

_____

You: Could you please describe your home?

Box Turtle: _____

_____

You: What are your favorite foods?

Box Turtle: _____

_____

You: Tell me a little bit about your childhood.

Box Turtle: _____

_____

You: What's the worst thing that ever happened to you?

Box Turtle: _____

_____

You: Describe a perfect day in your life.

Box Turtle: _____

_____

You: _____

(write your own question here)

Box Turtle: _____

_____

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Aquatic Macro invertebrates Lesson Plan

NGSS Standards:

MSESS3-3. Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Objectives (What should students learn when they leave this station?):

- What an aquatic macroinvertebrate is along with examples
- The difference between complete and incomplete metamorphosis
- The importance of macroinvertebrates
- Methodology for collecting macroinvertebrates in the field
- Using macroinvertebrates for stream assessment
- Using identification guides to ID preserved and live macroinvertebrates

Engage:

Ask students if they know some of the names of the species that they encounter while at a creek. Kindly, remind them that there are more things in creeks than just fish and frogs.

Next, ask them what they think a macroinvertebrate is. Allow them to guess and guide them in the correct direction. Break the words down for them. Aquatic means the organism spends some or all of its life cycle in the water. “Macro” means it is large enough to see without a microscope (the opposite of “micro”). An invertebrate is an animal that lacks a vertebral/spinal column. So we have an animal without a vertebral column that is large enough to see with the naked eye and lives at least part of its life cycle in the water.

Go back to the examples students gave at the beginning of the activity and ask them to guess which of those examples are considered macroinvertebrates. Students will likely guess species such as crayfish, dragonflies, and leeches. However, some answers you get here will be vertebrates. Explain to students and help them to reason through why these are not considered macroinvertebrates.

Ask for questions here before you move on.

Explore:

Explain that some of these macroinvertebrates, such as crayfish, spend their entire lives in the water. Then ask the students to define and explain the process of metamorphosis. Guide them if necessary.

Handout out the worksheet showing different life cycles of macroinvertebrates. Ask students to get into groups and discuss how they think the complete and incomplete lifecycles differ from one another along with what they think is the importance of macroinvertebrates and why we should care about them? Monitor groups to make sure they don't get off track. Remind them of the definition of aquatic macroinvertebrates and try to encourage them to use knowledge that they gained in other lectures, such as the fish and food web lectures.

Explain:

Get all the groups back together and quiz them on what metamorphosis is. Then allow each individual group to share what they identified as differences between the two lifecycles. Guide them in identifying that in incomplete metamorphosis there are only 3 stages of development and the adult has similar morphological features as the young and these young are often called nymphs. While in complete metamorphosis there are 4 stages and the adult usually looks drastically different than the young. Show the class a preserved dragonfly nymph and an adult dragonfly in the display case. Then show them the preserved specimens of the young and adult hellgrammite in the display case. Ask them to guess which undergoes complete metamorphosis and which undergoes incomplete metamorphosis and explain why. Identify the dragonfly as an example of incomplete metamorphosis and the hellgrammite as an example of complete metamorphosis. Explain that these hellgrammites live in the water for several years. They build a pupa near shore and when the adult flies emerge… they may only live a week or two. The adults do not eat. They simply reproduce and lay eggs near the water. Hellgrammites are often called dobsonfly larvae. It follows that the adults are called dobsonflies.

Again, ask for questions

Ask students to now share why they thought macroinvertebrates are important. Be sure to stress their ecological significance. The students may have just come from a food web lecture or a fish lecture. Explain to them that many fish survive by eating macroinvertebrates. Taylor this part of the discussion to build on something the students already know. This way you will continue to keep them involved. Spend some time on ecological significance and try to demonstrate the interconnectivity of all things in an ecosystem. The second point of discussion is biological assessments. This is not an answer to expect from most groups, but it is a nice transition.

Explain how we can use macroinvertebrates to assess the quality of a stream. Describe how macros are divided into three groups – Group One Taxa, Group Two Taxa, and Group Three taxa. If you actually use the word taxa, be sure to explain what it means. Group One Taxa are only found in clean streams. Explain that by "clean" we don't mean clear or not dirty. We mean unpolluted or something along those lines. Group Three Taxa can survive in almost any quality of water – integrate the leech stereotype. Remind the students that just because an organism can live in almost any quality of water, they are not just associated with "dirty" water. Again, be careful using words like dirty and clean. They will likely mean different things to the students than they mean to us. Group Three organisms will live in clean water as well. However they are usually outcompeted by Group One Taxa in healthy waters. Then try to explain how Group Two Taxa are an intermediate group. Ask for questions. This is a confusing point. A lost student here will not understand the point of the exercise. Be sure everybody is onboard before you proceed. Conclude by explaining to the students how aquatic macroinvertebrates are collected from streams. Show them the kick seine and explain how it

works. Also, explain how simple dip nets can be used or kick seines can be made for the class to study on their own.

Elaborate:

Bioassesment Procedure:

- Prior to the students arriving, prepare the lab tables. Each student/chair should have a petri dish with a preserved specimen, forceps, and magnifying glass.
- As soon as you start explaining three groups, hand out the identification guides and demonstrate where each group is on the guide.
- Reiterate what each group means as stated above.
- Tell the students that each table will represent one stream. The specimens in front of them were just collected from these hypothetical streams.
- Explain the points system to the students: Group One Taxa get 3 points for each group that is identified. Group Two Taxa get two points. Group Three Taxa get one point each.
- Have the students start identifying the organisms in front of them using their guides. Have them keep track of the species they identify and their "streams" total number of points on their handout.
- Walk around and be available to help the students answer questions. Depending on time limits, you can stretch this out by offering little help or speed things up by helping more.
- Once everything has been identified, choose one table/stream to start. Have each student state what their specimen is and what group it belongs to. As they do this, keep a running tally on the board of how many members of each group you have.
- Repeat this with the other tables/streams
- Once all the tables/streams are on the white board, have the students tell you the number of assigned points for each group.
- Once every table/stream has been tallied, explain to them the significance of what just happened. Read to the scale for excellent, good, fair, and poor. Tell them what we typically find around here.
- Ask for questions.
- If live specimens are available, perform the same activity with them. Instead of individual Petri dishes each table will have one or two large bowls. If time is short, just have them look through the bowls and identify things.

Evaluate:

Quiz the students on the material you have just lectured on. Stress the importance of macroinvertebrates in all aquatic ecosystems and their usefulness to us for biological assessment.

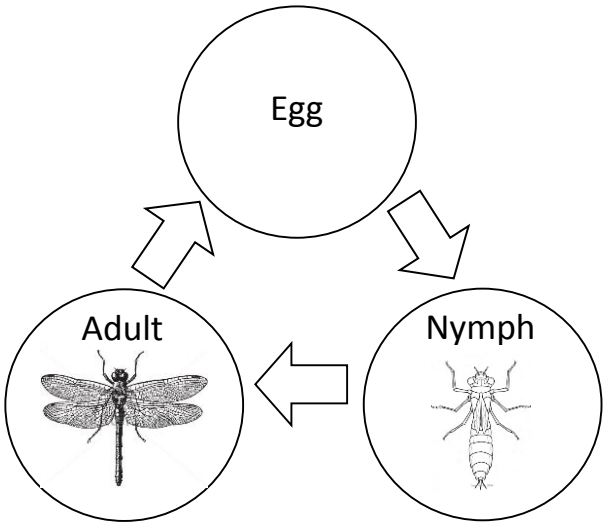
Name_____

AQUATIC MACROINVERTEBRATES

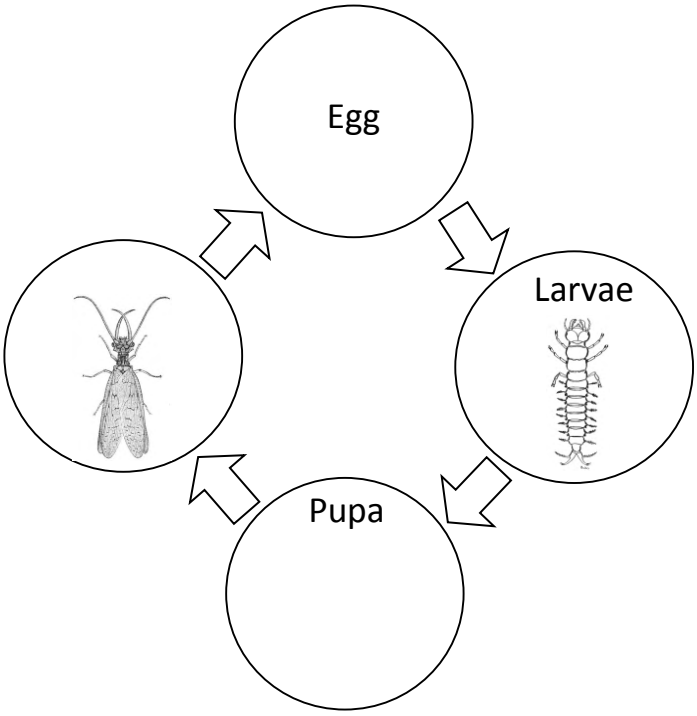
R C I U P E C O L O G Y R R Y K L O O
B S S L I A N S W O H S L C Q D A W Y
P Q L W A X Y P Q X J D E I T Q J X D
Y R Q D R A G O N F L Y D H P M L F M
K L O G C E N I E S A E B S C S B K K
L S Q C A D E T C E N N O C R E T N I
S L I D I Z F M E T Z F P H L B E R E
Y C Y S O T R K I T M M S C I S J L W
F L U L O M A F E H E I C O Y L D E X
L F F D H H I U V M F L A X E C U A H
V Y W Y S C P E Q Y T S P T U K A V P
J L I A A W D R A A S S E M Q H Q R M
O F P T J M Q R O E Q L X Z O C U A Y
S N I Z Z Z C P S M P T I L L C V L N
T O Z H X B R S R M A T Q A M T G Z H
N S X V Z H M O O W P T M X N M J V H
W B P I R E C C V L S S E A L Z K T C
V O L L N J N H T V F X U M F W U K D
J D I T X I Z D E L C Y C E F I L C I

aquatic	ecology	mayfly
bioassessment	identification	metamorphosis
clams	incomplete	nymph
complete	interconnected	scuds
crayfish	larvae	seine
dobsonfly	leeches	snails
dragonfly	lifecycle	

Aquatic Macroinvertebrates



Incomplete Metamorphosis



Complete Metamorphosis

How do these complete and incomplete metamorphosis lifecycles differ from one another? _____
_____

Why do you think macroinvertebrates are important? _____
_____

<u>"Macro" Identification</u>

The Ohio River is home to 1,000s of macro species. Can you name any?
Lets Identify some at your table

1) _____ 6) _____

2) _____ 7) _____

3) _____ 8) _____

4) _____ 9) _____

5) _____ 10) _____

Bioassesment

Did you know that macros can tell us about water quality?

GROUP 1 MACROS are clean water indicators. They get 3 points!

GROUP 2 MACROS are in between clean and poor. They get 2 points!

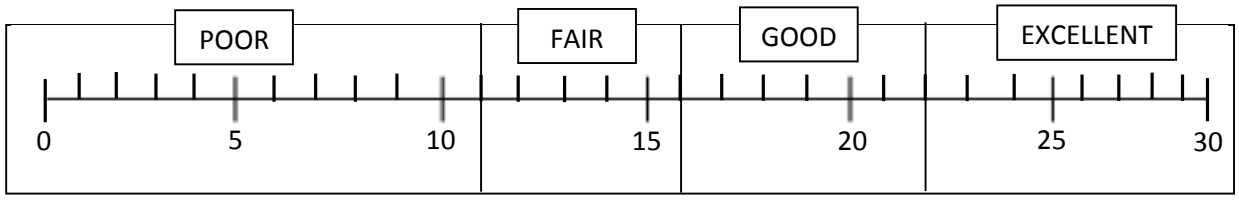
GROUP 3 MACROS are poor water indicators. They get just 1 point.

