The Pond Ecosystem

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Topic Focus: Life Science

Recommended Level
Grade 3

Time Frame
This unit is composed of 11 Lessons and a final Presentation session. Lesson lengths vary but are 45 minutes on average.

Objectives
As a result of these experiences, students will:

- Understand that scientific knowledge is an ongoing process, and that they can make a contribution to that knowledge.
- Collect data from observations and use it to make reasonable conclusions.
- Create a model of a pond food web, demonstrating an understanding of the inter-relationships of plants and animals in a pond.
- Understand that a pond is an ecosystem that provides food, water, shelter, and oxygen for a variety of plants and animals to live and reproduce.
- Understand that organisms have specific adaptations, characteristics that allow them to survive and reproduce, and describe specific examples of aquatic animal adaptations.
- Understand that a pond is an essential place for many animals during part or all of their life cycles.
- Describe the life cycle of the dragonfly, demonstrating an understanding of metamorphosis.
- Understand that some animals (e.g. some species of dragonfly) migrate during their lives and therefore depend on more than one habitat.
- Create a field guide to the pond to share with their school community.

Next Generation Science Standards April 2013

The following standards were drawn from the **Topic Arrangements** of the NGSS. The same standards may be found in the **DCI** (Disciplinary Core Idea) **Arrangements.** The two relevant topics for this unit are (1) Interdependent Relationships in Ecosystems and (2) Inheritance and Variation of Traits.
Note: LS refers to Life Science

Performance Expectations - Students who demonstrate understanding can:

Interdependent Relationships in Ecosystems
3-LS2-1. Construct an argument that some animals form groups that help members survive.
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.
3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

Inheritance and Variation of Traits: Life Cycles and Traits
3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

Science and Engineering practices:

Interdependent Relationships in Ecosystems
- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4 -3)
- Construct an argument from evidence and data about the natural world. (3-LS2-1)
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

Inheritance and Variation of Traits: Life Cycles and Traits
- Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1)
- Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)
- Use evidence (e.g., observations, patterns) to construct an explanation. (3-LS-2)

Connections to Nature of Science
Scientific Knowledge is Based on Empirical Evidence
- Science findings are based on recognizing patterns. (3-LS1-1)

Disciplinary Core Ideas:

Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

LS2.D: Social Interactions and Group Behavior

Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size *(Note: Moved from K–2)*. (3-LS2-1)

LS4.C: Adaptation

For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

LS4.D: Biodiversity and Humans

Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

Inheritance and Variation of Traits: Life Cycles and Traits

LS1.B: Growth and Development of Organisms

- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)

LS3.A: Inheritance of Traits

- Many characteristics of organisms are inherited from their parents. (3-LS3-1)
- Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)

LS4.B: Natural Selection

- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)

Crosscutting Concepts:

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1, 3-LS4-3)

Scale, Proportion, and Quantity

- Observable phenomena exist from very short to very long time periods. (3-LS4-1)

Systems and System Models

- A system can be described in terms of its components and their interactions. (3-LS4-4)

Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena. (3-LS3-1)

Connections to Nature of Science

Consistency in Natural Systems

- Science assumes consistent patterns in natural systems. (3-LS4-1)

Common Core State Standards Connections:

ELA/Literacy —

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. *(3-LS2-1),(3-LS4-1),(3-LS4-3),(3-LS4-4)*

R1.3.7 Use information gained from illustrations (e.g. maps, photographs)and the words in a text to demonstrate understanding of the text (e.g. where, when, why and how key events occur). (3-LS1-1)

W.3.1 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. *(3-LS4-1),(3-LS3-3),(3-LS3-4)*

W.3.9 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-LS4-1)

SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. *(3-LS4-3,(3-LS4-4)*

Mathematics —

MP.2 Reason abstractly and quantitatively. *(3-LS3-1),(3-LS3-2),(3-LS4-2)*

MP.4 Model with mathematics. *(3-LS1-1),(3-LS3-1),(3-LS3-2),(3-LS4-2)*

MP.5 Use appropriate tools strategically. *(3-LS4-1)*

3.NBT Number and Operations in Base Ten *(3-LS1-1)*

3.MD.B.3 Draw a scaled bar graph to represent a data set with several categories.

Unit Rationale:

In the northeast, we are abundant in ponds. Most communities have ponds that are known to their residents and are visited by families, bird watchers, and lovers of water. People are drawn to water for many reasons: to fish, play, observe wildlife, and to find a peaceful respite from busy lives.

A healthy pond is also an ecosystem where a great diversity of animal and plant species may be found, perhaps more than any other ecosystem in this part of the world. While many animals, like fish, will spend all of their lives in a pond, many others will inhabit the pond for only part of their life cycle. The American Toad is one such animal. Eggs hatch in as little as 2 days, and toadlets are ready to leave the pond for their woodland habitat within 55 days. At any time or season, a pond offers the observer a rich experience in how animals and plants interact with each other and with their environment.

As a local place for students to experience an ecosystem at work, there is nothing like a pond! The scale and accessibility is ideal for elementary students. In just one visit, students can easily collect and observe a great diversity of fascinating animals and plants with adaptations to living in water that are truly astonishing. Through a season, they can witness animals go through unusual life cycles. They can learn how to carefully handle and release live animals. These first-hand experiences help children connect to their place in the natural world, and give them a real world, concrete understanding of concepts such as ecosystem, adaptation, and metamorphosis. Collecting real data gives children the opportunity to do what scientists do: learn through their own observations and discoveries. And children love water.

If there is not a pond within walking distance of your school, most of the activities in this unit can be brought into the classroom, and some aquatic animals can be purchased from a biological supply company (see resources.) However, it is strongly recommended that you actually take your students to a pond. For many children, the experience is powerful, and the pond itself is the perfect motivator for learning. You may contact your local nature center as a resource for visiting a pond. Their expertise, particularly in identifying your aquatic animals, may prove extremely helpful. Dive in and have fun!

Unit Summary:

This unit explores ecosystems through the study of a pond. The concepts taught here can be generalized to other natural ecosystems.

A student journal, notebook, or folder is recommended! There are times when students will refer back to earlier work.

The unit begins with a story that illustrates the interconnections between plants, animals, and human activity in a lake ecosystem and how these affect an entire lake and river system. Students are then introduced to the life cycle of the dragonfly by observing live dragonfly nymphs. Students will visit a pond, collect macro-invertebrates (mostly aquatic insects), and record species and numbers of animals. They will observe animal adaptations to aquatic life in a classroom pond animal lab. They will also create a pond web of life in order to understand the many interconnections in this ecosystem. Students will be introduced to citizen science and learn how natural phenomena like dragonfly migration is discovered by people simply through making observations. Then, using their own observations, drawings and research, students will create a field guide to the pond to share with the school community. An extension of the unit includes an exploration of some of the physical characteristics of water, and how human activities can change a pond and affect its inhabitants.

Unit Overview:

Engage:

Lesson 1: Introduction to Ecosytems – Students will be introduced to the term Ecosystem through reading the book, *Yellow Eye*.

Lesson 2: "Predator-Prey Pond Game", an active game that demonstrates predator-prey relationships and factors in an ecosystem that affect animal survival.

Lesson 3: Mystery Animal – Students will observe, draw and record observations of a live dragonfly nymph, listing adaptations to life in a pond.

Explore:

Lesson 4: Dragonfly Life Cycle - Students will listen to a story about a dragonfly and watch videos to reinforce learning about a dragonfly's adaptations as well as its life cycle. Students will use new vocabulary to label and improve drawings of nymphs from Lesson 2.

Lesson 5: Pond Visit – The class will visit a local pond, make observations, collect pond animals, record data, and bring animals back to the classroom.

Explain:

Lesson 6: Limnology Lab - Students will learn that limnology is the study of fresh water habitats. They will draw and identify pond animals, act out pond animal adaptations with props, and begin work on the pond field guide.

Lesson 7: A Field Guide to the Pond - Students will meet to constructively critique each other's work, and continue to draw and research their pond animal for the field guide.

Elaborate:

Lesson 8: The Pond Web of Life and Water Quality - Students will observe pond micro-invertebrates, create a class food web to demonstrate pond ecosystem interactions, and investigate characteristics of water through an activity, "Red Drop/Green Drop."

Lesson 9: Dragonfly Migration - Students will follow the migration of a Green Darner Dragonfly on a map while the teacher reads from *A Dragon in the Sky*. They will watch a video of dragonflies in migration and learn about citizen science.

Lesson 10: Pond Visit #2 - The class will visit the pond and collect pond animals. They will record data of species and numbers. Students will compare data from the two visits through writing and a graph.

Evaluate:

Lesson 11: Pond Field Guide - Students will refine and complete drawings and writing for the class field guide.

Lesson 12: Presenting Our Field guide: A Pond Celebration! - Students will present their work and explain the process of creating a field guide to another class, an open house, or a school assembly.

Lesson 1: Introduction to Ecosystems (Engage):

Students will be introduced to the term Ecosystem through reading, discussing, and writing about the book *Yellow Eye.* (*Yellow Eye*, David Spillman and Mark Wilson, Crocodile Books, New York, 2002, ISBN: 1-56656-410-7)

Time: 45 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3, 3-LS4-4
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS4-2
Science and Engineering Practices:
Analyze and interpret data; Construct an argument from evidence; Make a claim about the merit of a solution
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS2.D, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS4.B
Crosscutting Concepts:
Cause and effect; Scale, proportion and quantity; Systems and systems models; Patterns; Consistency in natural systems

Introduction:
Review the upcoming Pond Ecosystem unit with your students. You may simply post the objectives in the room and emphasize the pond discovery days (Lessons 5 and 10) and the creation of a field guide.

Pre-Assessment:
Brainstorm answers to question: What is an ecosystem? What other words have "System" in them? Students may know about the Solar System. See Background Information at the end of this lesson for a definition of **system** and **ecosystem**.
Using student journals or notebooks, have students answer the question: "Are we part of an ecosystem? Give one example!"

Read book, *Yellow Eye*, a story about a lake ecosystem and how people worked together to solve a problem with some of the living things there. It illustrates the relationships and interactions between living things in an ecosystem. If possible, project book pages with an ELMO Visual Presenter.

Project pages 12 and 13 onto the board. This is a map of the area in the story.
Alternatively, copy the pages and have students look at them during the reading.
During the reading, pause and have students record: "Two things I didn't know." Students may work with a partner to do this.

Have students share what they didn't know.

Other questions for discussion:
1) Why don't the council members tell the 2 government officials about Yanatji?
This is a good place to introduce the idea that cultural differences can lead to a lack of communication. How was this overcome? (At Tom's suggestion, Uncle Ehboy spoke to Paul from the Department of Fisheries and asked him to ask Grandfather to speak at the next meeting.)
2) How did the old people know about the flower Yanatji? (By observing. They knew that Yellow Eye only came after this flower bloomed and that the flower had disappeared.)
3) What did the government research discover? (that nizbets, which feed on Yanatji, lay eggs in the creek that hatch into nymphs. These nymphs are what the Yellow Eye feed on.)

It is important in this story that both the elders and the government contributed information that led to solving the mystery of the disappearance of Yellow Eye. It shows how two different cultures came together to solve an environmental problem.

Post-assessment:
Have students write about one ecosystem interaction that they learned about in the book. Examples: Planting trees caused the grasses and yanatji flowers on the plain to die from lack of sunlight, nizbets feed on the yanatji flowers.

Teacher background information:
A **system** is a group of related parts that move or work together.

An **ecosystem** is *All living and non-living things that interact with each other in an environment. It includes the relationships between all parts of the ecosystem*. (For example, in a pond, any change in the water may affect the plants and animals living there. If people pollute the water, some plants may die. This would cause the animals that depend on them for food to die.)
Living things: Plants, animals, micro-organisms; Non-living things: sunlight, air, water

Lesson 2: Predator-Prey Pond Game
(Engage)

Overview:
This activity introduces ecosystem interactions between predators and prey.
Students go through a simulation that is like a game of tag to understand predator/prey relationships, how both have adapted in order to survive. Different rounds may be used to demonstrate the impact that prey and predators have on each other's populations and to demonstrate the effectiveness of adaptations for survival. See **Background Information** at the end of this lesson to help with ideas for different rounds.

After round one, you may introduce a change in the ecosystem, such as a disease that affects the fish population, so there are fewer predators. Does this affect the prey?

Time: 45 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS4-2
Science and Engineering Practices:
Analyze and interpret data; Construct an argument from evidence
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS2.D, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS3.A, LS4.B
Crosscutting Concepts: Cause and effect; Systems and systems models

Materials:
- Food tokens (poker chips or oak tag circles)
- Rope circles or hula hoops
- Brightly colored fabric to tie around the arms of predators
- Whistle or bell

Procedure:

- Choose a large playing area outdoors to be the **Pond.**
- Place hula hoops (or rope circles) around the playing area. These are "safe" places for prey animals to hide. Two or three is sufficient.
- Place "food" items around the area for the prey animals to eat. These may be game pieces such as poker chips, or small pieces of oak tag (something relatively sturdy).

