Open Spaces as Learning Places
POND UNIT

THE "OPEN SPACES AS LEARNING PLACES" PROGRAM

PROGRAM STRUCTURE

The Open Spaces as Learning Places program teaches environmental science through six curriculum units focused New Haven open spaces. The program takes place over 9 weeks in both the spring and fall semesters. Each year, we teach approximately 27 hours of science education to 200 New Haven 6th grade students. In addition, through teacher training workshops and on-going support, we provide professional guidance to New Haven public school teachers.

In the **Schoolyard Unit** students learn that even the schoolyard is part of the natural world. By studying New Haven's history and creating a wildlife enhancement project in their schoolyard, students recognize the role humans and nature play in shaping the landscape.

The **Greenspace Unit** raises student awareness of open space at the neighborhood level. Children learn about local stewardship efforts of neighborhood residents to restore open space by transforming vacant lots into greenspace sites, landscaping yards, and maintaining curb strips. Students note the effects of natural change on the neighborhood environment and examine the special adaptations that allow flora and fauna to thrive in their neighborhood habitats.

The **Park Unit** takes an ecological approach to open space by focusing on a nearby city park to teach students about natural communities and ecosystems within their local park. Students begin to appreciate the ecological significance of open space. They become aware of the dynamic state of nature as they observe materials cycling through the forest environment and learn about successional change.

The **River Unit** makes regional connections, showing how watersheds join together urban communities and suburban towns to open space areas. Students study stream dynamics to see how water shapes the Earth's surface. After learning that water is a limited resource, students identify sources of pollution that threaten local rivers. After a canoe trip on a nearby river, the children explore adjacent wetland habitats rich with wildlife.

The **Pond Unit** ties together concepts from previous lessons and uses the example of a local pond for the study. The children use physical, chemical and biological measurements to analyze water quality. As they sample pond life, students observe food webs, metamorphosis and adaptations to different pond habitats. The students see successional change and learn how overlapping ecosystems provide valuable edge habitat for wildlife.

The **Cemetery Unit** provides a geological overview of landscape change. Students discover that the Earth's crust, composed of rocks and minerals, moves slightly every day. At a local historic cemetery, students look for change over time on gravestones, noting differences in resistance to weathering among rock types. They also learn that cemeteries serve as wonderful habitat for urban wildlife.

To download any of these teaching materials for free, please visit www.urbanresourcesinitiative.org.

POND UNIT:
SUMMARY

This unit ties together concepts from previous lessons in a pond ecosystem study. The children use physical, chemical and biological measurements to analyze water quality. As they sample pond life, students observe food webs, metamorphosis and adaptations to the different pond habitats. The students see successional change and learn how the overlapping ecosystems surrounding ponds provide valuable edge habitat for wildlife. The children discover that the open spaces around ponds are linked by watershed to other open space areas, creating a wildlife corridor from inland sections to the shore.

POND UNIT: OBJECTIVES

Journal

- Students apply their observations of the structures and functions of the pond ecosystem in drawings of an imaginary pond.

Worksheets/Reviews

- Students can describe the metamorphosis of insects and amphibians.
  Review Sheet 5.2: Magical Metamorphosis

- Students can describe water in the different physical states of matter: solid (ice), liquid, gas (vapor).
  Review Sheet 5.1: Pond Parts

- Students can recognize the different habitats in a pond: surface film, water's edge, pond bottom, open water.
  Review Sheet 5.1: Pond Parts

- Students can identify the equipment used to measure temperature, turbidity and depth of a pond.
  Review Sheet 5.3: Pond Measurements

- Students are able to identify similarities and differences among aquatic invertebrates.
  Review Sheet 5.4: Amazing Adaptations

- Students can describe the adaptations of various animals to different pond habitats.
  Review Sheet 5.4: Amazing Adaptations

Classroom Performance

- Students can describe the effects of surface tension in water.

- Students observe the relative densities of hot and cold water.

- Students observe ecotones and discuss their importance for wildlife diversity.

- Students are able to present water quality data orally to their classmates.

- Students are able to record their observations of organisms in the pond aquarium.

- Students can discuss the interactions and interdependence of organisms in a pond ecosystem.