MACROINVERTEBRATE TALLY

GROUP 1 TAXA		GROUP 2 TAXA		GROUP 3 TAXA	
Water Penny Larvae		Damselfly Nymphs		Blackfly Larvae	
Mayfly Nymphs		Dragonfly Nymphs		Aquatic Worms	
Stonefly Nymphs		Crane Fly Larvae		Midge Larvae	
Dobsonfly Larvae		Beetle Larvae		Pouch Snails	
Caddisfly Larvae		Crayfish		Leeches	
Riffle Beetle Adults		Scuds			
Other Snails		Clams			
		Sow Bugs/Isopods			
Number of taxa present		Number of taxa present		Number of taxa present	
Times Index value of (3)=		Times Index value of (2)=		Times Index value of (1)=	

Cumulative Index Value _____

Biological Quality Assessment Scale



Add up all the numbers from the 3 columns. What is this total? _____

Now look at the scale below the table to determine the water quality of our stream.

How does your stream rate? _____ Are you surprised? _____

Now let's identify some live macros!

The Center for Ohio River

THOMAS MORE COLLEGE
TOGETHER IN PURSUIT OF TRUTH

How Can We Help Aquatic Macroinvertebrates?

At the Thomas More Biology Field Station you learned the importance of macroinvertebrates to stream health along with their ecological significance.

What if you collected samples of macroinvertebrates in a stream and they indicated through bioassesment that the stream was in poor health. What do you think are some things that could be done to promote stream health and thus increase the diversity of macroinvertebrates living in the stream? _____
_____
_____
_____

Scientist and conservationists have been thinking and researching this topic for many years. Some of the ideas and solutions that they came up with are listed below. Use the internet to research what each of these methods mean and how they will aid in promoting stream health.

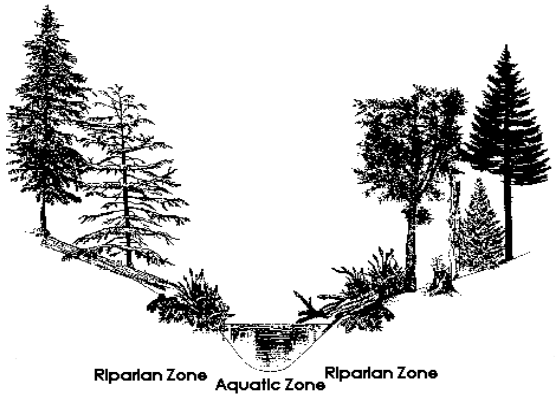
Riparian Zones: _____
_____

Pervious Pavement: _____
_____

Green Roof: _____
_____

Fertilizer Management: _____
_____

YOU CAN MAKE A DIFFERENCE!



Macroinvertebrate Mayhem!

Grade Level
Fourth to Sixth

Duration
- Prep time: 15 minutes
- Activity time: 50 minutes

Vocabulary
- Fauna
- Flora
- Habitat
- Hydrology
- Hydric
- Hydrophytic
- Macroinvertebrate
- Metamorphosis
- Peat
- Wetland

Materials
- Macroinvertebrate ID necklaces (42)
- Environmental stressor cards (4)
- Large chart paper/ whiteboard
- Colored markers (3)
- Boundary markers

Learner Objectives

Students will:
- Define macroinvertebrate
- Understand the role of macroinvertebrates as indicators of ecosystem health
- Understand and identify sources of pollution and the effects on a wetland habitat

Getting Ready!

- Read background information
- Set up play area

Summary

Students play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. Sensitive organisms are displaced by tolerant ones over time as stream conditions deteriorate. Community structure (biodiversity) is graphed to observe population changes among sensitive, moderate,

Background Information

A habitat is the arrangement of food, water, shelter, and space suitable for the needs of a plant or animal to survive. Different habitats support different communities of flora and fauna. Wetland habitats across North American support a large diversity of animals. A wetland is an area that is covered with water for all or part of the year. It is the transition zone between open water and land. Wetlands are classified by hydrology, hydric (saturated) soils, and hydrophytic (water tolerant) plant communities. Wetlands are generally thought of as coastal or inland. Coastal wetlands include tidal marshes, estuaries, and marine environments. Inland wetlands include a variety of marshes, swamps, and fens. Inland marshes include freshwater marshes, wet meadows, wet prairies, prairie potholes, playas, and vernal pools. Swamps include forested bogs, shrub swamps, and mangrove swamps. Fens are peat-forming wetlands that receive nutrients and water from upslope sources through drainage rather than precipitation. Wetland classification depends on the source of water, the presence or absence of peat, and dominant large vegetation. For example, the word “marsh” describes a wetland with non-woody vegetation that grows taller than the water (e.g. cattails). On the other hand, a swamp is dominated by trees. Fens are dominated by grasses, sedges, and wildflowers.

Wetlands are home to a large diversity marcoinvertebrates! Macroinvertebrates are organisms that lack a backbone and are visible without the aid of magnification. These animals live in water on rocks, logs, sediment, debris, and aquatic plants during some stage of their life cycle. Macroinvertebrates include crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms and the immature forms of aquatic

insects such as stoneflies and mayflies.

Macroinvertebrates are an important part of wetland, riparian, and lake ecosystems as they are a key part of the food web (both as food sources and decomposers), and act as indicators of the health of their aquatic habitats. There are several reasons why scientists use macroinvertebrates as indicators of water quality. Certain species are sensitive to different changes in the environment and they cannot easily escape these changes. Many species spend a year or more in their aquatic habitat and are susceptible to environmental changes throughout the year. Finally, they can be easily and inexpensively collected.

Some macroinvertebrates are more sensitive to pollution than others; picture the expressions "canary in the coal mine" and "cockroaches are able to survive a nuclear bomb." The same principle holds true for macroinvertebrates. In the presence of pollution, sensitive organisms, such as stoneflies, mayflies, and caddisflies, will die. Moderate and tolerant organisms can survive in polluted habitats, thereby taking the place of the absent sensitive organisms.

Organism Background

- **Stoneflies** are found in fast-flowing, oxygen rich water. They lack obvious gills and are predators of other macroinvertebrates or eat plant material they find in the stream. All stonefly species are sensitive to pollution.
- **Mayflies** are found among rocks in flowing water, on aquatic plants, or in burrows in calm water (including lakes). Their abdominal gills allow them to survive in moderately low dissolved oxygen environments. Most eat plant material they collect or scrape algae off rocks. Most mayfly species are sensitive to pollution.
- **Caddisflies** build either cases for protection or nets to catch food from flowing water. They are slow movers and absorb oxygen through their soft bodies. Very few are free-moving predators. Most caddisfly species are sensitive to pollution.
- **Dragonflies** are all predators and have a hinged lower jaw that allows them to jut out to catch prey. They are only found in slow-moving parts of streams or in lakes or ponds. Their gills are on their abdomen, which they use to propel themselves forward to ambush prey or to absorb oxygen in low-quality environments. All dragonfly species are moderately tolerant to pollution.
- **Midges** are very small, tolerant stream insects, usually found in high numbers when conditions are poor (excessive sedimentation, low dissolved oxygen, low flow, etc). Some are bright red because they use hemoglobin to absorb the last bit of oxygen from the water.

- **Rat-tailed maggots** are so tolerant they can live in pools of sewage sludge – their tail is actually a snorkel that allows them to breathe air, no matter how poor the dissolved oxygen levels get!

Discuss!

1. Get students to define macroinvertebrate and think of examples. *A macroinvertebrate is an animal with out a backbone that you can see without magnification. Examples of macroinvertebrates include insects, spiders, slugs, crabs, worms, etc*.
2. Go over the examples of macroinvertebrates used in this activity (stonefly, mayfly, caddishfly, dragonfly, midge, and rat-tailed maggot) and discuss the important role that they each play in the food chain.
    a. If time allows, explain the different lifecycle of insects: complete and incomplete metamorphosis. Caddisflies and butterflies undergo a complete metamorphosis. These insects begin as eggs, then hatch into a grub-like larvae which then pupate before becoming adults that do not resemble their larval form.
    b. Stoneflies, mayflies, and dragonflies undergo an incomplete metamorphosis. These insects begin as eggs, which then hatch into a nymph. Nymphs resemble adult forms and slowly grow wing pads until they are ready to molt a final time into adults.
3. Tell students that macroinvertebrates act as indicators for the health of their aquatic environments and habitats. Some macroinvertebrates are more sensitive to changes in pH, nitrogen, and other environmental stressors than others.
4. Discuss ways that a stream can become polluted and how this can alter stream conditions. *Examples include pollutions causing toxic conditions, algae blooms, sedimentation/low visibility, and low dissolved oxygen*.
5. Ask students if you would expect to see more or less species diversity in a healthy habitat compared to a polluted habitat?
6. Introduce the activity to the group! Students will become aquatic macroinvertebrates and try to survive several pollution events.

Investigate!

1. Select one or more students to be environmental stressors depending on the size of the group or the magnitude. These students will be the taggers.
2. Distribute 1 macroinvertebrate card to each remaining student.
    a. If their card has 2 sides, have them use the side with the more sensitive organism first (colored green or yellow).
3. Review each of the organisms and their tolerances. Sensitive organisms have limitations to their movements across the play area that reflects their individual adaptations:
    a. Stoneflies must perform 1 pushup every 5 steps across the field (10 steps for

younger students). They lack obvious gills and become oxygen-starved in polluted water; pushups move more water across their bodies for better oxygen absorption.
   b. Mayflies must flap their arms and spin in circles as they cross. They too need more oxygen when water is polluted, which is absorbed by their fluttering gills.
   c. Caddisflies, with their case, are limited to hopping across the field with their legs together.
   d. It's difficult for them to escape pollution events!
4. Have Sensitive organisms practice their movements.
5. Both moderate and tolerant organisms behave normally in polluted conditions, so they can run across the field.
6. When a sensitive or moderate organism is first tagged by pollution, the student flips over their ID card to show that the less tolerant macroinvertebrate was replaced by a more tolerant one.
   a. NOTE: Their card will not change during the rest of the activity, nor will any students' card who started out as a tolerant organism.
7. Before the beginning of each round, record the number of students in each tolerance group.
   a. See sample chart in teacher tips.
8. Ask students to predict what will happen before each round.
   a. During each round of play, environmental stressors will try to affect the macroinvertebrates by tagging them as they move from one side of the play area to the other ("crossing the stream").
9. Define the play boundaries and begin!
10. After three rounds, reconvene to discuss the results.
11. With student assistance, graph the starting organism numbers and the changes in numbers after each round.
12. As each round is completed, there will be an increasing number of tolerant organisms as they replace Sensitive and Moderate organisms. Remember to graph the number of students in each tolerance group before starting the next round.
   a. Environmental stressor students can change places with macroinvertebrates at the end of each round, selecting different types of pollution if desired.

Wrap Up & Review!

Generalize what happened to the distribution of organisms over time, particularly the rise of tolerant organisms as they take the place of sensitive macroinvertebrates. Ask for 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.
- How can the assorted pollution sources be remedied or prevented? Why is it important

to do so?