- Assign students to be either predators or prey animals. In a pond habitat, the predator/prey species might be one of the following: heron/fish, dragonfly nymph/tadpole, fish/dragonfly nymph, water snake/frog.

- There should be 2 or 3 predators for a class. Predators may wear a gym vest (if available) or a colorful bandana tied around their arm so everyone knows who they are.

- Each round should last approximately 2 minutes. The round ends with the blow of a whistle or other signal.

The goal of the prey animals is to not get eaten and gather at least three food items. Predators will roam the area searching for prey. If the prey animal is tagged, the predator has killed and eaten the prey. The prey animal must leave the playing field and wait in the out-of-bounds area. Predators need to tag at least two prey animals. Prey animals may go into the safe places to avoid the predators. If they are in the safe areas, they may not be tagged. However, once the round ends, prey must have collected 3 food items, or they have starved.

Play a number of rounds, changing one condition of the pond "ecosystem" each time. For example, you might change the number of predators, the number of food items the prey must collect, or the number of safe areas. Brainstorm with students about ways to change each round.

You may have students keep data about each round. Below are tables you may use, where students record the number of predators, prey, and other conditions in the pond for each round.

Adapted from: Predator Vs. Prey games to play with kids:
http://www.ehow.com/info_8072242_predator-prey-games-play-kids.html

Discussion and Post-Assessment:

The following suggestions may be done as either a class discussion or individual writing assignment:

How did the prey escape capture? How did the predators capture prey? Did any students come up with strategies to be successful? Relate this to pond animal adaptations for survival. For example, if students stayed in a small group, this may have made it easier for them to avoid being tagged. This is what fish do when they congregate in a "school."

What happened when the predator population increased? *Prey population may have declined.* What would happen to the predator population eventually if they kept eating all the prey, not allowing them to reproduce? *A shortage in prey (food) will eventually limit the predator population. When the predator population declines, it may allow the prey*

population to rebound again. The two populations depend on each other and are limiting factors for each other.

Can students think of real circumstances in which a safe area or hiding place in a pond may disappear or be eliminated. *Downed tree trunks (natural hiding places for fish) may be removed from a pond; plants such as cattails may be eaten by visiting geese, eliminating cover for aquatic insects and fish.*

What are some other adaptations used by prey or predators that were not covered in the game? *Causing a distraction (though this may have been done in the game), prey fighting the predator to survive (this better not have been done in the game!), prey camouflage, predator physical adaptations like claws, sharp teeth, etc.*

Extensions:

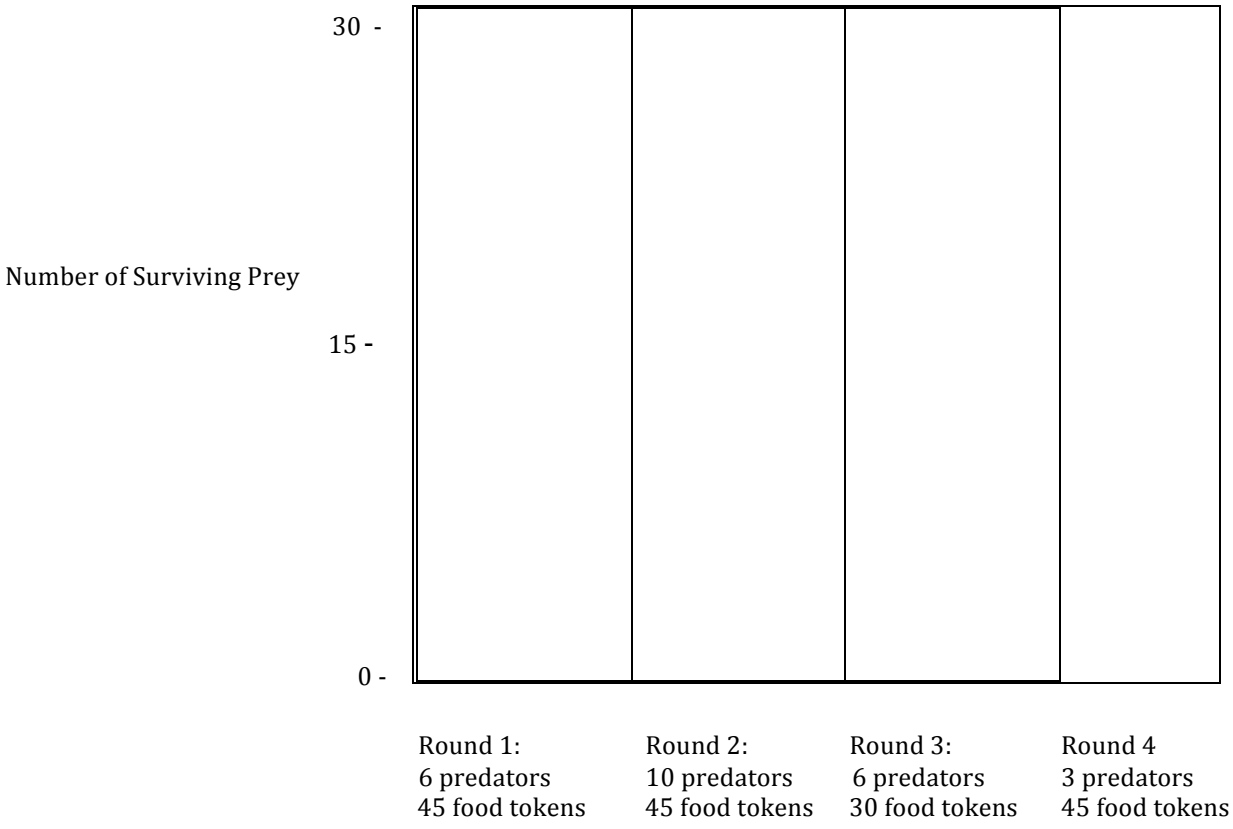
- Have student research and make a list of examples of predators and prey in a pond ecosystem.
- Select an aquatic creature and research its behavior patterns for avoiding detection and capture. Reports or demonstrations of behavior could be presented to the class.

Student Name _____ Date _____

	Round 1	**Round 2**	**Round 3**	**Round 4**
# of Prey at Start				
# of Prey at End				
# of Predators at Start				
# of Predators at End				
# Safe areas				
Other Conditions in the Round				

	Round 5	**Round 6**	**Round 7**	**Round 8**
# of Prey at Start				
# of Prey at End				
# of Predators at Start				
# of Predators at End				
# Safe areas				
Other Conditions in the Round				

Graphing Data:
In order to quantify this activity, you can create a bar graph with students, using data collected in each round. A simple graph is suggested below. This graph looks at how changing one variable in each round affects the number of prey that survives. In this graph, the numbers of predators and food tokens change with each round.



Background Information:

A **predator** is an animal that eats other living organisms (animals and plants) for food. **Prey** is the organism that is eaten by another organism. The predation/prey relationship includes the more common animal eating animal (a trout eating an aquatic insect), but it can also include an animal consuming a plant (a mosquito larva eating algae on rocks). Predation is an important factor in adaptive evolution because eating and avoiding being eaten are a part of reproductive success. Natural selection refines successful strategies for both predators and prey. Individual organisms that effectively forage for food are most likely to leave the most offspring, and prey that are more successful at avoiding predation are most likely to breed successfully.

Animals display a variety of behaviors in predator/prey relationships. These are adaptations to survive – getting enough food or avoiding being eaten. **Adaptations** are specialized characteristics that animals and plants have developed over time in response to environmental pressures. They may be physical features or specialized behaviors.

Predator physical adaptations can include acute senses enabling them to locate and identify potential prey. Predators may have adaptations like specialized teeth, stingers, claws, or poison to help catch prey. In an aquatic ecosystem, beetle larvae have a set of large mandibles in the front to better grasp insects they prey upon. Giant water bugs have a front pair of legs with a single hook also used for capturing and holding prey.

Both predators and prey can have adaptive coloration to help them survive. Some animals have developed colors, patterns, and shapes that help blend them into their surroundings. This is called **camouflage** and helps make prey, or in some cases a predator, difficult to spot in a natural background. Aquatic insects are often dark colors that blend into the mud and debris of stream bottoms. Some aquatic insects such as whirligig beetles and fish will have a light bottom side and dark top side. The light side blends in with the sky when a predatory fish is looking up at the prey from the pond bottom and the dark side blends with the muddy bottom when looking downward into the water. Probably the best camouflage in the pond is the case-building caddisfly larva. It builds a protective, tube-like shelter out of vegetation or small stones, then drags the case around with it.

Some prey behaviors that may help them escape predation can include: flight, scrambling for cover, hiding, fighting, signaling to other for warning, or remaining still to escape detection. Fleeing or fighting is a costly anti-predator response in terms of energy, so many animals flee into a temporary shelter and avoid being caught without expending the energy required for a prolonged flight. Crayfish will often scurry backward (in order to continue facing the danger) under a rock or into a narrow crevice. Minnows will dart into crevices or thick vegetation when faced by a predator. Frogs will jump into a pond and bury themselves into the mud in the face of danger. Active self-defense such as fighting is often a last resort by prey and often fighting is undertaken in an effort to protect young and offspring. Another common prey behavior that fish use is living in large groups. Schools of fish will move together with a safety in numbers concept. Predators can be confused by the multiplicity of moving prey items and have trouble concentrating on a single fish.

Lesson 3: Mystery Animal
(Engage)

Students will observe, draw and record observations of a live dragonfly nymph, the "mystery animal", focusing on its adaptations to life in a pond.

Time: 60 minutes

Next Generation Science Standards:
Performance Expectations:
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS1-1, 3-LS3-1, 3-LS3-2
Science and Engineering Practices:
Analyze and interpret data; Construct an argument from data
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems –LS4.C
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A
Crosscutting Concepts:
Scale, proportion and quantity

Materials:
- live dragonfly nymphs – one per student
- enough water to cover all animals
- containers to hold nymphs in shallow water – small deli containers work well
- hand lenses
- student observation sheet or blank paper for drawing and recording observations. See "Pond Animal Observations" sheet at the end of Lesson 6, page 44, for an example.

Observe a live "mystery animal" – dragonfly nymph (ordered from biological Supply: Connecticut Valley Biological Supply Company: www.ctvalleybio.com)

Tips for observing live aquatic animals:

- Aquatic animals must be kept in water either from a local pond, or store-bought spring water. NOTE: Most tap water has chlorine in it and this will kill the animals!
- Begin by explaining that students will be observing a live animal. It is important to emphasize that it is their responsibility to respectfully care for these animals.
- Demonstrate how to carefully and respectfully handle the animals. If you are observing them in small deli dishes, show students how to fill the dish with enough water to cover the mystery animal. Alternatively, you might have these set up for students.
- If students will be transferring the nymphs to a microscope tray, demonstrate this. Use a plastic spoon to move the animals.
- Show students how to use magnification. A hand lens is sufficient for observing these animals. NOTE: If students seem nervous once they look "up close", assure them that the animals will not jump or crawl out of the water, since they need to live there in order to survive!
- Make sure students don't touch the aquatic animals, as this may harm them.
- Have students help you return the nymphs to the class container, which gives them experience in handling the animals carefully.

Each student will observe the "mystery animal", recording through a drawing and written observations. Encourage a focus on body structures that allow this animal to live in a pond.

Students might have guesses about the identity of the mystery animal. At some point, identify it as a dragonfly nymph.

Dragonfly nymphs possess two very dramatic physical adaptations. They have a large, hinged mouth structure that can shoot out from under their head to capture unsuspecting prey. They have gills inside their abdomen through which they get oxygen. They do this by taking in water through an opening in the back of their abdomen and pumping it back out, forcing water over the gills. This action also propels them rapidly through the water, and is used to escape predators.

Formative Assessment:
As an assessment of observation through drawing, you might create one large drawing, where students come up to a large piece of chart paper at the front of the room and add parts of the nymph, building a detailed class drawing. They can then use this to add details to their individual drawings. This will prepare them for the field guide work.

Pre-assessment for pond visit (Lesson 5):
Many animals spend all or part of their lives in a pond. How many do we know? LIST on chart paper.

We will be visiting a pond and learning more about it. Do you think we'll discover more mystery animals?

Lesson 4: Dragonfly Life Cycle
(Explore)

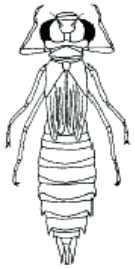
Students will listen to the first chapter of a story about a dragonfly and watch videos to reinforce learning about a dragonfly's adaptations as well as its life cycle. Students will use new vocabulary to label and improve drawings of nymphs from Lesson 2.

Time: 45-60 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS1-1
Science and Engineering Practices:
Analyze and interpret data
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS2.D, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A, LS4.B
Crosscutting Concepts:
Cause and Effect; Scale, proportion and quantity; Systems and systems models; Patterns; Consistent patterns in natural systems

Materials:
- Book: *A Dragon in the Sky: The Story of a Green Darner Dragonfly*, Laurence Pringle, illus. Bob Marstall, Orchard Books, New York, 2001 ISBN: 0-531-30315-2
- Poster of dragonfly life cycle – This requires advance preparation by the teacher. See below.
- Student worksheet to accompany reading. Attached below.