- Students are able to formulate hypotheses about the health of the pond ecosystem and can use the water quality data to evaluate and modify their hypotheses.

- Students apply their observations of the structures and functions of the anatomy of pond animals to create accurate figure drawings.

POND UNIT																					
Science Standards and Curriculum Framework - Grade 6		**Classroom Activities**										**Outdor Activities**					**Focus Activities**				**Journal**
Content Standards	**Expected Performances**	Water Hazards	What is water?	(N)ice Trick	Seeds on the Move	The Disappearing Trick	Drink Some Air	Water Bookmarks	Water's Tense Skin	Erupting Colors	Water Volcano	Pond Study Introduction	Lets Get Physical	Cool Chemistry	Best biology	On Edge from Fairway to Forest	Water Quality Analysis	Creature Feature	Show Me the Light	Indoor Pond	Neighborhood pond
Scientific Inquiry, literacy, and numeracy	**C INQ. 3** Design and conduct appropriate types of scientific investigations to answer different questions			X		X	X	X	X	X	X		X	X	X				X		
	C INQ. 5 Use appropriate tools and techniques to make observations and gather data												X	X	X						
	C INQ. 8 Draw conclusions and identify sources of errors			X		X	X	X	X	X	X						X		X		
	C INQ. 9 Provide explanations to investigated problems or questions			X		X	X	X	X	X	X						X		X		
	C INQ. 10 Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic			X		X	X	X	X	X	X						X		X		
6.2 Matter and Energy in Ecosystems	**C 4.** Describe how abiotic factors, such as temperature, water and sunlight, affect the ability of plants to create their own food through photosynthesis							X													
	C 5. Explain how populations are affected by predator-prey relationships														X			X		X	
	C 6. Describe common food webs in different Connecticut ecosystems														X			X		X	
6.3 Energy in the Earth's Systems	**C 7.** Describe the effect of heating on the movement of molecules in solids liquids and gasses.		X																		
6.4 Science and Technology in Society	**C10.** Expalin the role of septic and sewage systems on the quality of surface and groundwater resources.											X			X		X				
	C 11. Explain how human activity may impact water resources in Connecticut, such as ponds, rivers and the Long Island Sound ecosystem											X	X	X	X		X				

POND UNIT																					
English Language Arts Standards and Curriculum Framework - Grade 6		Classroom Activities									Outdor Activities					Focus Activities				Journal
Content Standards	**Expected Performances**	Water Hazards	What is water?	(N)ice Trick	The Disappearing Trick	Drink Some Air	Water Bookmarks	Water's Tense Skin	Erupting Colors	Water Volcano	Pond Study Introduction	Lets Get Physical	Cool Chemistry	Best biology	On Edge from Fairway to Forest	Water Quality Analysis	Creature Feature	Show Me the Light	Indoor Pond	Neighborhood pond
1.1 Students use appropriate stategies before, during, and after reading in order to construct meaning	**a.** Activate prior knowledge, establish purposes for reading and adjust the purposes while reading.															X				
	c. Select and organize relevant information from text to summarize.															X				
	e. Draw conclusions and use evidence to substantiate them by using texts heard, read, and viewed.															X				
1.2 Students interpret, analyze, and evaluate text in order to extend understanding and appreciation	**a.** Generate and respond to questions.			X	X	X	X	X	X	X										
1.3 Students select and apply strategies to facilitate word recognition and develop vocabulary in order to comprehend text.	**a.** Use phonetic, structural, syntactical and contextual clues to read and understand words.								X											
	d. Develop vocabulary through listening, speaking, reading and writing.	X	X		X	X	X	X	X	X						X				
	e. use content vocabulary appropriately and accurately (math, music, science, social studies, etc).															X				
1.4 Students communicate with others to create interpretations of written, oral, and visual texts.	**a.** respond to the ideas of others and recognize the validity of differing views															X				
	b. Persuade listeners about judgments and opinions of works read, written and viewed.															X				
3.1 Students use descriptive, narrative, expository, persuasive, and poetic modes.	**a.** use oral language with clarity, voice and fluency to communicate a message.															X				
	c. use the appropriate features of persuasive, narrative, expository or poetic writing.																			X
	d. write to delight in the imagination.																			X
3.2 Students prepare, publish and/or present work appropriate to audience, purpose, and task.	**b.** choose from a range of strategies to generate and develop ideas for a variety of writing, speaking and visual activities.																			X
	d. research information from multiple sources for a specific purpose.															X			X	
	f. publish and/or present final products in a myriad of ways, including the use of the arts and technology.															X				X
4.2 Students seek and write using standard language structures and diction appropriate to audience and task.	**a.** use sentence patterns typical of spoken and written language to produce text.															X				X
4.3 Students use standard English for composing and revising written text	**a.** use sentence patterns typical of spoken and written language to produce text.																			X