Teacher Tips

Consider the following ratio for sensitive, moderate, and tolerant macroinvertebrate necklaces:

- 30 Sensitive (green): 10 each of stoneflies, mayflies, and caddisflies
- 8 Moderate (yellow): dragonflies
- 4 Tolerant (orange): 2 each of midges and rat-tailed maggots
- The back side of each Sensitive or Moderate card has an orange Tolerant organism

Sample Chart:

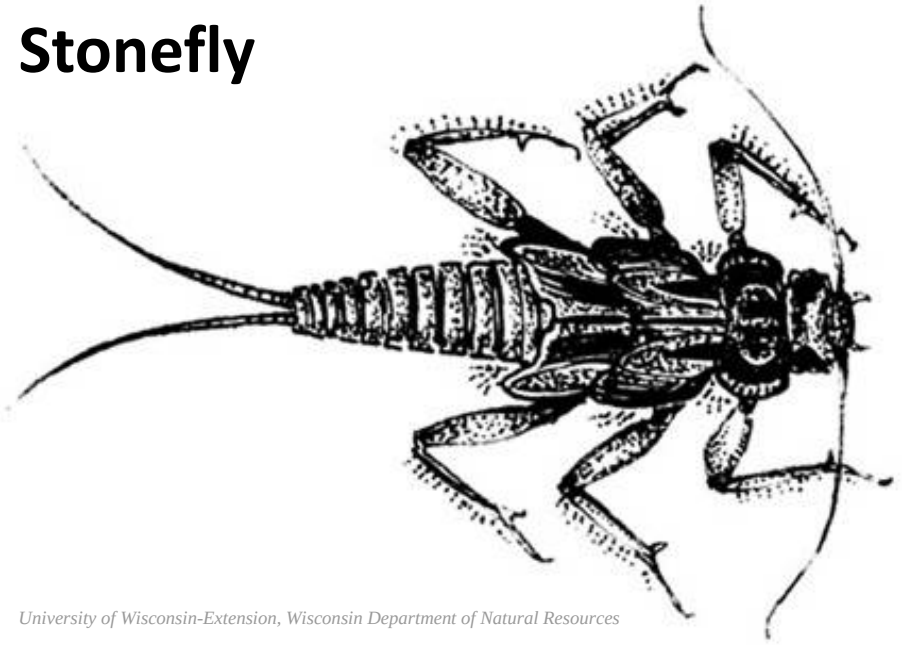
Organism	Tolerance	Number of Organisms			
		Start	Round 1	Round 2	Round 3
Stonefly Larva	Sensitive	6	5	2	0
Mayfly Larva	Sensitive	6	3	1	0
Caddisfly Larva	Sensitive	6	4	3	1
Dragonfly Nymph	Moderate	4	3	2	1
Midge Larva	Tolerant	2	6	9	14
Rat-tailed Maggot	Tolerant	2	5	9	14
TOTALS		**26**	**26**	**26**	**26**

Resources:

Project Wet

http://www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/macro/

Stonefly



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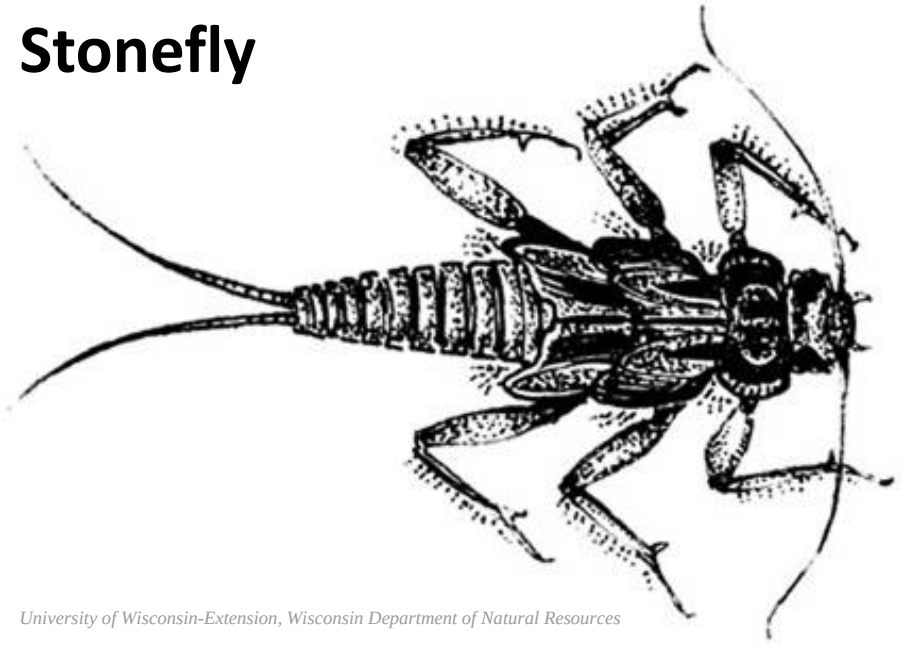
Stonefly



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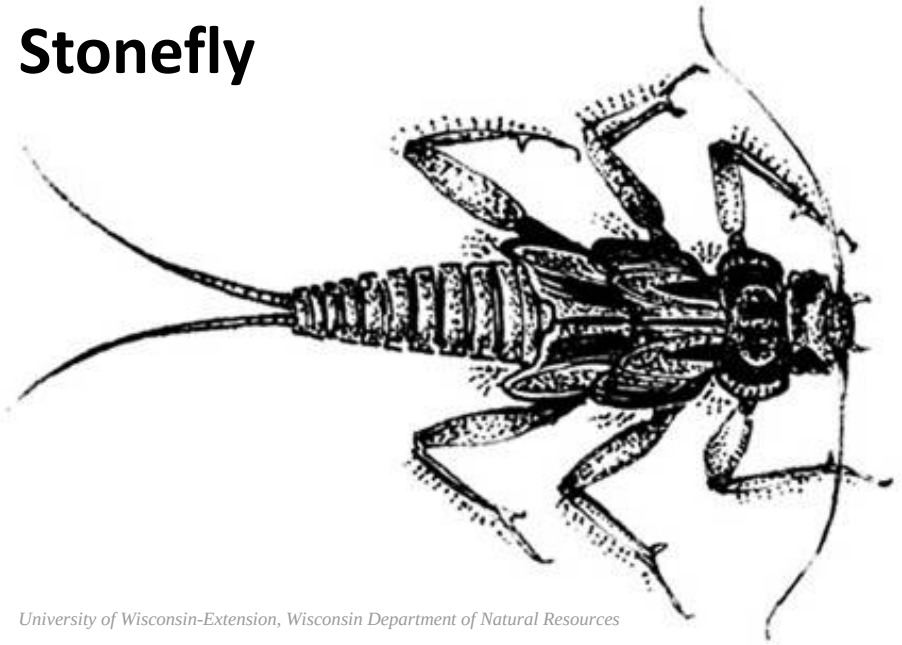
Stonefly



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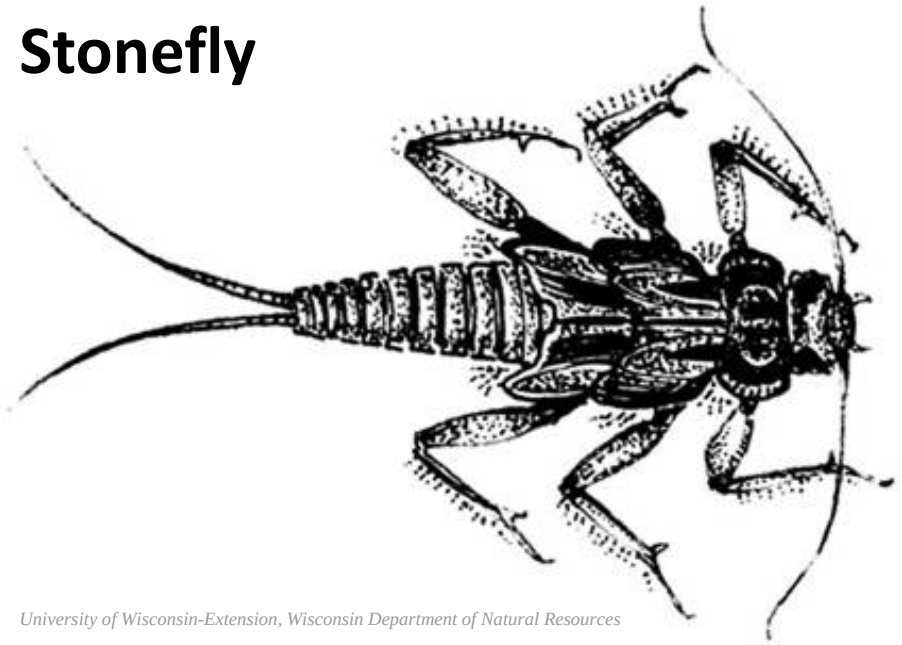

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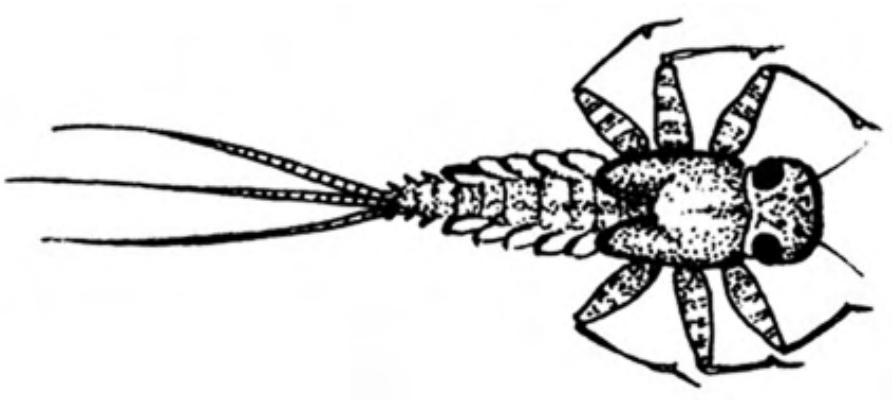
Mayfly



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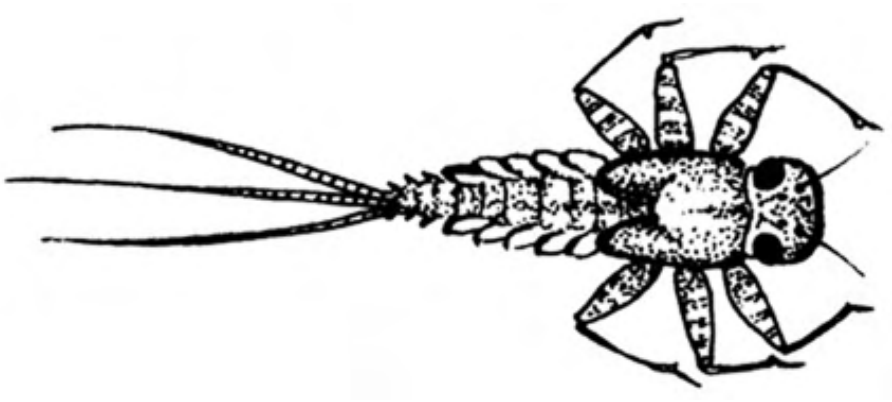

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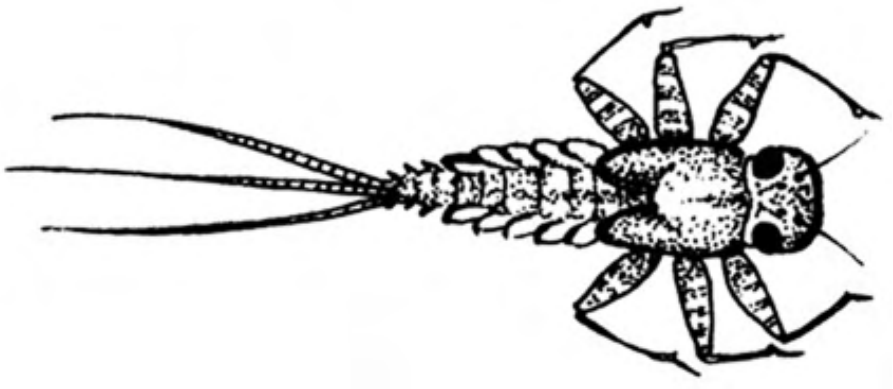
Mayfly