Read first chapter of *A Dragon in the Sky: The Story of a Green Darner Dragonfly*.
You may pause at intervals through the chapter so students can fill in the worksheet below as they listen to the story.



A Dragon in the Sky: The Story of a Green Darner Dragonfly

Name _____ Date _____

1. Name one frog that lives in the swamp _____

2. Where did the female dragonfly lay her eggs? _____

3. What is the scientific name for the green darner dragonfly?

_____

What does this name mean? _____

4. What is a young dragonfly called? _____

5. Name one other animal that lives in the swamp. _____

6. What is an exoskeleton? _____

7. How did Anax escape from the giant water bug? _____

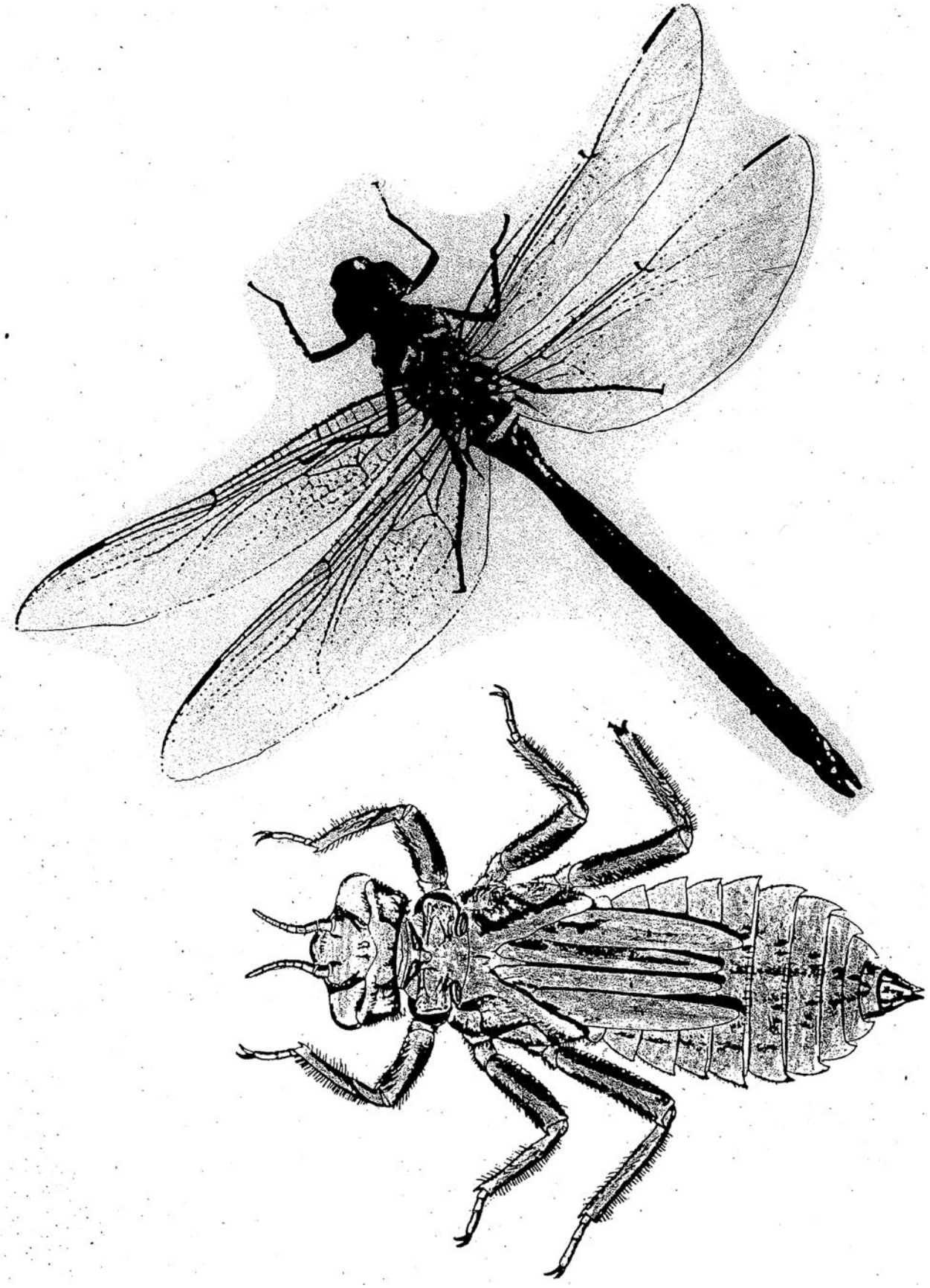
_____

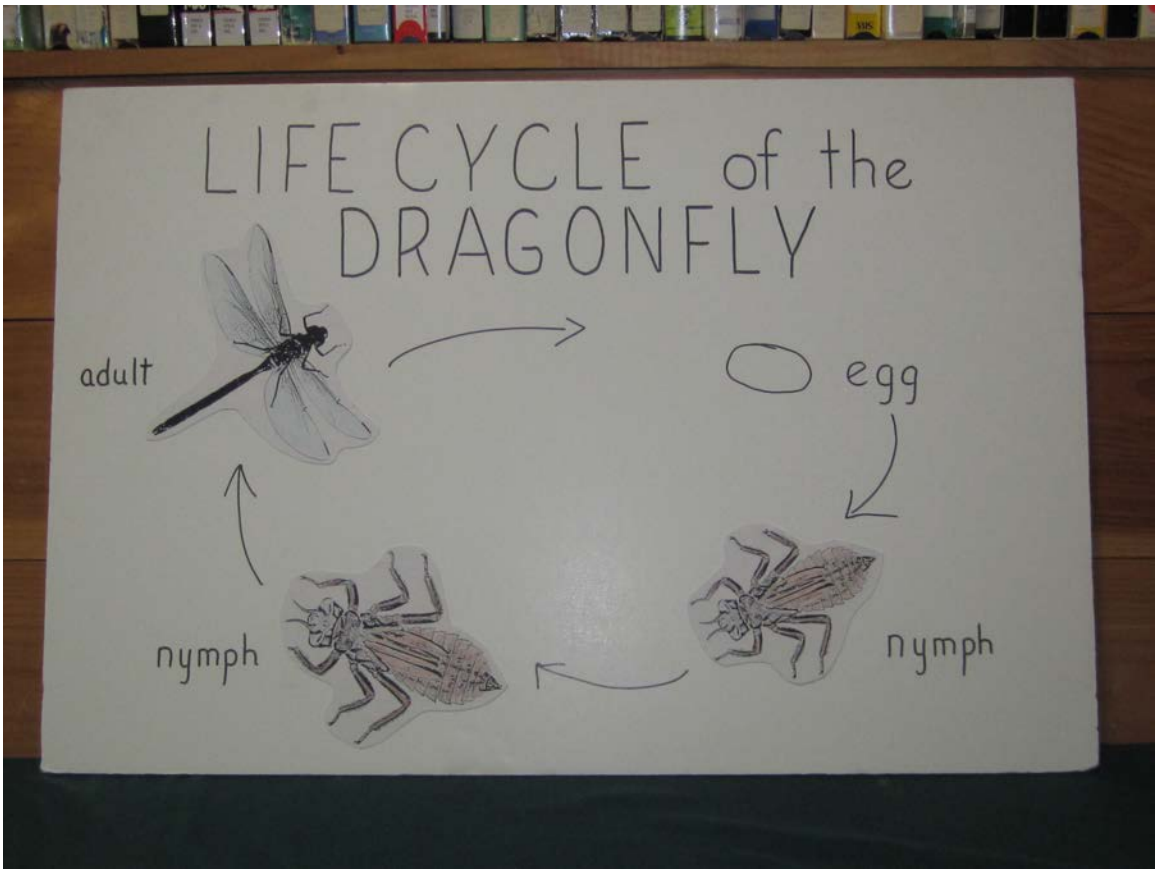
Teacher key to A Dragon in the Sky student worksheet:

1. Bullfrog, green frog.
2. In the leaf of a cattail plant.
3. *Anax junius*, "Lord and Master of June"
4. A protonymph or nymph (They only last as a protonymph for less than an hour.)
5. Any of the animals listed on pages 17 – 20 in the book.
6. The outer covering of the nymph's body. All insects have an exoskeleton. "Exo" means outside. Humans, and all mammals, have an internal, or "endo" skeleton.
7. He forced water out of the back of his abdomen, causing his body to move quickly through the water – jet propulsion! When the nymph relaxes its abdomen, water enters the back of the abdomen. As it is pushed out, water moves over the internal gills, which is how the nymph "breathes", or gets oxygen from the water.

Introduce the dragonfly life cycle and vocabulary:

- Show poster depicting life cycle of the dragonfly from egg – nymph – larger nymph – adult. See below for illustrations to use for making the poster, as well as a photo of a poster.
- Vocabulary - nymph, thorax, abdomen, molt, *Anax junius* - "lord and master of June", metamorphosis
- Discuss Latin names and classification. Scientists throughout the world use these names so that they can communicate with each other, even when they speak in different languages.





Show You-tube videos of dragonflies:
You-tube video of dragonfly life cycle: Time - 3:31 minutes
http://www.youtube.com/watch?v=Ezq_JWd1Sd8

You-tube video of nymph catching food: Time – 0:28 minutes
http://www.youtube.com/watch?v=SJiwcRt-gQw

Revising drawings:
At this point, students may re-visit Lesson 3 drawings and label parts of the dragonfly nymph (thorax, abdomen)

Additional videos of Dragonfly nymphs emerging as adults:
Southern Hawker Dragonfly Emerging: Time – 1:51 minutes
http://www.youtube.com/watch?v=BlwXdRzvPtg

Emperor Dragonfly emerging: Time – 1:23 minutes
http://www.arkive.org/emperor-dragonfly/anax-imperator/video-09b.html

Prepare for first pond visit:
- Make sure students will wear clothing to be out in the weather and sturdy shoes that can get wet, or boots.

- A change of shoes and socks is advisable.
- Depending on the time of day you'll be going, you may also want to have students bring water and a snack with them.
- You may need to send a note home as well as permission slips.

Teacher background information:
Dragonflies are insects, and like all insects they have:

- Three body parts – head, thorax, and abdomen. An insect's legs are attached to the thorax. Insects take in oxygen (or breathe) through their abdomens and/or thorax, though the structures they have may vary.
- Six legs, that are jointed (they bend)
- An exoskeleton, or external skeleton
- Antennae

Dragonfly nymphs have internal gills in their abdomens. They take in water through the back of the abdomen and then force the water back out. Water moves over the gills and oxygen is taken up. An adult dragonfly takes in air through spiracles, or small holes, in its thorax and abdomen.

Additional activity: This song is a good, and active, way to reinforce insect body parts:

Insect Body Parts Song
Sing to the tune of "Head and Shoulders"

Stand in a circle so students can see each other. Demonstrate the body movements for this song.

Head, and Thorax, Abdomen (Touch head, chest and stomach)
Jointed legs (Hold out arms and/or leg and bend at the elbow and knee to show joints)

Head and Thorax, Abdomen (repeat)
Jointed legs and…

Eyes (Touch eyes)
Antennae (Make antennae on top of head with your fingers)
Exoskeleton (Run hands down your sides until you touch your toes)

Head and Thorax, Abdomen (repeat)
Jointed legs!

Lesson 5: Pond Visit:
(Explore)

The class will visit a local pond, make observations, collect pond animals and bring some back to the classroom.

Time: 60 – 90 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS1-1, 3-LS3-1, 3-LS3-2, 3-LS4-2
Science and Engineering Practices:
Analyze and interpret data; Construct an argument from data; Use evidence to support an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS2.D, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS4.B
Crosscutting Concepts:
Cause and effect; Scale, proportion and quantity; Systems and systems models; Patterns; Consistency in natural systems

Materials:

- A whistle or other loud device for getting student's attention outdoors. Crow calls can be purchased at sporting goods/hunting stores, and work well.
- Common Aquatic Animals sheet (page 28), laminated if possible.
- A clipboard or student notebook if students will be writing.
- Pencils
- Snacks and/or water, if desired

- Pond collecting tools:
  - Nets – one per student
  - Basins – 5 total
  - Small deli containers – one per student
  - Plastic spoons – one per student
  - If possible, 2 or 3 large nets
  - Pond field guides – 5 total (See bibliography)
  - Macroinvertebrate Identification Key (See online key: http://s3.amazonaws.com/chicagoriver/rich/rich_files/rich_files/231/original/riverwatch-20macroinvertebrate-20key.pdf)
  - Two buckets with lids for carrying pond animals back to school. Sheet rock buckets work well.
  - Temporary aquarium – large plastic storage bin or fish tank. You can also keep the animals in the buckets. In either case, be sure you have plants and animals in the buckets, so animals have food and places to hide from predators.

Pre-Assessment: What will we find? Visit the list made during Lesson 3. Add any new ideas.