POND UNIT																					
Math Standards and Curriculum Framework - Grade 6		Classroom Activities									Outdor Activities					Focus Activities				Journal
Content Standard	Expected Performances	Water Hazards	What is water?	(N)ice Trick	The Disappearing Trick	Drink Some Air	Water Bookmarks	Water's Tense Skin	Erupting Colors	Water Volcano	Pond Study Introduction	Lets Get Physical	Cool Chemistry	Best biology	On Edge from Fairway to Forest	Water Quality Analysis	Creature Feature	Show Me the Light	Indoor Pond	Neighborhood pond
2.1. Understand that a variety of numerical representations can be used to describe quantitative relationships.	**a. (1)** Locate, order and compare whole numbers, fractions, decimals and integers on number lines, scales and the coordinate grid.															X				
	b. (2) Compare large numbers using expanded forms and powers of 10.															X				
	d. (3) Solve problems involving ratios, proportions, and percents.															X				
2.2. Use numbers and their properties to compute flexibly and fluently, and to reasonably estimate measures and quantities.	**a. (1)** Estimate and predict reasonable answers and recognize and explain when an estimate will be more or less than an exact answer.															X				
	a. (2) Use a variety of computational strategies (mental computation, paper-and-pencil and calculator) to add, subtract, multiply, and divide multidigit numbers in the context of multistep word and practical problems.															X				
	a. (6) Create and solve a variety of provlems involving fractions, decimals, mixed numbers, money and simple percents.															X				
4.3 Understand and apply basic concepts of probability.	**a. (1)** Explore the relationship between the number of trials in an experiment and the predicted outcomes.															X				

POND UNIT:
BACKGROUND INFORMATION

In this unit, students are introduced to ponds as blue open spaces that are surrounded by a variety of habitat for many wildlife species. Where two ecosystems meet, there is an overlap of living and nonliving components from the different areas. The process and the results of this interaction are called the **edge effect**. The greatest wildlife diversity often occurs in overlapping sections, or **ecotones,** where organisms common to both ecosystems are brought together. Humans tend to create harsh boundaries between ecosystems by mowing right up to the edge of a forest or a pond. A softer edge that connects ecosystems with low-growing shrubs, tall grass and other vegetation provides important cover for wildlife near more open areas.

The pond unit focuses on the pond ecosystem in a detailed study that ties together ecological concepts from previous units. Students assess system health using physical, chemical and biological indicators. They learn about human and natural influences that affect water quality. The students look at the surrounding landscape and discover that open spaces are interconnected within watersheds, creating wildlife corridors from inland areas to the shore.

A **pond** is a shallow body of water with a muddy bottom that has rooted plants growing from shore-to-shore. Because the depth is so shallow, water temperatures are fairly uniform from top to bottom but will change as air temperature fluctuates. The pond is composed of four habitats: surface film, water's edge, bottom, and open water. Pond creatures are adapted or designed to live in specific parts of a pond.

The **surface film** is the habitat of many air-breathing creatures and floating plants and animals. Many animals that live on the surface film are able to walk on water because water molecules (H_2O) are attracted to each other and are held together by **surface tension**. Other organisms hang beneath the surface film. The **water's edge** is the richest habitat in the pond with the greatest diversity of plant and animal life. Here, organisms easily find light, cover, food and oxygen. Many emergent plants that are rooted in the bottom extend out of the water at the pond's edge. The pond's **bottom** is dark, low in oxygen and covered with organic debris from decaying plants and animals. Many animals burrow in the muddy bottom for warmth and protection. Bacteria that help recycle nutrients also live at the bottom of the pond. Large, free-swimming animals (turtles, birds and fish) and microscopic, floating plants live in the **open water**. The open water is where plants are no longer rooted in the pond's bottom. Most ponds do not have a genuine open water zone because plants extend from shore-to-shore in shallow bodies of water.