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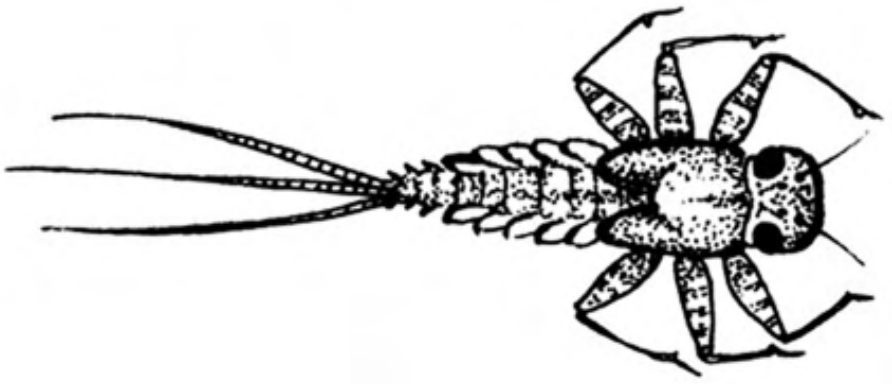

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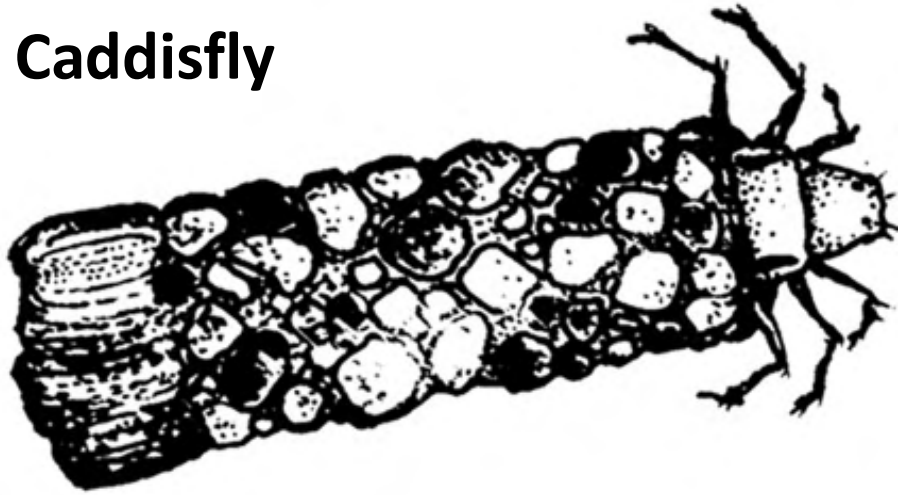
Caddisfly



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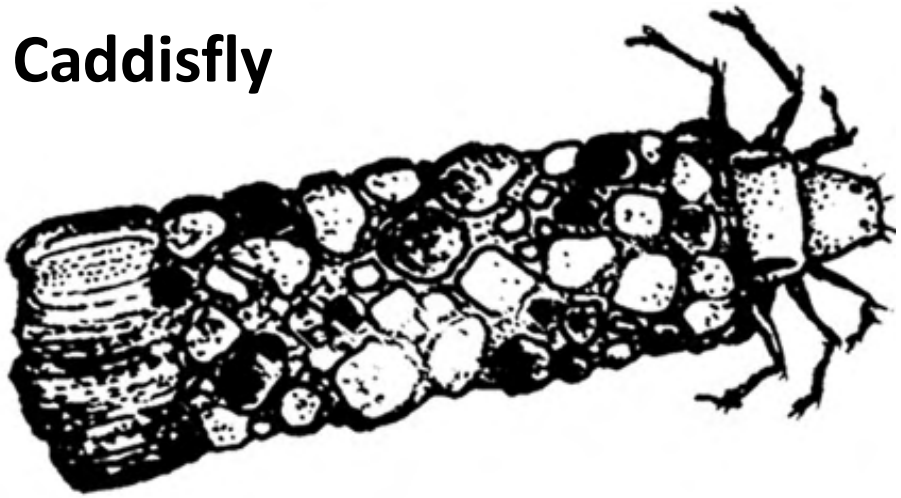
Caddisfly



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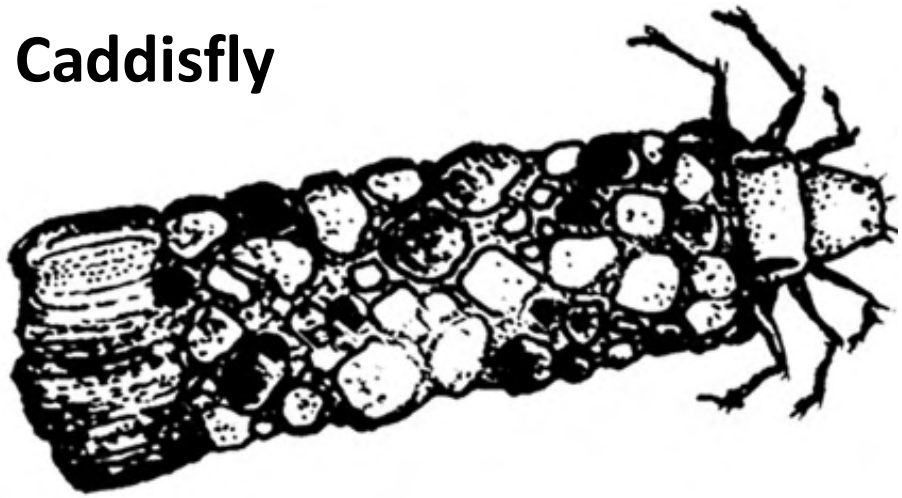
Caddisfly



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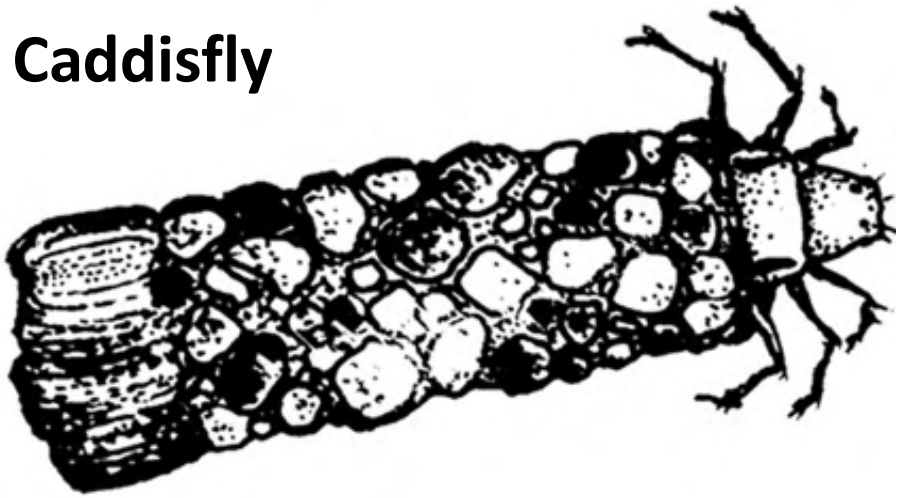
Caddisfly



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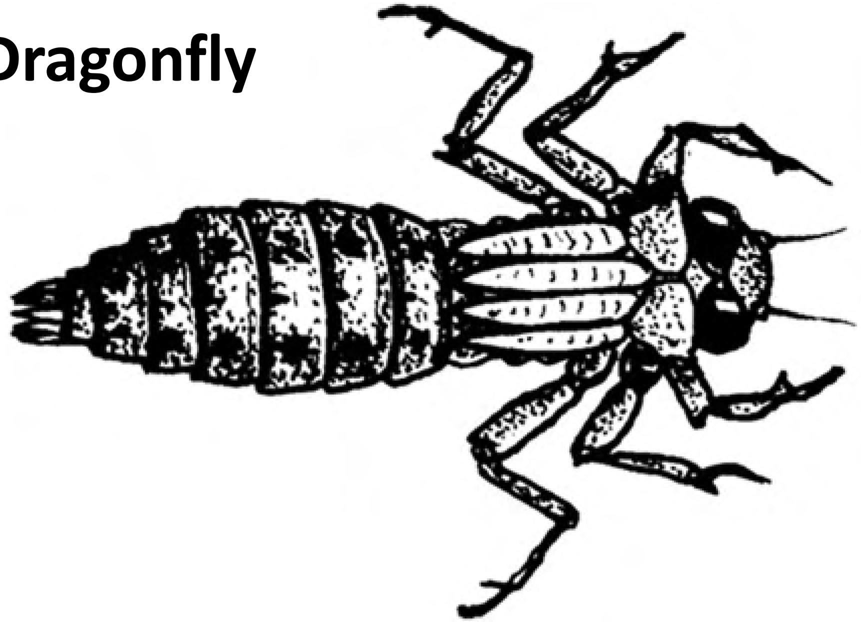
Dragonfly



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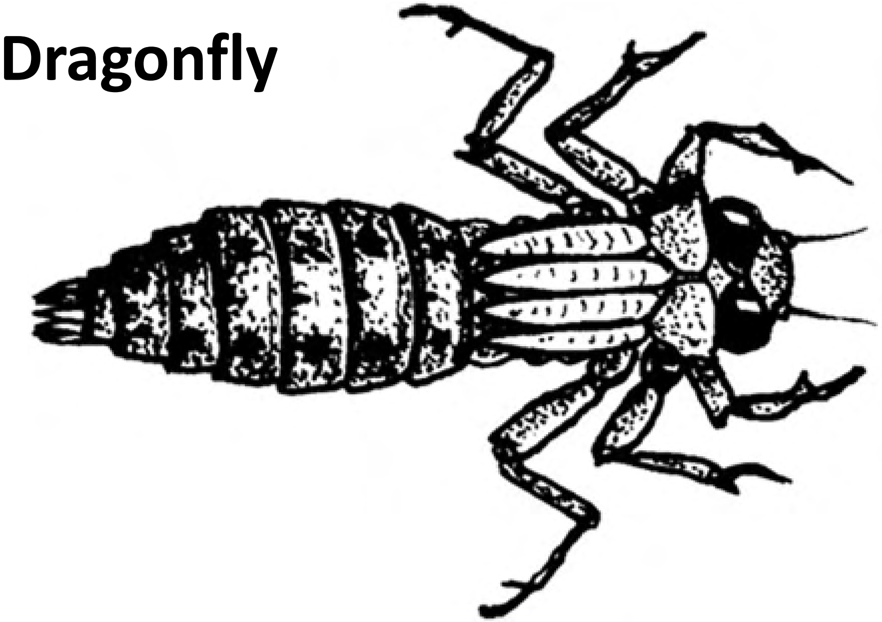
Dragonfly



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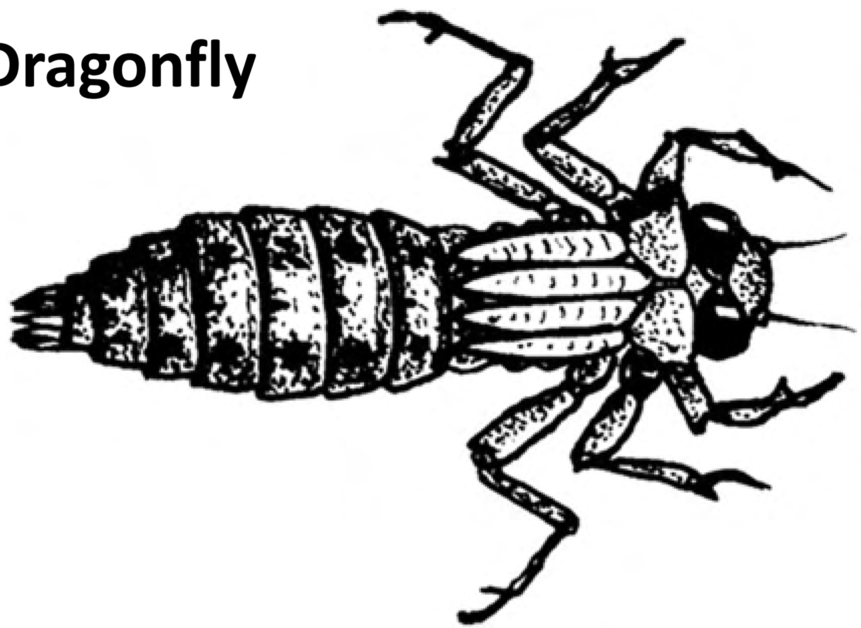
Dragonfly