Show students the pond collecting tools and demonstrate how to collect pond animals. NOTE: It is a good idea to do this in the classroom prior to the trip, at a time when students will be less distracted. You might gather the students in a circle so everyone can see you. This circle can be imagined as the "pond". As you show each piece of equipment, act out the motions (e.g. Pretend to dip the basin into the "pond" to collect clear water.)

- At the pond you will put about 2 inches of clear water into each basin.
- Students will work in 5 groups, one group per basin
- Students use nets to sweep through plants at the edge of the pond. To demonstrate this, you might pretend that a couple of students are plants growing at the edge of the pond, and sweep a net around them. Many aquatic animals will be taking shelter in the plants and this is a good place to find them.

- In order to **keep the basins clear** (no mud or plants), students use spoons to carefully take animals out of the nets and place them in basins. Alternately they can "rinse" the net into a deli cup with clear water and then use a spoon to collect the animals and place them in the basin.
- Large nets are useful for reaching further into the pond and for picking up bottom debris, where some animals like dragonfly nymphs are typically found.
- Use page 28 below: "Common Aquatic Animals" and field guides to identify pond animals.

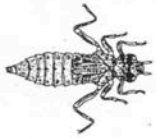
NOTE: A "no frog" rule can be very helpful at the pond! Frogs are very sensitive to being handled and can be injured by children. Frog catching also distracts from collecting other animals, such as aquatic insects.

At the pond:
1) Observe quietly and write: I hear, I see, I smell, I feel, I notice.
2) Collect animals.
3) Bring animals and some water plants back to class and place in a temporary aquarium. You will likely lose some animals to predation, so be sure to bring back a good number. You can put the obvious predators, like dragonfly nymphs, in a bucket by themselves. DO NOT bring back amphibians (tadpoles, frogs, salamanders) or fish, as they will require more oxygen than you will be providing.

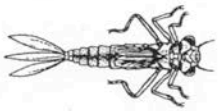
NOTE: If you want to keep the pond animals for more than 2 days, you will need an aerator. You can purchase an inexpensive one at a local pet store.

Common Aquatic Animals

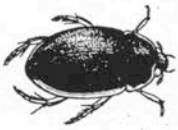
Dragonfly nymph



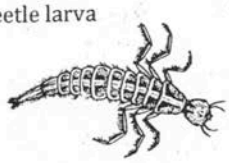
Damselfly nymph



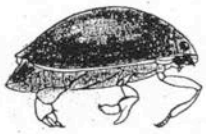
Water scavenger beetle



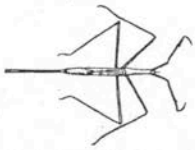
Beetle larva



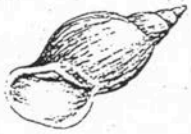
Whirligig beetle



Water scorpion



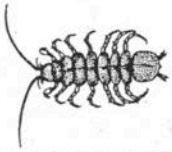
Snail



Leech

Sideswimmer/Scud

Isopod

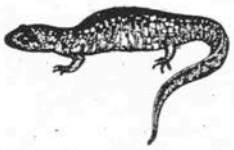


Dobsonfly larva (hellgrammite)

Water strider

Mosquito larva

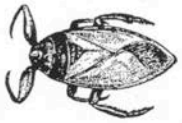
Salamander



Water boatman

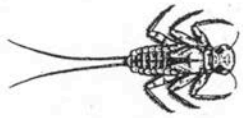
Backswimmer

Giant water bug



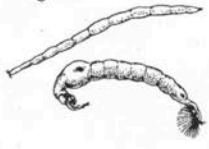
Caddisfly larva

Mayfly nymph



Crayfish

Midge larvae



Lesson 6: Limnology Lab
(Explain)

Students will learn that Limnology is the study of fresh water habitats. They will act out pond animal adaptations with props, draw and identify pond animals, and begin work on the pond field guide.

Time: 60 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS1-1, 3-LS3-2, 3-LS4-2
Science and Engineering Practices:
Interpret data; Use evidence to construct an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS4.C
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A, LS4.B
Crosscutting Concepts:
Scale, proportion and quantity; Systems and systems models; Patterns; Consistent patterns in natural systems

Materials:
- Pond animals
- Pond field guides
- For identifying pond animals, use The Pond Web of Life Cards, Appendix 1
- Microscopes, or deli containers and magnifiers
- Observation sheets for drawing
- Animal Adaptations props

Student share:
Students share their writing from yesterday.

Introduction:
What is Limnology and why is it important?
Limnology (/lɪmˈnɒlədʒi/ *lim-**nol**-ə-jee*; from Greek: Λίμνη *limnee*, "lake"; and λόγος, *logos*, "knowledge"), also called **freshwater science**, is the study of inland waters. It is often

regarded as a division of ecology or environmental science. This includes the study of lakes and ponds, rivers, springs, streams and wetlands. It is important because it informs us about these important ecosystems and the animals and plants that live there. We also get our drinking water from these sources and so it is important to keep them clean.

Tell students that today they will be observing pond animals they collected in a live Limnology Lab. Remind them that they will be using the same careful techniques in handling animals as they did with the dragonfly nymphs.

Aquatic Animal Adaptations Activity:

Teacher background and preparation:

This activity introduces students to the many adaptations of aquatic animals, particularly macro-invertebrates. Macro-invertebrates are animals without a backbone that are large enough to be seen without magnification.

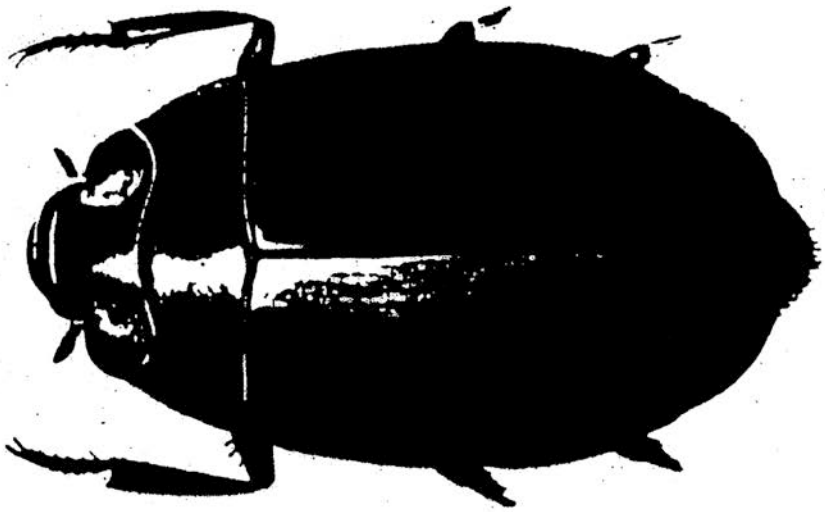
For this activity, you the teacher will have to create the props, or "body parts", for each of the animals listed below. See photos and descriptions below for ideas, or invent your own.

Signs for the activity are below. Copy, cut, and laminate the following sheets and add yarn to make a sign. These signs go with the props in the photos.

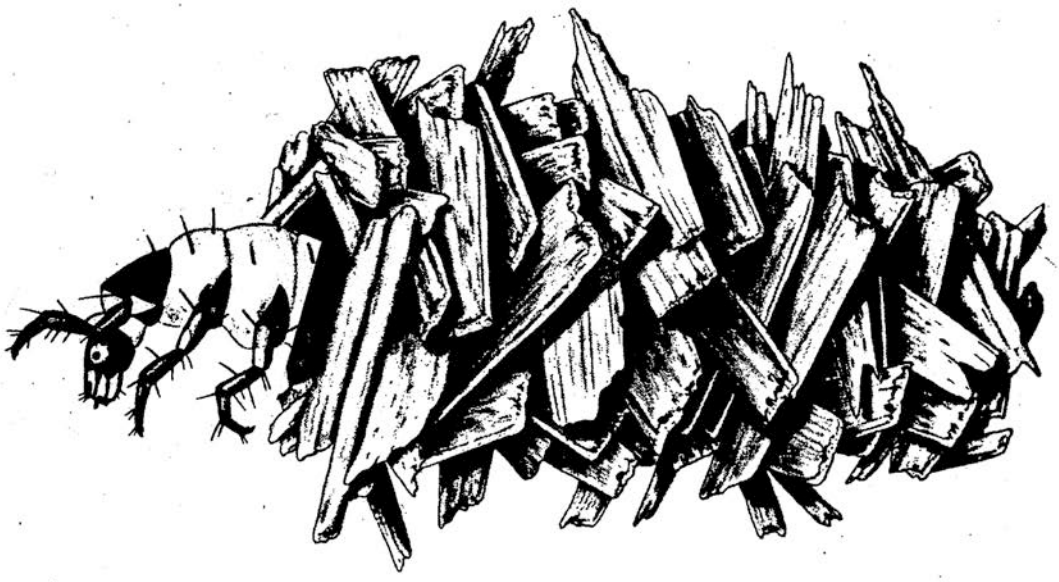
Directions:

Before beginning the Limnology Lab, we will learn about some amazing adaptations of pond (aquatic) animals.

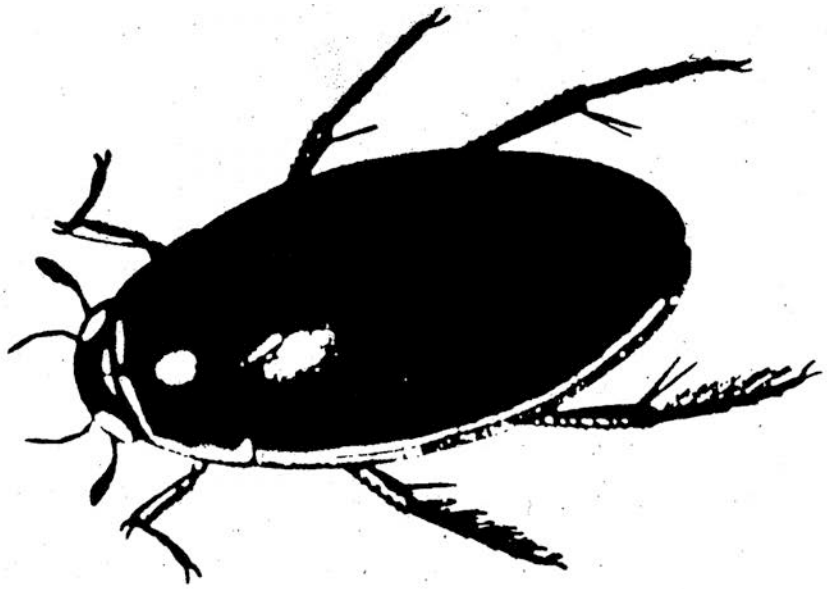
Have volunteers come to the front of the room one by one and put on a pond animal sign. Explain each adaptation and then hand the student the prop, helping them to demonstrate how it helps the animal survive (e.g. the mayfly nymph may wiggle its gills in order to get oxygen.)