Ponds are nurseries for many insects and amphibians that hatch from eggs laid in water, and start out looking quite different from how they will appear as adults. The transformation process from egg to mature adult is called **metamorphosis**. There are two kinds of insect metamorphosis: incomplete and complete. **Incomplete metamorphosis** consists of three stages: egg; nymph; and, adult. The **nymph** looks like a wingless adult that molts as it outgrows its exterior skeleton. Some nymphs have gills to facilitate underwater breathing. The nymph stage may extend for years, lasting even longer than

the adult phase. Damselflies, dragonflies, mayflies, cicadas and grasshoppers undergo incomplete metamorphosis. **Complete metamorphosis** consists of four stages: egg, larva, pupa, and adult. Eighty-seven percent of insects undergo complete metamorphosis including moths, butterflies, bees, wasps, ants, beetles and flies. The egg hatches into a larva that does not resemble the adult. When the **larva** has finished feeding and growing, it rests in the **pupa** stage. During this time, the body is reorganized and adult organs slowly form.

Frogs, toads, salamanders and newts undergo **amphibian metamorphosis**, consisting of egg, larva (tadpole) and adult stages. For example, when a frog egg hatches, a drab colored tadpole, well-camouflaged with the bottom of a pond, emerges with a flattened tail for swimming, gills for underwater breathing and a rounded mouth for scraping algae. As the tadpole matures, it grows legs with webbed feet, lungs replace the gills and the tail is absorbed. The adult frog is gray, green or brown to blend in with vegetation, has eyes on top of its head and a wide, gaping mouth to capture live prey.

In addition to life cycle changes, the pond ecosystem experiences daily, seasonal and long-term changes. Temperature varies throughout the day, dependent on the level of the sun. Oxygen levels change as well as. Even though warm water holds less oxygen than cold water, oxygen levels tend to increase during the daytime hours when plants are releasing oxygen through photosynthesis. The changing conditions affect animals in different ways. **Cold-blooded** animals have body temperatures that vary with external temperatures. They become sluggish when it is cold and more active when it is warm. **Warm-blooded** animals maintain constant body temperatures despite external conditions.

There are many seasonal changes in a pond. Warm water is less **dense** (or lighter) than cold water. Water is most dense at 39.2 degrees Fahrenheit (4 degrees Celsius). The top layer of a pond is warmer during the summer, but as the water starts to cool in the fall, the temperature at the surface begins to match the temperatures of the lower layers. As it cools to 39.2 degrees, the dense surface water sinks to the bottom of the pond. The water continues to cool until it nears freezing. At this point, the density decreases because ice is less dense than water. Fish and aquatic invertebrates swim in the warmer waters insulated by the ice. As the spring sun melts the ice, the deep, warmer water "turns over" and circulates nutrients throughout the pond. These biannual mixings are called **overturns**.

Pond succession is an example of a natural process that creates long-term change in a pond. A pond may fill in over time and become a meadow and eventually a forest. When aquatic plants and animals die, they add to the decaying organic matter on the bottom of the pond. These materials start to fill in the pond, making it shallower. In addition, the decomposing organic material provides nutrients that facilitate increased plant growth. Over time, these plants die, thereby continuing the process. The pond gradually fills in to become a marsh, swamp or bog. The wetland eventually dries out as plants use up the water and add more matter to the area. In time, a forest replaces the former pond.

Although succession is a natural process, humans can speed it up. When fertilizer enters a body of water via run off from lawns and farms, more plants grow, eventually die and start to fill in the water area. This excessive input of nutrients is called **eutrophication**. Feeding waterfowl at a pond has the same effect. Increased food supply

leads to increased waste. The nutrient base in the water is enriched, plant growth increases and the pond fills in. Humans can also slow down succession by dredging ponds, cutting down trees and mowing grass.