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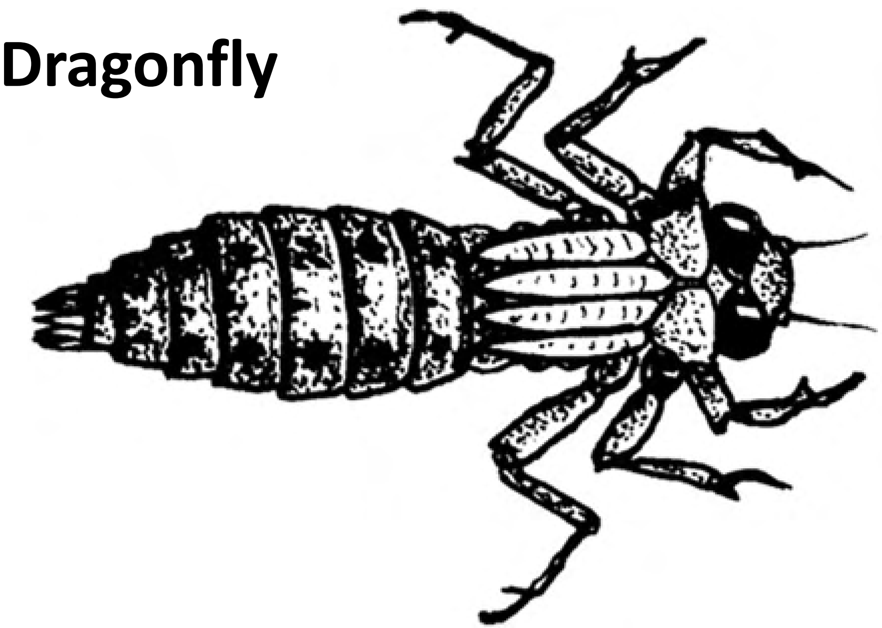
Dragonfly



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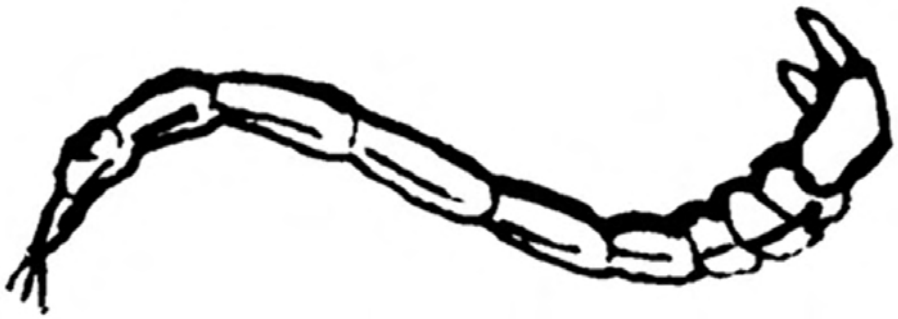
Midge



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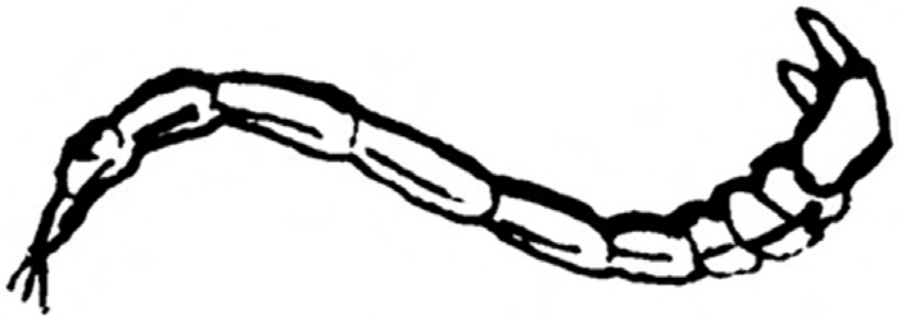
Midge



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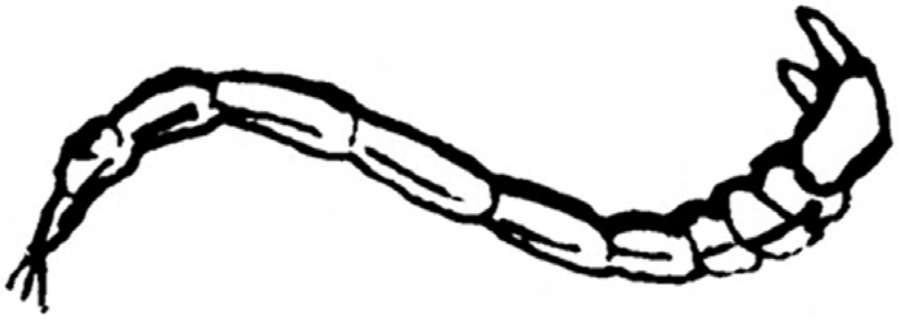
Midge



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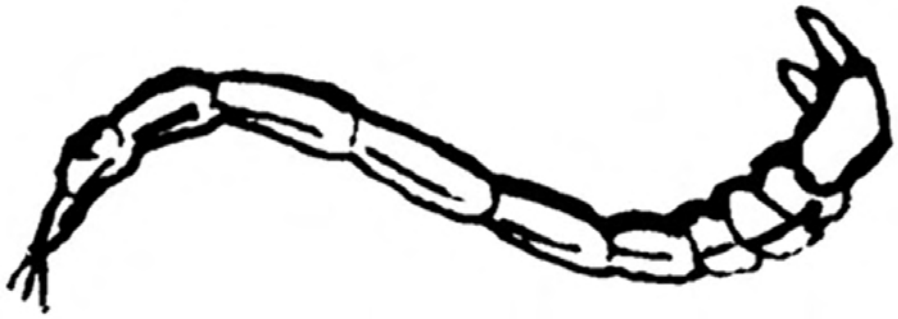
Midge



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Rat-tailed Maggot

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Rat-tailed Maggot

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Rat-tailed Maggot

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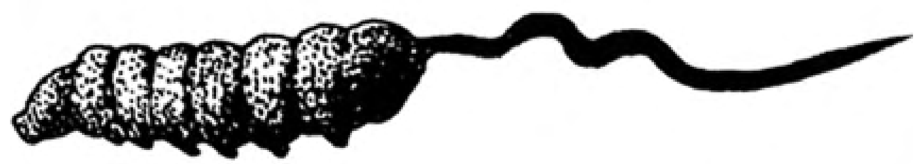
Rat-tailed Maggot



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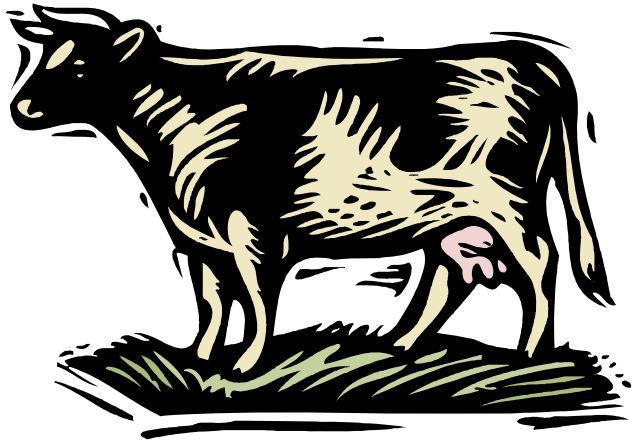
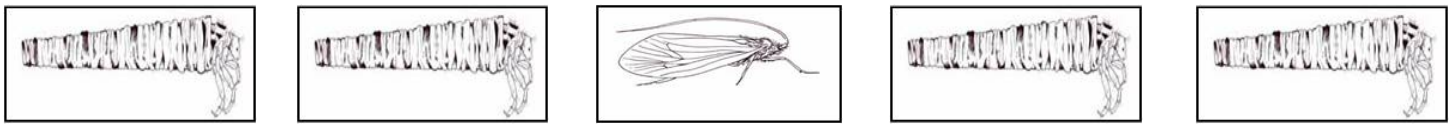
Fertilizer



Pesticide

Erosion

High Water Temperature



Build-A-Bug

Revised October 2011

PURPOSE: To introduce students to aquatic macroinvertebrates and their unique adaptations.

SUMMARY: By watching a presentation where one of their classmates is dressed up in a bug costume, students learn what adaptations macroinvertebrates have in order to live in an aquatic environment.

BACKGROUND: The small animals that live in water are called aquatic macroinvertebrates. These macroinvertebrates include many types of insects as well as other animals such as worms, mollusks, and crustaceans.

Most aquatic macroinvertebrates make their home in rocks, leaves, and the sediment of streambeds. These organisms have many special adaptations that allow them to live in demanding environments. Macroinvertebrates that live in riffles and fast-moving water may have features that help them hold on to rocky or hard substrates such as hooked feet or suction cups; or flat, streamlined bodies that can handle high water velocity. Macroinvertebrates that house themselves deep in muddy substrates may have different sets of adaptations for low oxygen environments, such as air tubes or oxygen trapping red hemoglobin in their tissue. See the "Adaptations" column on page #3 for more examples.

MATERIALS: Items contained in the "Items Representing Adaptations for Build A Bug" column on page #3. Use your imagination! Bright colors and silly items work well.

PROCEDURE:

1. Ask the students to brainstorm different adaptations a bug would need to live in an aquatic environment. (For younger students you may want to start with what an adaptation is.)

2. As students give you ideas, show pictures of invertebrates with these adaptations (see pages #4-6).

3. Choose a volunteer from the class. Explain that you will be preparing the student to live as an aquatic macroinvertebrate.

4. Ask the students to recall adaptations the volunteer needs in order to live in water.

5. As students give you ideas, dress the volunteer in the items from the table on page #3 that represent the adaptations.

Suggested grade level:
K-6

Duration:
15 minutes

Setting:
Classroom or outdoors

Core Alignments
Click the links (or visit streamsidescience.usu.edu for grade-by-grade alignments.

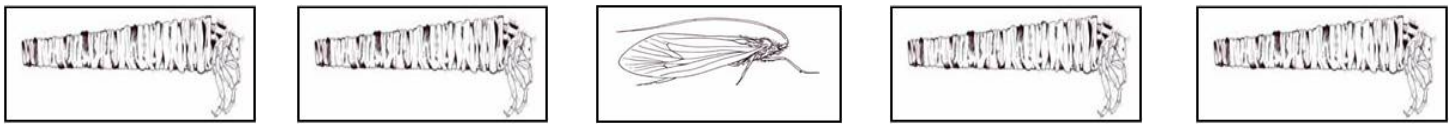
Kindergarten:
Science ILOs
1st Grade:
Science ILOs
2nd Grade:
Science ILOs
3rd Grade:
Science ILOs
4th Grade:
Science ILOs
5th Grade
Science ILOs
6th Grade:
Science ILOs

NOTE: An individual macroinvertebrate may not have all of the adaptations listed on the table. Your volunteer "bug" will have features found on many different types of macroinvertebrates.

http://extension.usu.edu/waterquality

NR/WQ/2005-02

UtahStateUniversity
WATER QUALITY EXTENSION



6. Discuss the adaptations as you go along. Why would a macroinvertebrate need them? How do they help the macroinvertebrate survive?

7. A good way to end this activity is with a photo. "Does our volunteer need anything else? I think he/she needs his/her picture taken!"

OPTIONAL ART ACTIVITY:

You can enhance this lesson with the following art activity (use the materials listed in the table on page #3).