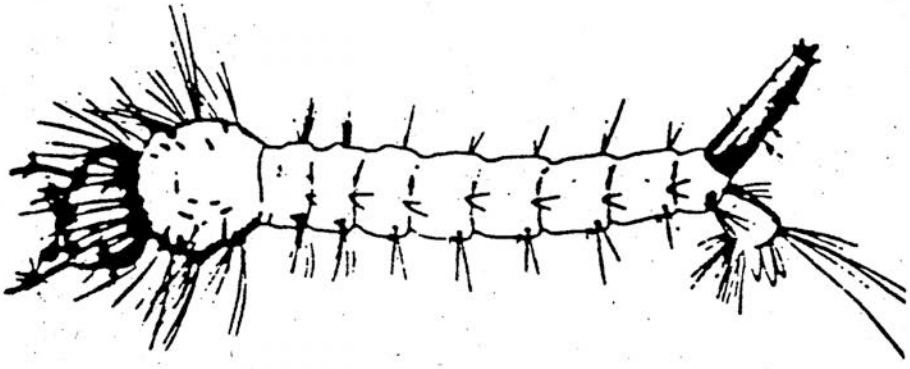
Whirligig beetle



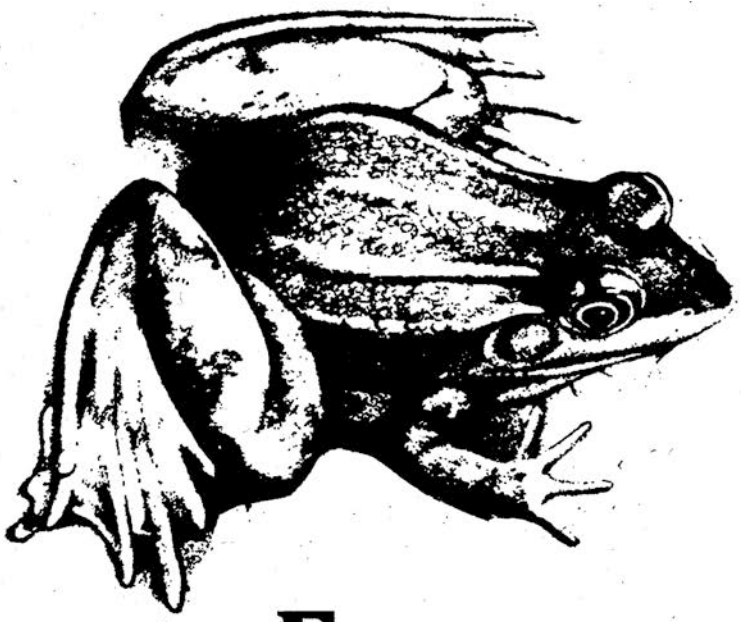
Caddisfly larva



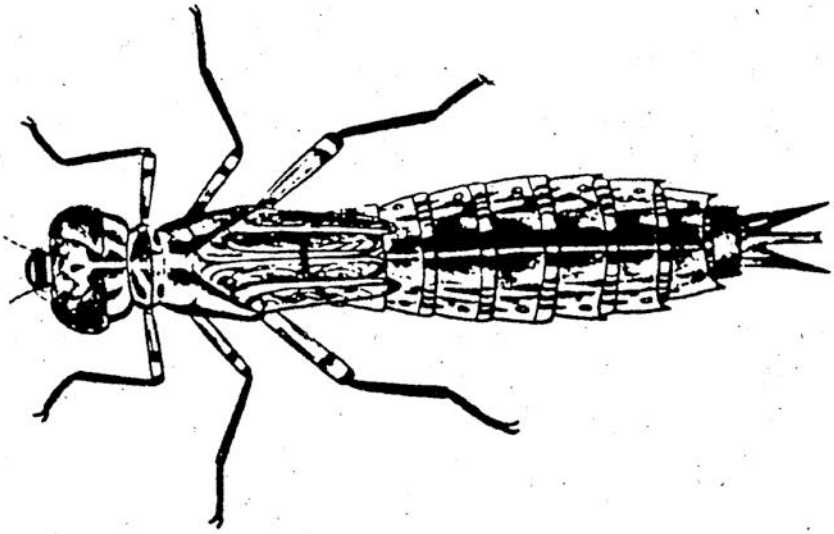
Diving beetle



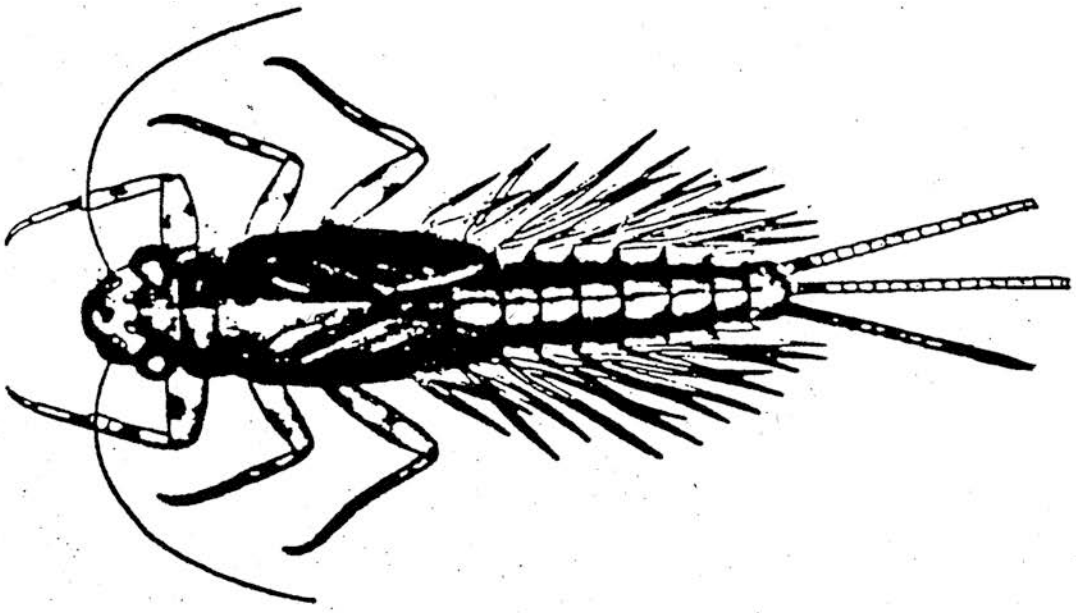
Mosquito larva



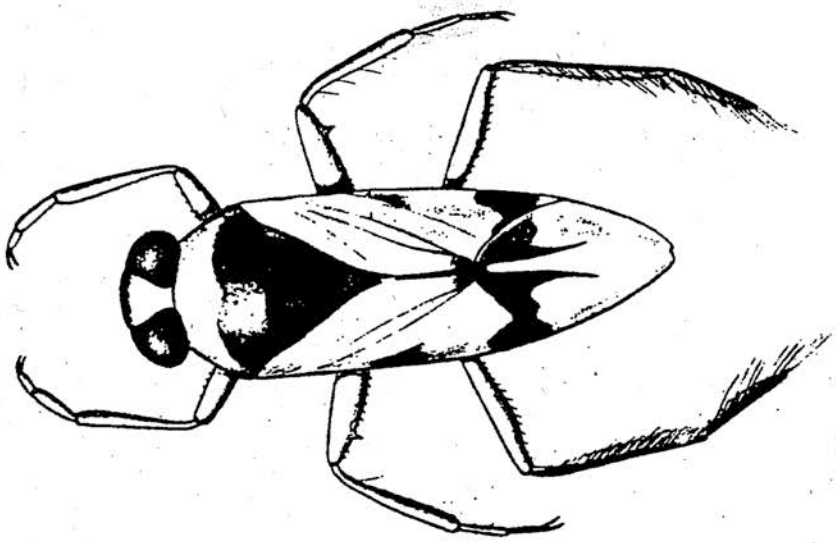
Frog



Dragonfly nymph



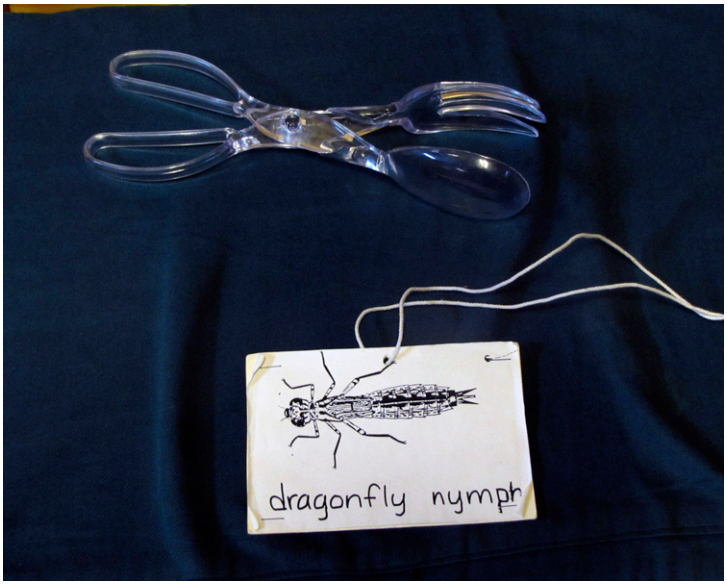
Mayfly nymph



Water boatman

Caddisfly larva – builds a camouflaged home from leaves, stones or shells, and hides inside it for protection. Students puts forearm through tube and wiggles fingers, demonstrating how the larva emerges from its home to walk around while dragging its home with it. This prop is made from a tube of oak tag with leaves glued to it. A hot glue gun works well for this.

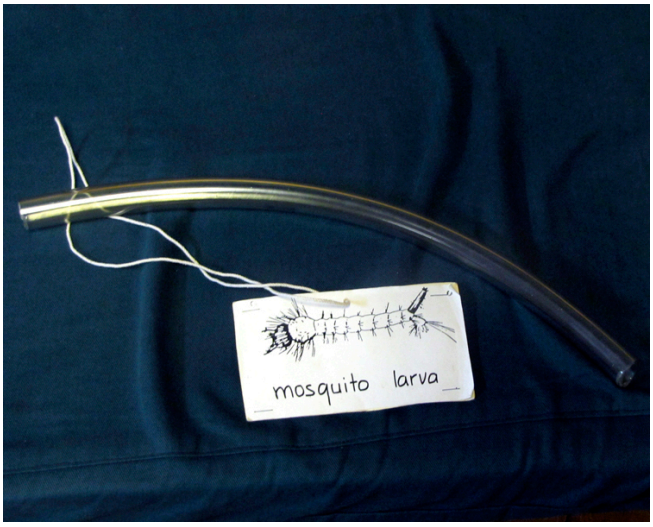
Diving beetle – comes to the water's surface to get air by tipping its abdomen up and trapping air with the many hairs on its lower abdomen (It has a very hairy abdomen). The air can then pass through spiracles (small holes) in the abdomen. Student holds a plastic bag of air against his/her own abdomen.



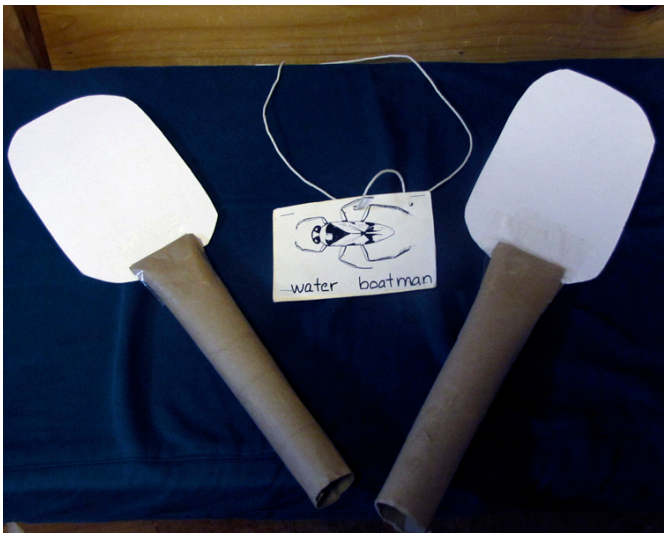
Dragonfly nymph – extends lower jaw to grab prey. Student holds salad tongs below jaw.

Frog – has webbed feet for fast swimming, which helps it escape prey. Student places webbed feet made of oak tag onto the tops of their shoes.

Mayfly nymph – breathes by wiggling gills on each side of abdomen. Student holds gills at their sides and wiggles them. Props are made of oak tag.



Mosquito larva – comes to the surface to extend a breathing tube into the air. Student holds plastic tubing.



Water boatman – has one pair of very long legs for fast swimming, using them like the oars of a boat. Student holds legs at sides. Props are paper towel tubes with cardboard "feet".

Whirligig beetle – has two sets of eyes, one below and one above the water's surface for watching for predators (e.g. birds like swallows swoop down from above, and fish prey on them from below). Student wears glasses that have an extra set of "eyes" made from oak tag.

Limnology Lab:
Draw and identify live pond animals.

- Give each student a live pond animal to observe and draw, using magnification.
- Emphasize that they will be looking for adaptations that their animal has for survival in the pond. Since **camouflage** is an adaptation that most students are able to recognize right away, it is a good example to give students.
- Have students draw the live animal they will be working on for the field guide. A worksheet to use is attached below.
- Use field guides and online resources to identify the pond animals. See resources at the end of this unit.

Note to teachers:
As students are working on their pond animal illustrations, remind them that this is the beginning of their work on the field guide to the pond. If you have examples of other student-created field guides, it is a good idea to show these to the class in order to provide inspiration.

It is important to have the student's field guide be shared with another class, presented to the school at an assembly, and/or presented to the wider community, such as the local Conservation Department. Students should view this project as relevant and important to their community, and that, therefore, their best work is essential.

The field guide will ideally include as many different species as possible, so you may assign a different species to each student, depending on the diversity of life in the pond.

One possible format for the field guide is a book where each student has a page with the drawing or painting of their animal and 5 interesting adaptations, written as bullet points.

Students will complete first detailed pencil sketch of their animal.

Pond Animal Observations

Limnologist's name _____ Date _____

Pond animal name _____

I noticed: _____

_____

Some questions for discussion:
Do any of these other pond animals look like dragonfly nymphs? What kinds of animals did we find? (insect nymphs and larvae). Like the dragonfly, many insects spend part of their life cycle in a pond.

Assessments:

- Revisit the list of pond animals you made during Lesson 1. How many more animals (and plants) did we learn about?

- Return animals to the pond after this lesson. If students make this trip, you will need to add another time block to the unit. It is important to model returning the animals so that they don't die in the classroom!

- Writing exercise at the pond: "What do I know about the pond now?" This can also be done in the classroom or as a homework assignment.

- Sharing circle: Each student completes the sentence: "I would like to be a _____ in the pond because _____."

Homework:
Ask a family member about their experiences at a pond.

Lesson 7: A Field Guide to the Pond
(Explain, Elaborate)

Students will meet to constructively critique each other's work, and continue to draw and research their pond animal for the field guide.

Time: 45 - 60 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits 3-LS1-1, 3-LS3-2, 3-LS4-2
Science and Engineering Practices:
Use evidence to construct an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS4.C
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A, LS4.B
Crosscutting Concepts:
Scale, proportion and quantity; Systems and systems models; Patterns; Consistent patterns in natural systems

Sharing Circle:
- Homework share.
- Critique each other's drawings to revise.

Some helpful guidelines for student's critiquing each other's work:
On large paper:

A good critique will help us learn and improve our work.

A critique should be:
- kind
- specific
- helpful

Our best work is something we feel proud of.

As students present their first drawings, refer to the chart and model critiquing for your students. A good starting place with students is to tell them to **first** say something positive about the drawing they are critiquing, and **then** make a suggestion if they have one.

An example of an **unhelpful** critique is: "Your drawing doesn't look like the mayfly nymph."

An example of a **helpful** critique is: "I like the way you added the gills to your drawing. (This is a positive comment). The shape of the mayfly nymph looks a little more oval than your drawing. Maybe you could make the body a little bit longer."
This is **kind**, **specific** and **helpful** – and also encouraging.

Revise drawings for field guide. These should be done in pencil.

Students may also research their pond animal using field guides to find 5 adaptations that their animal has. Use books and resources listed at the end of this unit.

If time, students present their revised drawings to the class.

Lesson 8: The Pond Web of Life
(Elaborate)

Students will observe pond micro-invertebrates and create a class Web of Life to demonstrate pond ecosystem interactions. An extension to this lesson is offered at the end of the unit: "Red Drop/Green Drop" is an investigation of the physical characteristics of water, and introduces the affect that humans can have on pond ecosystems.

Time: 45 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS1-1, 3 LS3-2
Science and Engineering Practices:
Use evidence to support an explanation; Analyze and interpret data; Use evidence to construct and support an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS4.B
Crosscutting Concepts:
Cause and Effect; Systems and systems models; Patterns

Students will observe microscopic life in pond water using 10X microscopes. This doesn't reveal the very smallest algae and plankton; it does reveal many species that nymphs and other macro-invertebrates feed on.

Materials:
- Pond water
- 10X microscopes
- Depression slides to hold pond water
- Eye droppers
- Student worksheet
- **Pond Web of Life Cards (See Appendix 1)**
- Large ball of twine, enough to connect all the students in the class

Activity: Observing microscopic life in the pond:

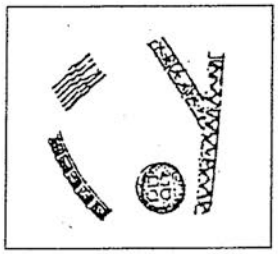
Introduce the term "food web" or "web of life". In every ecosystem, there are many interactions taking place all the time. Just as in the game "Quick Frozen Critters", there are many predators and prey in our pond. An animal can be both a predator as well as prey to another animal. We are going to look up close at some animals that are smaller than the ones we've see already. Many of these are **micro-invertebrates**, and they provide food for many of the insects we've been drawing. They may also observe plants, like algae, and other pond life.

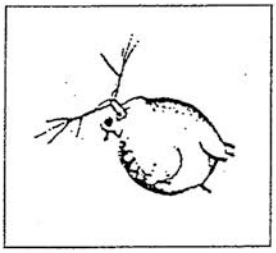
Students draw one or more of the micro-invertebrates. See Microscopic Observations of Pond Life worksheet below.

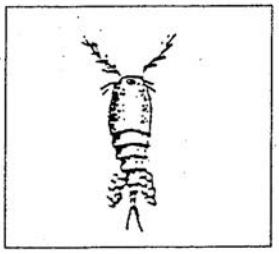
You may want to view the vimeo, Pond Life:
http://www.microworldsphotography.com/Videos
There are 2 videos at this site. The second one is "Pond Life", and shows micro-invertebrates in a pond. Time: 4:41 minutes

Microscopic Observations of Pond Life

Limnologist's name: _____ Date _____

Algae 

Daphnia 

Cyclops 

Activity: ***The Pond Web of Life:***

This activity is a simple and effective way for students to learn about some of the interconnections between animals and plants in the pond ecosystem.

- Prepare Pond Web of Life Cards (Appendix 1) by copying them back to back and then cutting them out. Each card should have a drawing of an animal on one side and the corresponding text on the other side. They will last longer if laminated.
- Give each student a card from the Pond Web of Life deck. Have them read the information on the back.
- Students sit in a circle and hold their card in front of them so everyone can see it.
- Hand the ball of twine to a student. They should tell the class who they are.
- Student will then look at the back of their card to see who their predators are and what they eat.
- Student will find a predator or "food" in the circle, and roll the ball of twine to them, saying the name of the plant or animal they are rolling it to. Make sure student holds onto his/her piece of twine when rolling!
- After everyone has part of the twine, or they run out of possible connections, introduce an event to the pond. Example: Due to a long heat wave, algae grows so much that it covers the entire pond, choking out the other Aquatic plants, which die.
- The Aquatic plant must drop his/her piece of twine.
- Anyone "connected" to the Aquatic plant must then drop his/her piece of twine. The Pond Web of Life quickly becomes undone, since they are all connected!
- Have students come up with their own scenarios.

Assessment:
Students may write a description of one interaction they in this activity. They may complete the sentence, "I learned that _____ depends on _____ in a pond by (describe the interaction)."

Lesson 9: Dragonfly Migration
(Elaborate)

Students will follow the migration of a Green Darner Dragonfly on a map while the teacher reads from the book: *A Dragon in the Sky: The Story of a Green Darner Dragonfly*. They will watch a video of dragonflies in migration and learn about Citizen Science.

Time: 45 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS2-1, 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS4-2
Science and Engineering Practices:
Use evidence to construct an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS2.C, LS2.D, LS4.C, LS4.D
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A, LS4.B
Crosscutting Concepts:
Cause and Effect; Scale, proportion and quantity; Systems and systems models; Patterns; Consistent patterns in natural systems

Materials:

- Book: *A Dragon in the Sky: The Story of a Green Darner Dragonfly*, Laurence Pringle, illus. Bob Marstall, Orchard Books, New York, 2001 ISBN: 0-531-30315-2
- For each student, make a copy of the map "Anax's Journey", from the Contents page at the front of the book
- Make copies of pages 50 – 51 from book, showing the eight species of dragonflies that migrate along the east coast of the U.S.

Read:
Using book, *Dragon in the Sky,* present map to class and read portions of pages 42 – 47, following Anax's journey south. Students will have a map to trace the journey as we read.

Show video of migrating dragonflies: Time- 0:35 minutes
http://www.youtube.com/watch?v=jjPMVuERo7Y

Citizen Science!

Citizen Science is scientific research conducted, in whole or in part, by amateur or nonprofessional scientists – citizens! Citizen science is sometimes called "public participation in scientific research." (definition taken in part from Wikipedia)
It is a way for people to participate in real science through their own observations and data collecting, much like what we did at the pond.
Introduce Migratory Dragonfly Partnerships and Dragonfly Pond Watch.
NOTE: Dragonfly Pond Watch is a Citizen Science project that students might do with their families. It is found at the Migratory Dragonfly Partnership website under "Take Action". There are beautiful photos of different dragonfly species here.
Migratory Dragonfly Partnership: http://www.xerces.org/dragonfly-migration/

Distribute pages 50 -51 from *A Dragon in the Sky*, showing dragonfly species that migrate in the eastern U.S.

Read last chapter of *Dragon in the Sky.* Follow Anax's journey with student maps.

Discussion:
Did we see any of the migrating dragonflies at our pond?
Why is it important to protect ponds in all parts of the country?
Why is it important to protect ecosystems in all parts of the country? The world?

Assessments:
- Have students write "Two things I learned from this reading."
- Draw adult dragonfly from pages in the book or online photos.

Prepare for pond visit:
- Make sure students will wear clothing to be out in the weather and sturdy shoes that can get wet, or boots.
- A change of shoes and socks is advisable.
- Depending on the time of day you'll be going, you may also want to have students bring water and a snack with them.
- You may need to send a note home as well as permission slips.

Lesson 10: Back to the Pond!
(Elaborate)

The class will visit the pond and collect pond animals. They will record data of species and numbers and create a graph of numbers of animals and numbers of each species.

Time: 60 – 90 minutes

Next Generation Science Standards:
Performance Expectations:
Interdependent Relationships in Ecosystems – 3-LS4-3
Inheritance and Variation of Traits: Life Cycles and Traits – 3-LS3-1, 3-LS3-2
Science and Engineering Practices:
Analyze and interpret data; Use evidence to construct and support an explanation
Disciplinary Core Ideas:
Interdependent Relationships in Ecosystems – LS4.C
Inheritance and Variation of Traits: Life Cycles and Traits – LS1.B, LS3.A
Crosscutting Concepts:
Cause and effect; Scale, proportion and quantity; Systems and systems models; Patterns; Consistent patterns in natural systems

Materials:

- Pages 50-51 from *Dragon in the Sky* with drawings of migratory dragonflies.
- Binoculars for viewing dragonflies (optional)
- A whistle or other loud device for getting student's attention outdoors. Crow calls can be purchased at sporting goods/hunting stores, and work well.
- A clipboard or student notebook if students will be writing.
- Pencils
- Pond Animal data sheet (see below)
- Snacks and/or water, if desired

- Pond collecting tools:
    - Nets – one per student
    - Basins – 5 total
    - Small deli containers – one per student
    - Plastic spoons – one per student
    - If possible, 2 or 3 large nets
    - Pond field guides – 5 total (See bibliography)
    - Macroinvertebrate Identification Key from Illinois River Watch: http://s3.amazonaws.com/chicagoriver/rich/rich_files/rich_files/231/original/riverwatch-20macroinvertebrate-20key.pdf)

Review:
Remind students about techniques for collecting and careful handling of animals.

At the Pond:

- Collect and count pond animals
- Record data – See data sheet below
- Look for dragonflies, and identify some, if possible.
- Release animals back to the pond.

Student writing at the pond:
How is the pond different today? Explain why it might be different (weather, temperature, animals are at a different place in their life cycles)

At school:
Make a simple graph of animal numbers and species numbers.

Pond Animal Data

Limnologist's name _____ Date _____

Pond Animal	Number
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	_____
	

Lesson 11: Pond Field Guide
(Evaluate)

Students will refine and complete drawings and writing for the class field guide.

Time: 45 minutes

Work on field guides:
Remind students that this will be presented to the community, and therefore should be our best work.

- From final pencil drawing, outline it w/permanent marker. NOTE: Be sure to **make a copy** of each child's original drawing in case mistakes are made during the painting!
- Paint. It would be ideal for students to work on this with the art teacher. Watercolors are recommended.
- Continue with research for adaptations of their pond animal. Use resources given at the end of this unit. The Golden Guide to Ponds is great!
- Type or write final text.

Lesson 12: Presenting Our Field Guide: A Pond Celebration! (Evaluate)

Students will present their work, explain how to use the class field guide to learn about the pond ecosystem, and describe the process of creating a field guide to another class, an open house, or a school assembly.

Time: 30-45 Minutes

Creating a class field guide to the pond is a concrete way of sharing student's work with the school (or broader) community. It gives an authentic purpose to this unit. In the world, scientists share their work by publishing articles, meeting with other scientists, and presenting to audiences. In this final presentation, students will be doing what scientists do. A copy of the field guide should become part of the class library and the school library, and may even be given to the local Conservation Department.

It is recommended that students practice their presentation in front of each other if possible, and give each other feedback. This builds a collaborative attitude among the class, and generates pride in all the student's work.

Extension Activity: Red Drop/Green Drop

Adapted from: *Science on a Shoestring*, Herb Strongin, Addison-Wesley Publishing Co., Menlo Park, CA, 1985, ISBN: 0-201-07329-3

This activity develops observation skills while demonstrating how pollution can affect water. Many animals depend on surface tension. For example, water striders and water spiders walk on the water's surface tension; the oil in a duck's feathers sheds water due to water's properties.

Time: 30 minutes

Next Generation Science Standards:
Performance Expectations:
Structure and Properties of Matter – 2-PS1-1
Science and Engineering Practices:
Analyze and interpret data; Use evidence to construct and support an explanation; Planning and carrying out an investigation
Disciplinary Core Ideas:
Structure and Properties of Matter – PS1.A
Crosscutting Concepts:
Patterns; Consistent patterns in natural systems

Materials:

- Wax paper, enough for each student to have 3 sheets
- 2 eyedroppers - one for red Drop and one for Green Drop
- Red Drop – see below
- Green Drop – see below

Preparation:
Prepare one bottle of Red Drop and one of Green Drop.
Red Drop is water with a few drops of red food coloring in it.
Green drop has water, green food coloring and a water softener. Clear liquid detergent works well, but make sure no bubbles are visible (allow it to settle).

Red drop should form a rounded drop on wax paper. Green drop will spread out and lie flat.

1) Each student will receive a drop of Red Drop on wax paper – about half an eyedropper full. They are to discover all they can about it and make a list of their findings. Some typical descriptions are:
    - It's round but when it moves it stretches like a teardrop.
    - Big drops swallow the little ones.
    - It follows my eraser.
    - It has no smell.