1. Tell your students that they will be making an aquatic macroinvertebrate of their own.

2. Show the students the materials listed in the adaptations table on page #3, (or substitute other materials to represent adaptations as you see fit).

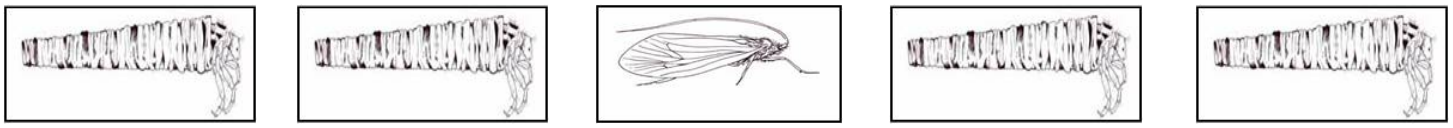
3. Ask them to recall adaptations they saw during the lesson and show them what materials might represent that adaptation (a feather might represent gills, bendaroos might represent legs and/or tails, etc.).

4. Have students use the materials to create their own macroinvertebrate

5. Have each student share his or her macroinvertebrate with the class and explain the adaptations.

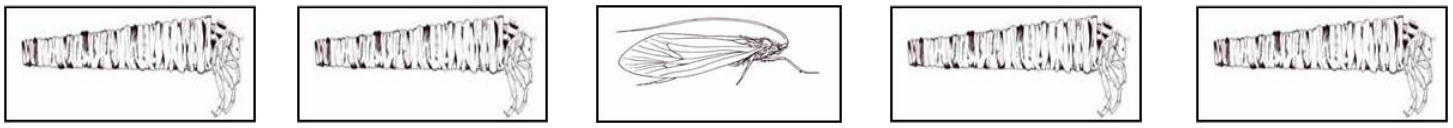
CONTINUED LEARNING:

This lesson can be followed with Macroinvertebrate Simon Says to teach about specific feeding adaptations. You can also follow this lesson with Macroinvertebrate Mix and Match to teach the three parts of a bug.



Suggested props for macroinvertebrate adaptations

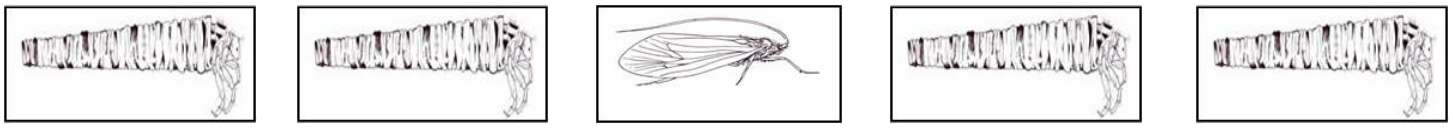
Adaptations	Use	Items Representing Adaptations for Build A Bug	Items Representing Adaptations for Make A Macroinvertebrate
Legs, claws, hooked feet, suction cups, hairs on legs	Holding on to rocks and hard substrate, scraping algae off rocks, attacking prey	Water noodle with hooks on the end	Bendaroos®, pipe cleaners
Tails	Swimming and maneuvering	Garland or rope	Bendaroos®, pipe cleaners
Compound Eyes	Help insect detect motion	Sunglasses with googly eyes glued on	Googly eyes (various sizes)
Hairs on head or body	Help detect movement or chemical changes in water	Wig or furry hat	Puff balls, feathers
Antennae	Sensing food, water, surroundings	Store bought or homemade antennae	Bendaroos®, pipe cleaners
Gills	Breathing dissolved oxygen in the water	Feather boa	Bendaroos®, feathers
Air bubble	Breathing oxygen from the surface air	Balloon	Plastic necklace pop-beads, bouncy ball, beads
Breathing tube	Breathing oxygen from the surface air	Straw	Straws
Specialized mouth parts	For scraping, piercing, shredding, etc. The mouth parts reflect food choices of the insect	Vampire teeth	Toothpicks
Device for catching food, i.e. net (made by the insect or part of their body structure) or special hairs	Catching food in the current	Fishing net	Fabric netting and toothpicks, feathers

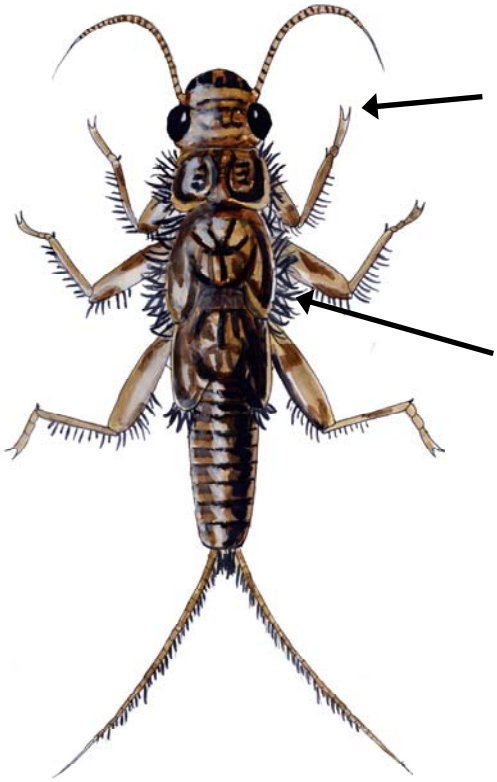


Examples of aquatic macroinvertebrate adaptations

The **Blackfly larva** has a net on its head for collecting food.

The **Cranefly larva** has tiny hairs and suction cups along its body so it can hold on to rocks and hard substrates in fast flowing water.

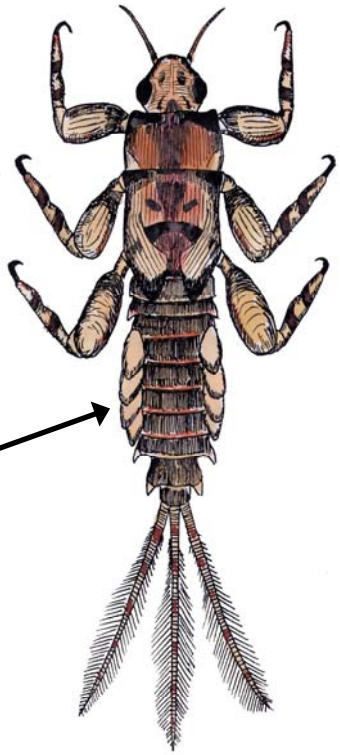




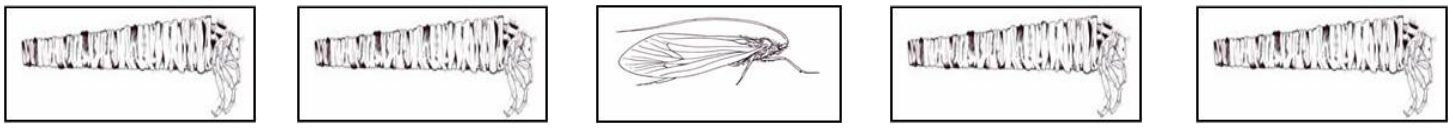
The **Stonefly** nymph has <u>claws</u> for capturing prey and holding on tight to rocky substrates.

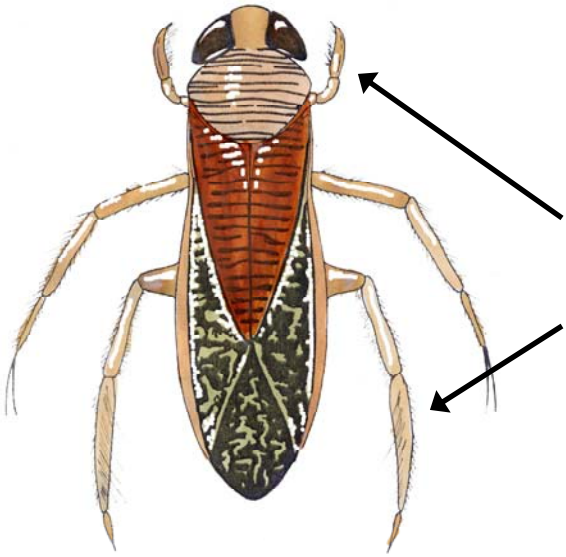
The **Stonefly** nymph has <u>gills</u> in its “armpits” for breathing dissolved oxygen in fast flowing streams.

The **Mayfly** nymph has <u>hooks</u> for holding on tight to rocky substrates.



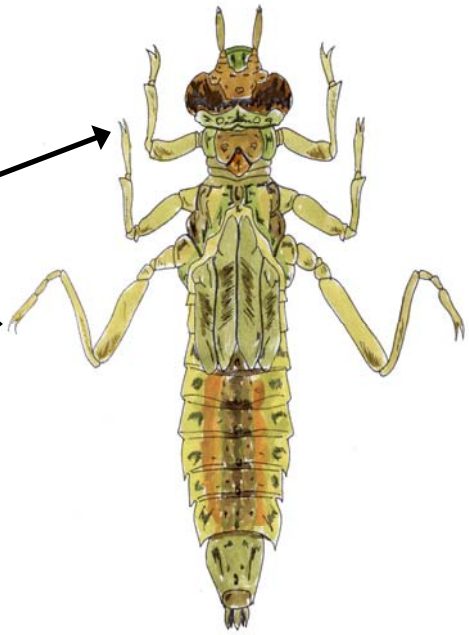
The **Mayfly** nymph has <u>gills</u> on its abdomen for breathing dissolved oxygen in fast flowing streams.

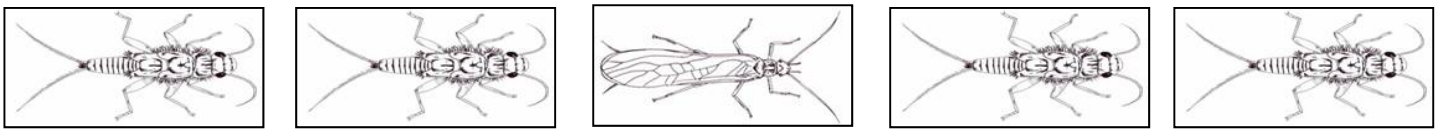




The **Water boatman** has <u>paddle-like legs</u> for swimming in slow moving water.

The **Dragonfly nymph** has <u>claws</u> on its legs for capturing prey and for climbing emergent vegetation.





If Bugs Could Talk

Revised October 2011

Suggested Grade level: K-6

Duration: 30 minutes

Setting: Classroom

Core Alignments

Click the links (or visit streamsidescience.usu.edu for grade-by-grade alignments.)

Kindergarten: Science ILOs / Math

1st Grade: Science ILOs / Math

2nd Grade: Science ILOs / Math

3rd Grade: Science ILOs / Math

4th Grade: Science ILOs / Math

5th Grade: Science ILOs / Math

6th Grade: Science ILOs

PURPOSE: To describe and identify the link between land use activities within a watershed and water quality. Students will also understand the link between aquatic macroinvertebrates and water pollution.

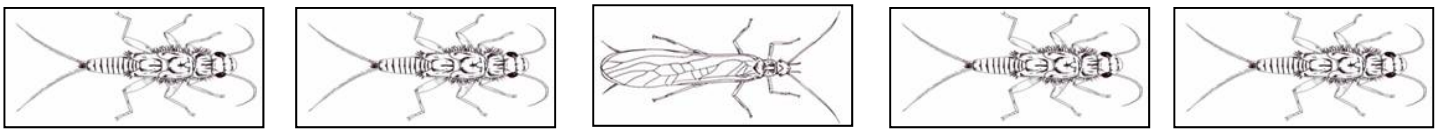
SUMMARY: Students will evaluate the quality of a "water sample" (using a bag of skittles to represent pollution and pictures of aquatic macroinvertebrates to represent invertebrates found in their sample), graph their results, and form a hypothesis about the land use near the location their "water sample" was collected.