   Have students move Red Drop to the side. They will use it again later.

2) The students will receive a second sheet of wax paper with Green Drop on it. Be sure to use a clean eyedropper for this. They are to discover and record their findings for Green Drop. Some typical descriptions are:
    - It spreads out.
    - You can't pull it around.
    - It's no fun.
    - When two drops touch, they join.
    - It's like water.

3) Have students transfer a bit of Green Drop to the Red Drop. Have them list the properties of the merged drop. (The combined drop behaves like Green Drop.)

4) Tell the class you are going to give them a drop of plain water on their third sheet of wax paper. But first, have them predict which drop (Red or Green) behaves most like water.

5) Place about half a dropper of water onto the third piece of wax paper. Allow time to observe and compare. Water and Red Drop behave identically. Allow time to explore both drops on different surfaces.

6) Explain how each drop was made and discuss surface tension in the pond. Water striders and spiders have special hairs that allow them to walk on the surface tension of the water. A duck's feathers have oils that allow water to roll off them without getting them wet, behaving much like the wax paper.

7) Question: What would happen to the pond ecosystem if detergent or another water softener were spilled into the water? This may be used as a homework assignment.

Funded in part through a grant from the New England Environmental Education Alliance in cooperation with the Massachusetts Environmental Education Society. Although the information in this document has been funded in part by the U.S. Environmental Protection Agency under assistance agreement number 96157901 to the New England Environmental Education Alliance, it may not necessarily reflect the views of the Agency and no official endorsement should be inferred.

Books for Pond curriculum

A Dragon in the Sky: The Story of a Green Darner Dragonfly, Laurence Pringle, illus. Bob Marstall, Orchard Books, New York, 2001 ISBN: 0-531-30315-2

Green Darner: the Story of a Dragonfly, Robert M. McClung, illus. Carol Lerner, William Morrow and Co, New york, 1980, ISBN:0-688-22216-1

Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

Pond Life: A Golden Guide, Western Publishing Co., Inc., New York, 1987, ISBN: 0-307-24017-7

Science on a Shoestring, Herb Strongin, Addison-Wesley Publishing Co., Menlo Park, CA, 1985, ISBN: 0-201-07329-3
Red Drop/Green Drop Activity is written up here.

Secrets of the Garden: Food Chains and the Food Web in Our Backyard, Kathleen Weidner Zoehfeld, illus. Pricilla Lamont, Alfred A. Knopf, New York, 2012, ISBN: 978-0-517-70990-0

description

Who Eats What? Food Chains and Food Webs, Patricia Lauber, illus. Holly Keller, Harper Collins, New York 1995, ISBN: 0-06-022981-0
description

Yellow Eye, David Spillman and Mark Wilson, Crocodile Books, New York, 2002, ISBN: 1-56656-410-7

Online Resources:

Predator Vs. Prey games to play with kids:
http://www.ehow.com/info_8072242_predator-prey-games-play-kids.html

Guide to Aquatic Invertebrate of the Upper Midwest, University of Minnesota:
http://www.chemungriverfriends.org/pdf/Guide_to_Aquatic_Invertebrates.pdf

Illinois River Watch Macroinvertebrate Identification Key, Illinois Department of Natural Resources:
http://s3.amazonaws.com/chicagoriver/rich/rich_files/rich_files/231/original/riverwatch-20macroinvertebrate-20key.pdf

Macroinvertebrates as Bioindicators of Stream Health, Michigan's Clean Water Corps: http://wupcenter.mtu.edu/education/stream/Macroinvertebrate.pdf

Migratory Dragonfly Partnership: http://www.xerces.org/dragonfly-migration/

Online Videos:

Video of dragonfly life cycle: http://www.youtube.com/watch?v=Ezq_JWd1Sd8
Video length: 3:31 minutes.

A dragonfly eats a tadpole: http://www.youtube.com/watch?v=SJiwcRt-gQw
Video length: 0:28 Minutes

Southern Hawker Dragonfly Emerging: http://www.youtube.com/watch?v=BlwXdRzvPtg
Video length: 1:51 minutes

Emperor Dragonfly emerging: http://www.arkive.org/emperor-dragonfly/anax-imperator/video-09b.html
Video length: 1:23 minutes

Pond Life video: http://www.microworldsphotography.com/Videos
There are 2 videos at this site. The second one is Pond Life, and shows micro-invertebrates in a pond. Time: 4:41 minutes

Green Darner Dragonfly – Two videos. One shows and describes a newly emerged green darner building up her flight muscles by quivering them. The second, narrated by David Attenborough, shows a Green Darner flying in slow motion. It's an excellent way to see how their flight muscles work and how their wings can move independently of each other, something birds and airplanes cannot do!
http://www.wildernessclassroom.com/blog/component/resource/article/18-animal-of-the-day/415-green-darner-dragonfly.html
Video lengths: 0:48 and 0:38 minutes

Dragonfly Swarm Video – This is short but effective in showing how dragonflies look in migration: http://www.youtube.com/watch?v=jjPMVuERo7Y
Video length: 0:35 minutes

Charles Anderson discovers dragonflies that cross oceans - While living and working as a marine biologist in Maldives, Charles Anderson noticed sudden explosions of dragonflies at certain times of year. He explains how he carefully tracked the path of a plain, little dragonfly called the globe skimmer, only to discover that it had the longest migratory journey of any insect in the world.
http://www.youtube.com/watch?NR=1&feature=endscreen&v=WNDWYW4yWEM
Video length: 19:15 minutes

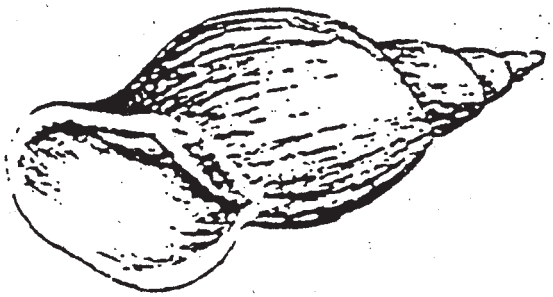
Funded in part through a grant from the New England Environmental Education Alliance in cooperation with the Massachusetts Environmental Education Society. Although the information in this document has been funded in part by the U.S. Environmental Protection Agency under assistance agreement number 96157901 to the New England Environmental Education Alliance, it may not necessarily reflect the views of the Agency and no official endorsement should be inferred.

Live Animals and other Biological Supplies

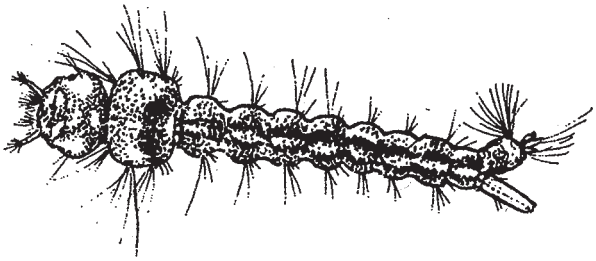
Connecticut Valley Biological Supply Company: www.ctvalleybio.com
Ideal for ordering dragonfly nymphs. This is also a good place to shop for pond collecting equipment like nets.

Note: Your local pet store may sell small nets for aquariums. These work well for pond collecting.

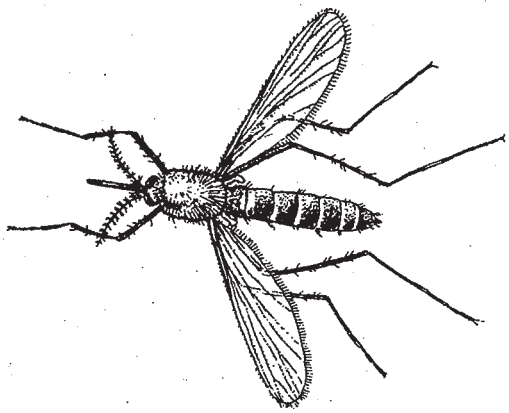
The Pond Web of Life Cards



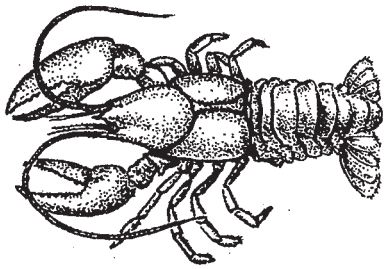
Snail



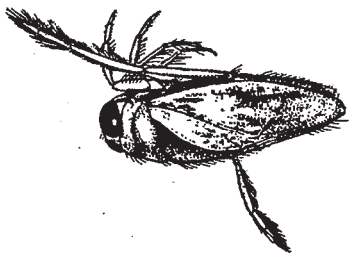
Mosquito larva



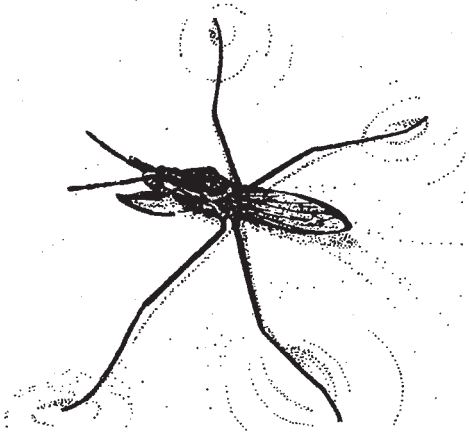
Mosquito



Crayfish



Backswimmer



Water strider

Adapted from: Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

The Pond Web of Life Cards

Mosquito larva

Food: Algae, microscopic organisms

Predators: Water beetles, insect larvae, dragonfly nymphs, fish, tadpoles

Snail

Food: Aquatic plants, dead animals

Predators: Fish, herons

Crayfish

Food: Dead plants and animals, aquatic plants

Predators: Humans, herons, painted turtles

Mosquito

Food: Humans, frogs, herons

Predators: Frogs, dragonflies, humans

Water strider

Food: Mayfly nymphs, isopods, insect larvae

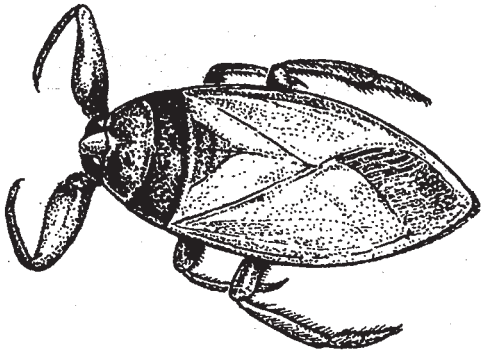
Predators: Fish, herons

Backswimmer

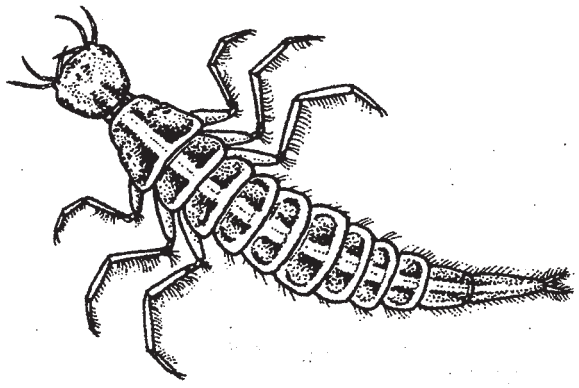
Food: Insect larvae, insect nymphs, tadpoles, fish

Predators: Fish, dragonfly nymphs, water beetles

The Pond Web of Life Cards

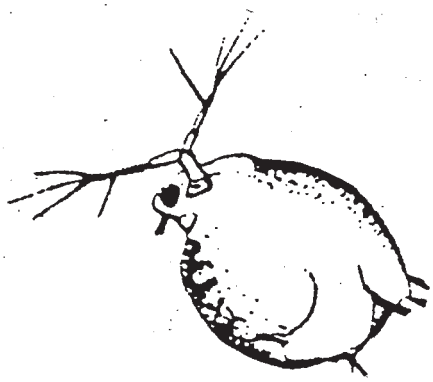


Giant water bug

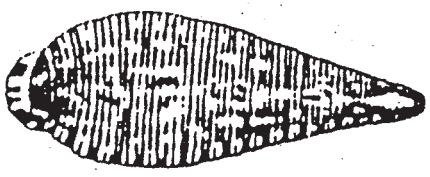


Beetle larva

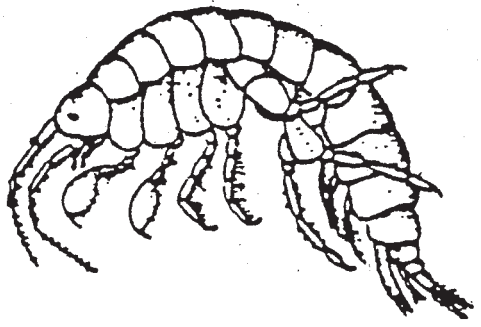
Caddisfly larva



Daphnia



Leech



Sideswimmer

Adapted from: Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

The Pond Web of Life Cards

Beetle larva

Food: Insect larvae, insect nymphs, small tadpoles

Predators: Fish, giant water bugs

Giant water bug

Food: insect larvae, insect nymphs, tadpoles, fish

Predators: Birds, fish

Daphnia

Food: Algae, microscopic organisms

Predators: Fish, tadpoles, water beetles, beetle larvae, dragonfly nymphs, caddisfly larvae