BACKGROUND: A watershed is an area of land from which all the water drains to the same location such as a stream, pond, lake, river, wetland, or estuary. A watershed can be large, like the Colorado River drainage basin, or very small, such as all the water that drains to a small farm pond. Large watersheds are often called basins and contain many small watersheds.

Watersheds can transport non-point source pollution. Non-point source pollution is associated with rainfall and snowmelt runoff moving over and through the ground, carrying natural and human made pollutants into water sources. Examples of non-point source pollutants are fertilizers, pesticides, sediment, gas, and oil. Pollutants accumulate in watersheds as a result of various human driven and natural events. These pollutants, while sometimes inevitable, drastically alter the state of the ecosystem. If we can determine the type of pollutant and its cause, then we can classify the source of the pollutant and take preventative measures to reduce any further contaminants. Below are some examples of land use and their potential problems:

NOTE: These problems only occur because of a lack of proper management.

Land Use	Activities	Potential Pollution Problems
Agriculture	tillage, cultivation, pest control, fertilization, animal waste	sediment, nitrate, ammonia, phosphate, pesticides, bacteria
Construction	land clearing and grading	sediment
Forestry	timber harvesting, road construction, fire control, weed control	sediment, pesticides
Land Disposal	septic system	bacteria, nitrate, phosphate
Surface Mining	dirt, gravel, and mineral excavation	sediment, heavy metals, acid drainage, nutrient
Urban Storm Runoff	lack of automobile maintenance, lawn and garden care, painting	oil, gas, antifreeze, nutrients, pesticides, paints



Aquatic macroinvertebrates can indicate the level of water quality. Stoneflies, mayflies, and caddisflies (called indicator species) are not well adapted to living in water with high levels of pollution. They are pollution intolerant. Often, when these species are limited or absent in a river or stream where they typically should be found, that can be indicative of poor water quality. Aquatic macroinvertebrates can be classified by their level of tolerance to pollution.

Sensitive or Intolerant Species:
Organisms easily killed, impaired, or driven off by bad water quality; includes many types of stonefly, dobsonfly, and mayfly nymphs, caddisfly larvae, and water pennies.

Somewhat Tolerant Species:
Organisms with the ability to live under varying conditions may be found in good or poor quality water; includes amphipods, scuds, beetle and cranefly larvae, crayfish, and dragonfly nymphs.

Tolerant Species:
Organisms capable of withstanding poor water quality; includes most leeches, aquatic worms, midge larvae, and sow bugs.

MATERIALS:

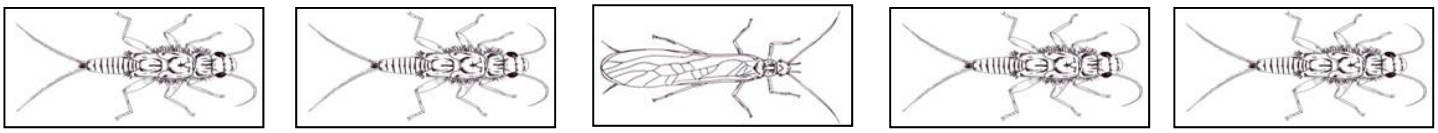
Candy (skittles)
Plastic sandwich bags
Graph paper (see page 5)
Colored pencils
Pollutant labels (pages 6-10)
Macroinvertebrate pictures (see pages 11-13)

PROCEDURE:

1. Before the lesson, divide the candy up into the sandwich bags so that each student or group of students has two “water samples”. Make sure each set is the same: one with fewer pollutants and one with more pollutants.

2. Tell the students you have taken two macroinvertebrate samples from similar streams (or one taken years previous in the same location) and show them pictures of the aquatic macroinvertebrates from each sample. One sample should have pollution intolerant invertebrates; the second sample should have more tolerant invertebrates). Show them the pictures and ask them why they think the insects are different in each sample.

3. Tell the students that you also have a water sample that may help them decide why the bugs are different. Pass out the bags of skittles to each student or group of students.



4. Ask the class to define the word pollutant. Tell them that each color of skittles represents a different kind of pollutant. You can use the visual aids provided in Appendix D to hang up in the classroom.

   PURPLE = Sediment
   RED = Pesticides
   GREEN = Fertilizers
   YELLOW = Oil and Gas
   ORANGE = Toxic Waste

5. Discuss each of these pollutants with the students. Ask them where they come from, what they are used for, how they can be beneficial, and how they may be harmful. Refer back to the Land Use Chart, on page 1 of this lesson, for more information. Discuss what "land use" means, and what kind of land uses may produce the different kinds of pollution.

6. Distribute the graph paper to each student or group. Tell the students that they will be completing a bar graph to show the number of pollutants found in their "water sample". Show them the sample graph provided. Have the students label the x-axis with the pollutant types and the y-axis with the amount of pollutants.

7. Tell the students to separate and count the number of each pollutant and graph them on the paper. Remind the students that they cannot eat the skittles until they are finished with their graph!

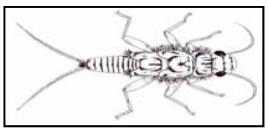
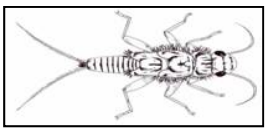
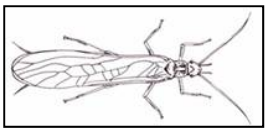
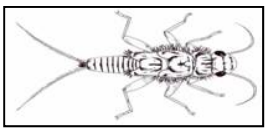
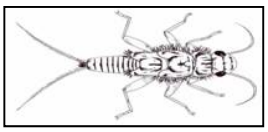
8. Go over the graphs as a class by creating a master graph in front of the classroom. Talk about what land use activities may be happening near the high pollution sample. Refer to the land use chart at the beginning of the lesson.

9. Review the pictures and ask students again why they believe the macroinvertebrates are different in each sample.

10. Discuss ways students can help reduce water pollution.

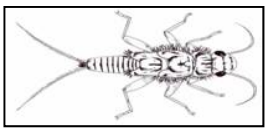
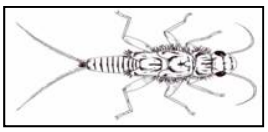
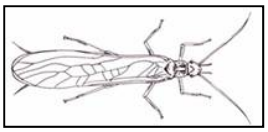
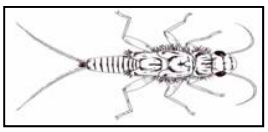
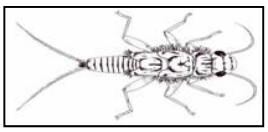
- *Don't use excessive amounts of fertilizers or pesticides around your house. They can wash into the storm drains and end up in a stream.*
- *Never put anything but water down a storm drain.*
- *Don't be a litterbug. Always dispose of trash in a proper container, not in the water.*
- *Make sure that your family car doesn't leak oil or antifreeze. This can wash into the water and be dangerous for fish, birds, even cats and dogs.*
- *Walk only on existing trails when near the water to help reduce erosion*

NOTE: Be sure the students understand that the factors (materials) we consider non-point source pollutants only become a problem when they are used incorrectly. For example, oil and gas become a problem when they are leaking onto the ground and washing into a water body. Fertilizers and pesticides become a problem when too many are applied and they run off into a water body.

CONTINUED LEARNING:

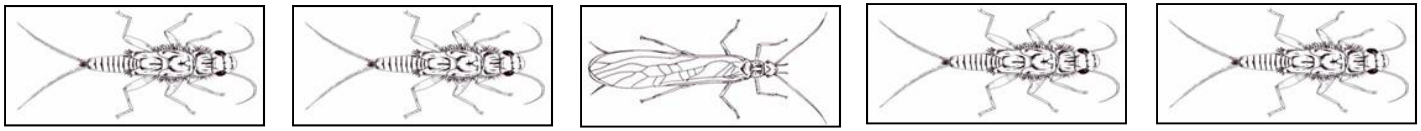
- Make each sample different to compare different land uses (see land use table in the background section).
- Talk about how pollutants or contaminants affect our water supply.
- Discuss the adaptations of different aquatic macroinvertebrates and why some are more tolerant to pollution.
- Talk about how pollutants or contaminants might affect the food chain.
- Prepare the second group of macroinvertebrates with fewer bugs or no bugs rather than just different bugs
- For older students, have them do research on different pollutants and macroinvertebrates at the library or on the internet to help them determine the water quality of their sample. They can also research what other factors might affect there being no pollution in the water.
- See Stream Side Science manual for more lesson ideas on watersheds and water quality.

If Bugs Could Talk Graphing Activity

Amount

Sediment **Fertilizer** **Pesticides** **Gas and Oil** **Toxic Waste**



SEDIMENT

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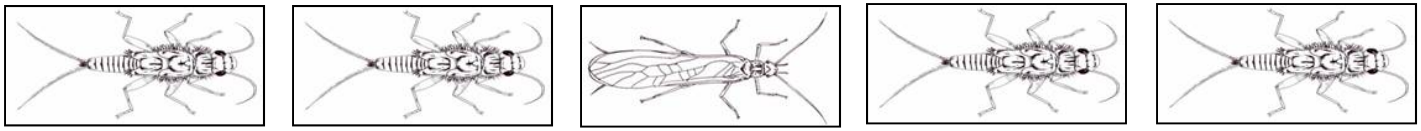

FERTILIZERS/ NUTRIENTS

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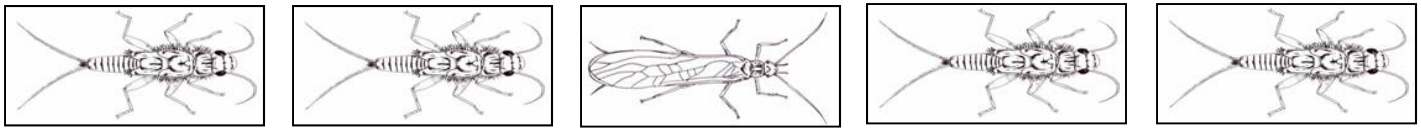
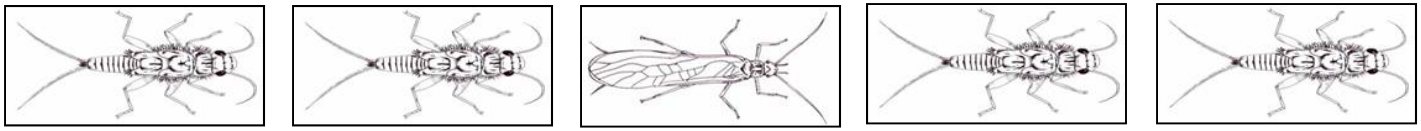


PESTICIDES

http://extension.usu.edu/waterquality

UtahStateUniversity
WATER QUALITY EXTENSION

NR/WQ/2011-10



TOXIC WASTE

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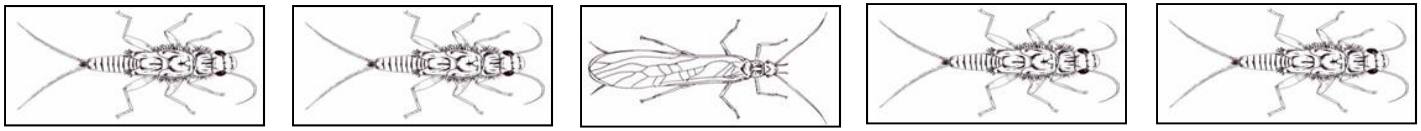
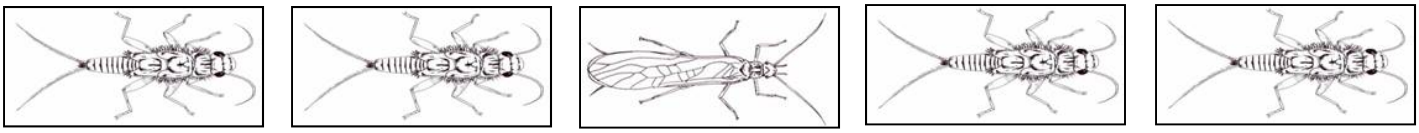
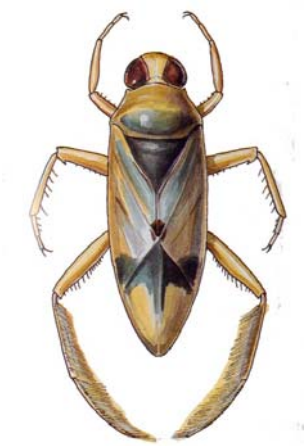