Caddisfly larva

Food: Cyclops, daphnia, algae

Predators: Water beetles

Sideswimmer

Food: Algae, aquatic plants, microscopic organisms,

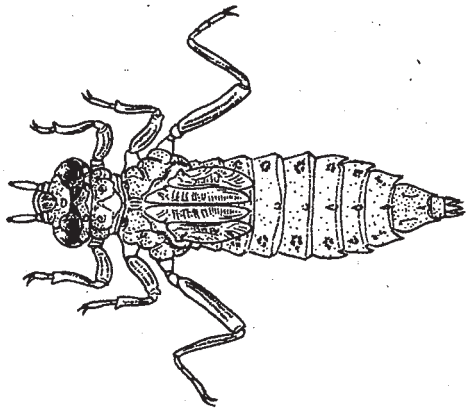
Predators: Damselfly nymphs, dragonfly nymphs, fish

Leech

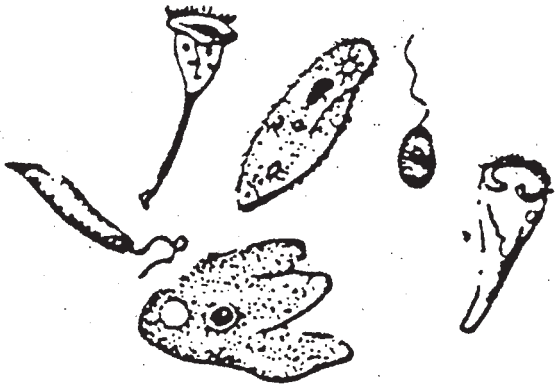
Food: Tadpoles, fish, frogs, turtles, humans

Predators: Water beetles, beetle larvae, Snakes, salamanders, fish

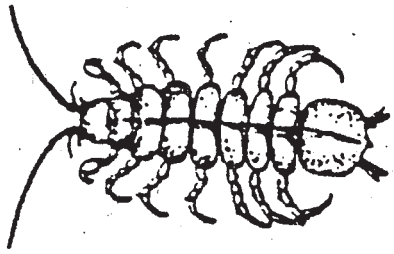
The Pond Web of Life Cards



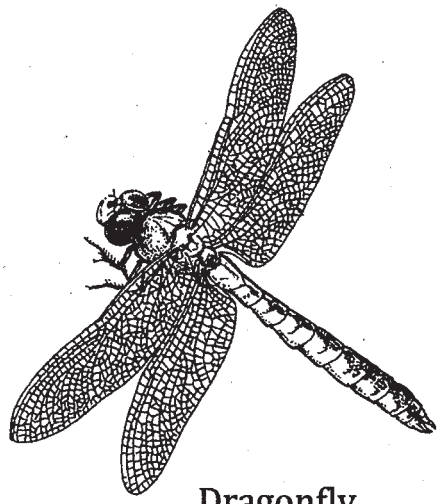
Dragonfly nymph



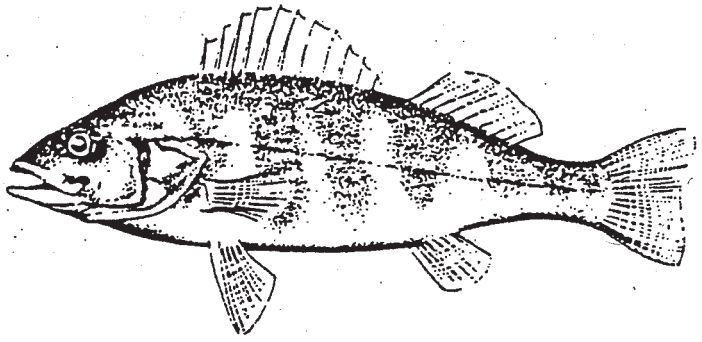
Microscopic organisms



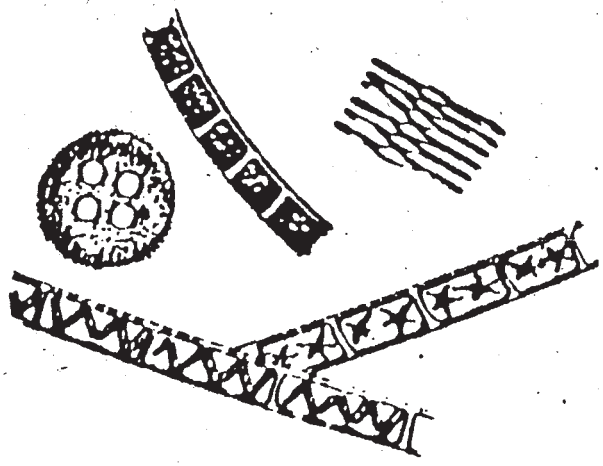
Isopod



Dragonfly



Fish



Algae

Adapted from: Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

The Pond Web of Life Cards

Microscopic organisms

Food: Algae

Predators: Cyclops, daphnia, crayfish, caddisfly larvae

Dragonfly nymph

Food: Tadpoles, salamanders, insect larvae, side swimmers

Predators: Birds, fish

Dragonfly

Food: Flying insects

Predators: Frogs, birds

Isopod

Food: Algae, aquatic plants, decaying plants and animals, microscopic organisms

Predators: Water beetles, beetle larvae

Algae

Food: Make their food from sunlight, water and carbon dioxide

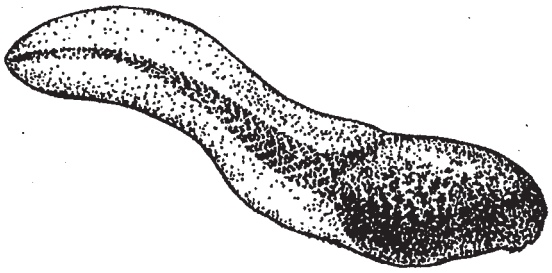
Predators: Microscopic organisms, cyclops, daphnia, snails, insect nymphs, caddisfly larvae, isopods, side swimmers, tadpoles

Fish

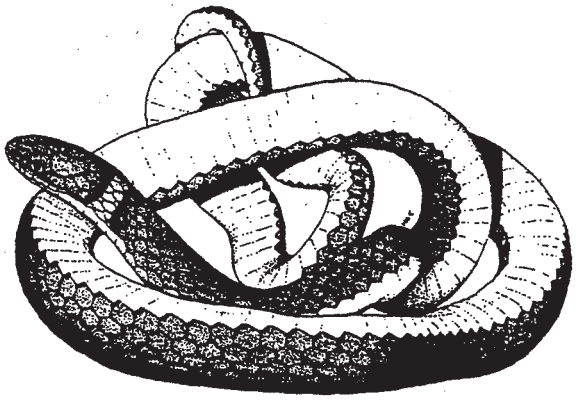
Food: Tadpoles, fish, frogs, turtles, humans

Predators: Water snakes, heron, humans

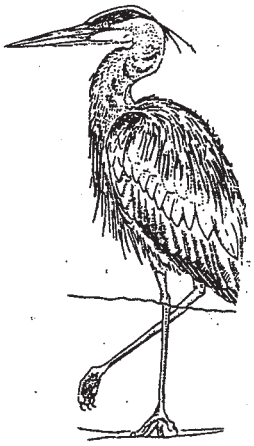
The Pond Web of Life Cards



Tadpole

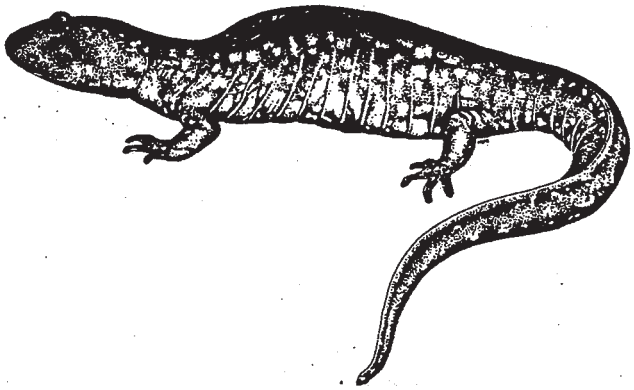


Water snake

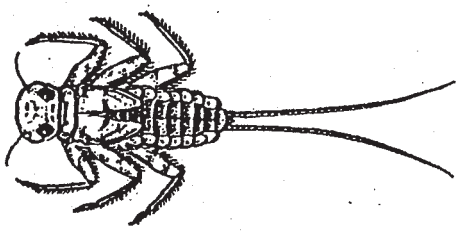


Heron

Human



Salamander



Mayfly nymph

Adapted from: Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

The Pond Web of Life Cards

Water snake

Food: Frogs, tadpoles, fish

Predators: Herons, humans

Tadpole

Food: Aquatic plants, mosquito larvae, algae, isopods

Predators: Fish, crayfish, dragonfly nymphs

Human

Food: Fish, frogs

No predators

Heron

Food: Fish, frogs, tadpoles

Predators: Humans

Mayfly nymph

Food: Aquatic plants, algae

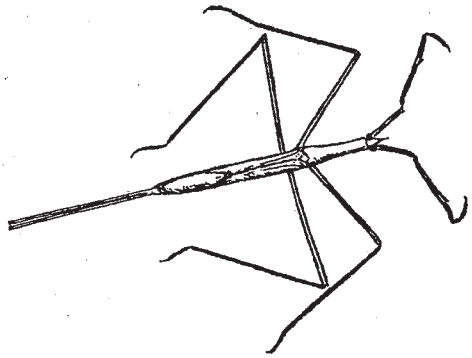
Predators: fish, dragonfly nymphs, beetle larvae

Salamander

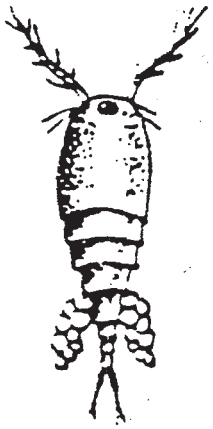
Food: Frog eggs, aquatic plants

Predators: Water snakes, fish, herons

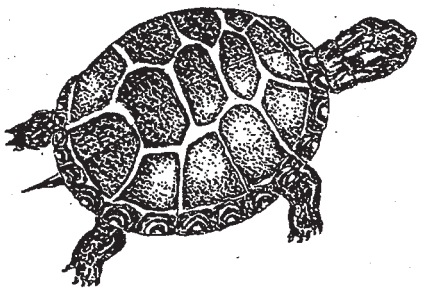
The Pond Web of Life Cards



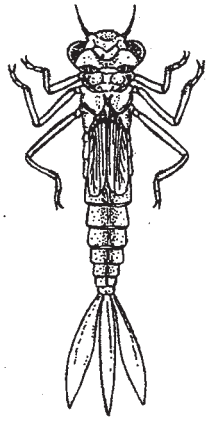
Water scorpion



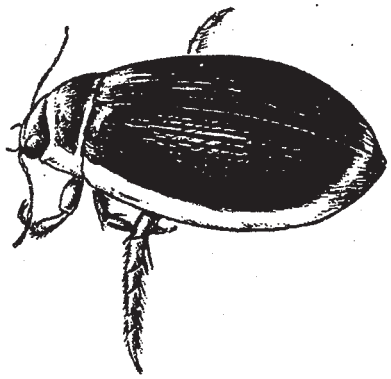
Cyclops



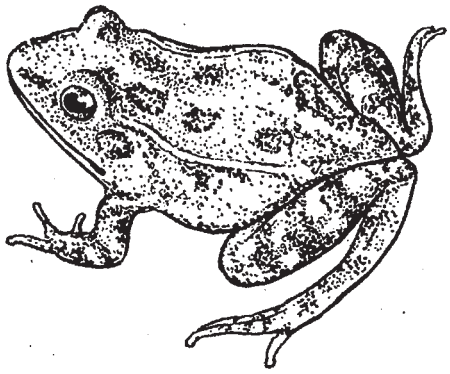
Painted turtle



Damselfly nymph



Predaceous diving beetle



Green frog

Adapted from: Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates, A Cornell Cooperative Extension Publication, Cornell University, 1993.

The Pond Web of Life Cards

Cyclops

Food: Algae

Predators: Water beetles, caddisfly larvae

Water scorpion

Food: Isopods, mayfly nymphs, water beetles

Predators: Fish, crayfish

Damselfly nymph

Food: Cyclops, insect larvae

Predators: Dragonfly nymphs, fish

Painted turtle

Food: Aquatic plants, algae, fish, crayfish, insect larvae, leeches

Predators: Humans, herons

Frog

Food: Mosquitos, dragonflies

Predators: Fish, herons, water snakes, leeches, humans

Predaceous diving beetle

Food: Insect larvae, insect nymphs, tadpoles

Predators: Fish, crayfish