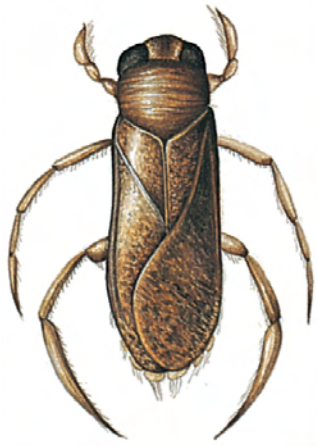
OIL AND GAS



Aquatic Macroinvertebrates with high pollution tolerance



Back swimmer

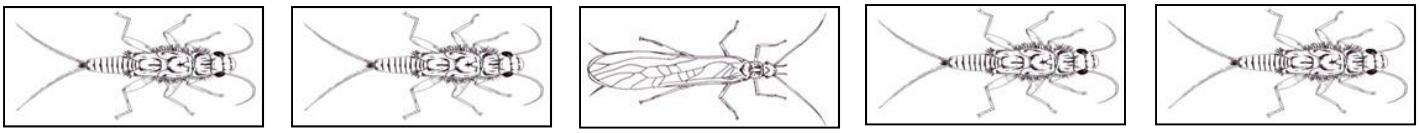


Water boatman

Water Strider

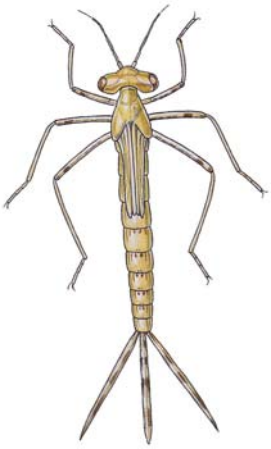
Diving Beetle

Rat-Tailed Maggot



Aquatic Macroinvertebrates with medium pollution tolerance

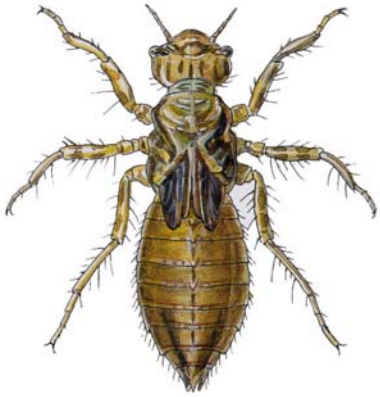
Blackfly



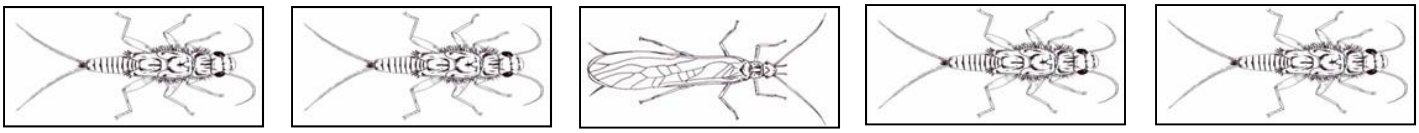
Damselfly

Cranefly

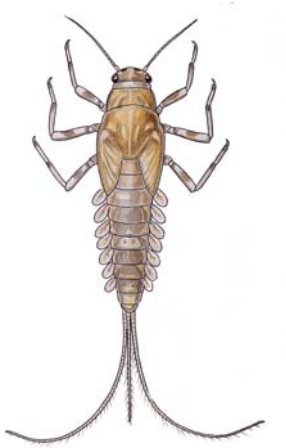
Flat worm



Dragonfly



Aquatic Macroinvertebrates with low pollution tolerance

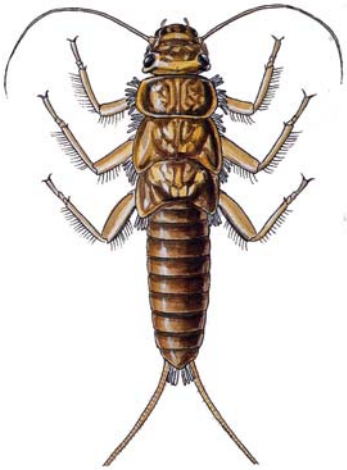


Mayfly

Caddisfly

Stonefly

Mayfly



Stonefly

NR/WQ/2011-10

Macroinvertebrate Simon Says

Revised October 2011

PURPOSE: To introduce students to the feeding adaptations found in aquatic macroinvertebrates.

SUMMARY: After a short introduction to macroinvertebrate feeding habits, students will play a Simon Says game.

BACKGROUND: The macroinvertebrates we will cover can be classified into four groups, called functional feeding groups, depending on their feeding habits. They are shredders, collectors, scrapers (or grazers), and predators.

Shredders are those organisms that chew on intact or large pieces of material. Leaves, needles, flowers, and twigs that fall from trees and shrubs on the shore into the water are the most common food for shredders.

Collectors acquire and ingest very small particles of organic matter. They eat the organic matter suspended in the water by catching it with net-like features or other adaptations. Often they eat fine organic matter that has fallen out of suspension onto the streambed (substrate).

Scrapers (also called grazers) remove and eat the algae growing on rocks in shallow water.

Predators are organisms that prey on other organisms. They have special mouthparts called mandibles which they use to pierce prey and hold it while they eat.

MATERIALS: None needed; however, pictures of the macroinvertebrates can be helpful (see pages 3-5, or http://www.extension.usu.edu/waterquality).

PROCEDURE:

1. Divide the students into six groups: Dragonflies, Craneflies, Blackflies, Mayflies, Stoneflies, and Caddisflies.
2. Explain the different feeding habits of each group, and assign them an action.
   a. DRAGONFLIES are predators. They have long mouthparts that extend and unfold to catch prey. For their action, have the students put their hands to their mouths with their elbows tucked down in front of them. To mimic eating, have the students straighten their elbows and make an upward scooping action. Students can also hold hands out with one up high and one down low and clap them together in a large "chomping" motion.

Suggested grade level:
K-6

Duration:
30 minutes

Setting:
Classroom
Outdoors

Core Alignments
Click the links (or visit streamsidescience.usu.edu for grade-by-grade alignments.)

Kindergarten:
Science ILOs
1st Grade:
Science ILOs
2nd Grade:
Science ILOs
3rd Grade:
Science ILOs
4th Grade:
Science ILOs
5th Grade:
Science ILOs
6th Grade:
Science ILOs

NR/WQ/2005-03

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b. CRANEFLIES are collectors. They wiggle around until they find a place to feed. The action should be a wiggly walk.

c. BLACKFLIES are also collectors, but they collect with a large net-like feature on their head, which they use to gather food. They can lower it down to their mouths to eat. The action should be placing your hands above your head, and lowering them down to your mouth.

d. STONEFLIES are shredders. They wait for leaves or other debris to fall into the water and then they tear off small pieces to eat. The action should be similar to tearing up a piece of paper.

e. CADDISFLIES AND MAYFLIES are scrapers. They scrape algae off rocks and sticks. This action should be similar to scratching someone's back.

3. After groups have learned their actions, have them act out their part at the same time for one minute.

4. Then test the students on all of the feeding habits by playing "Simon Says" with the actions. (Example: Simon says act like a blackfly. Everyone should have their hands above their head.)

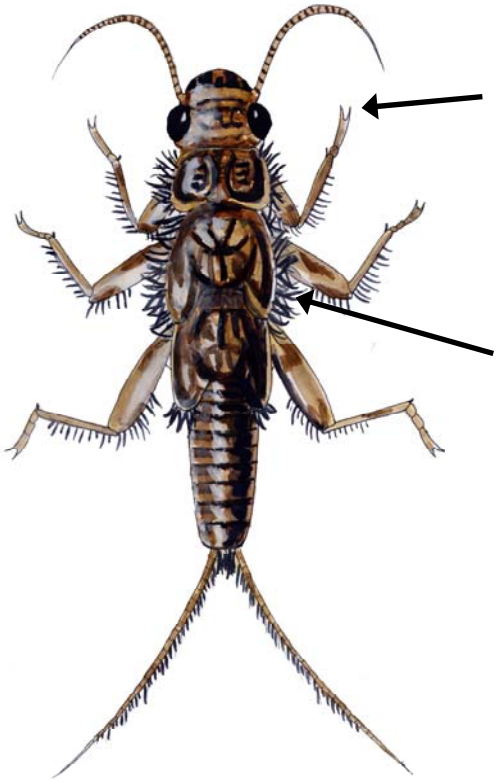
CONTINUED LEARNING:

Now that students have been introduced to aquatic macroinvertebrates, follow this lesson with Macroinvertebrate Mix and Match to introduce their body parts and life cycles.

Examples of aquatic macroinvertebrate adaptations

The **Blackfly larva** has a net on its head for collecting food.

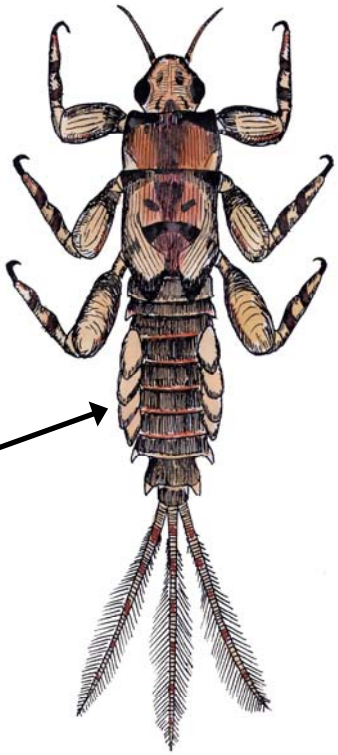
The **Cranefly larva** has tiny hairs and suction cups along its body so it can hold on to rocks and hard substrates in fast flowing water.



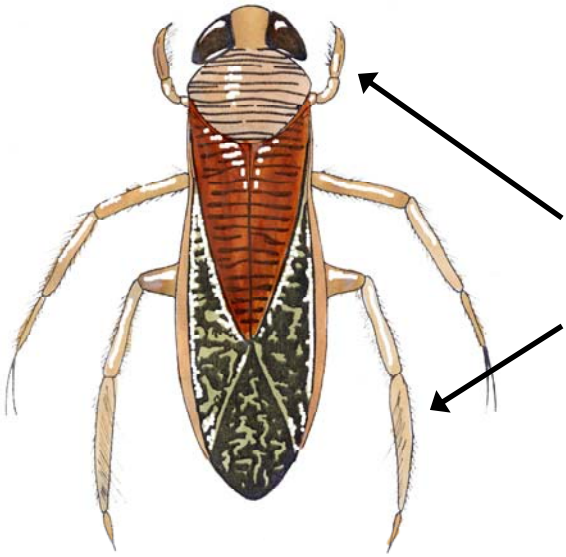
The **Stonefly** nymph has <u>claws</u> for capturing prey and holding on tight to rocky substrates.

The **Stonefly** nymph has <u>gills</u> in its “armpits” for breathing dissolved oxygen in fast flowing streams.

The **Mayfly** nymph has <u>hooks</u> for holding on tight to rocky substrates.



The **Mayfly** nymph has <u>gills</u> on its abdomen for breathing dissolved oxygen in fast flowing streams.



The **Water boatman** has <u>paddle-like legs</u> for swimming in slow moving water.

The **Dragonfly nymph** has <u>claws</u> on its legs for capturing prey and for climbing emergent vegetation.