Water quality can be evaluated using **physical**, **chemical** and **biological indicators**. When water is very cloudy or **turbid**, the sun cannot penetrate through the surface, thereby precluding plant growth. Water clarity is important to system health because plants produce oxygen that pond life needs for respiration. Turbid water generally has a great deal of suspended particulate matter. These materials can clog gills, which inhibits breathing in aquatic organisms. If suspended particles fall, they can cause the pond to fill in, becoming more shallow over time. With decreasing **depth**, the water **temperature** begins to more closely match the air temperature. **Dissolved oxygen** (DO) levels are temperature dependent and vary throughout the year. Cold water retains dissolved oxygen better than warm water does. Many pond organisms have stringent temperature requirements and cannot survive in warm, shallow waters with low oxygen levels. Another limiting factor is **pH**, which measures the percentage of hydrogen ions in a solution. Most pond life prefers water with a pH between 6.5 and 8.5. Acidic water has a pH below 7, a pH of 7 is neutral and alkaline water has a pH between 8 and 14. Acid rain lowers pH levels. Acid rain is produced when sulfur dioxide and nitrogen oxides from automobiles and factories mix with water in the atmosphere.

The different organisms in water are a biological indicator of water quality. The **biotic index** uses aquatic animals to determine the health of a pond. Water quality is measured by classifying organisms according to their pollution tolerance. Some species can only live in clean water. The presence of these organisms is an indicator of good water quality. **Biological diversity** is another indicator of water quality. Diverse systems have a wide range of plants and animals. Biological diversity is important because it allows for more complex food webs and ecosystem interactions.

POND UNIT:
CLASSROOM ACTIVITIES

CLASSROOM ACTIVITY ONE

Title: Water Hazards
Objectives: Students will be introduced to the focus on ponds in the pond unit and will learn about pond habitats and species composition.
Time: 15 minutes
Materials: Large pond and golf course pictures, poster board, scissors, tape, plastic dragonfly, dragonfly nymph molt, butterfly metamorphosis model and amphibian metamorphosis puppet.
Preparation: Cut out and mount pictures and photographs on poster-board.
Procedure:

- Introduce the pond unit by using the example of a golf course as a place in the city where students might find ponds. Show pictures of golf courses and other types of green, open space as you continue the discussion. Despite clearing, mowing, digging, building and the use of pesticides and fertilizers, golf courses offer valuable habitat to many wildlife species. Animals can find field, forest and water areas at a golf course. In particular, golf courses offer a great deal of edge habitat for wildlife species that seek out open areas with nearby cover for hiding from danger. Some golf courses add wildlife enhancements (nest boxes, birdfeeders etc.) and make an effort to use native plantings. One of the best spots to observe wildlife is where golfers least like to be, in the water hazards or ponds.
- Explain that the focus of this unit is to study what lives in a pond and why. Use photographs throughout the pond introduction. Ponds are shallow bodies of water with plants growing from shore to shore. Careful observation reveals that there are four different parts to a pond: the surface film, the water's edge, the bottom and the open water. These pond habitats offer food, shelter, water and space to different types of organisms. The inhabitants of the different pond zones are adapted or designed to live where they live.
  (1) The surface film at the top of a pond is the habitat of many air-breathing creatures and floating plants and animals.
  (2) The water's edge towards the side of a pond is the richest habitat with the greatest diversity of plant and animal life. Here, organisms easily find light, cover, food and oxygen. Many emergent plants that are rooted in the bottom with their leaves extending above the water's surface are found in this zone.
  (3) The pond's bottom is generally covered with organic debris from decaying plants and animals. Many animals burrow in the muddy bottom for warmth and protection.
  (4) The open water is where large, free-swimming animals (turtles, birds, fish, etc.) and microscopic, floating plants are found.
- Many animals start their life out in water even though they leave the pond as adults. Ponds are nurseries for baby animals going through a series of growth stages called

metamorphosis. Insects and amphibians undergo metamorphosis and look very different as they develop from egg to adult. There are two kinds of insect metamorphosis: incomplete and complete.

(1) Incomplete metamorphosis consists of three stages: egg, nymph and adult. The nymph looks like a wingless adult. The nymph molts as it grows, shedding its exoskeleton and growing a new one. Often, because eggs hatch in water, the nymphs have gills to facilitate underwater breathing. Show a model of an adult dragonfly and demonstrate how it bends towards the water to deposit its eggs. Display a nymph molt and explain that a dragonfly remains in a pond for years as a nymph.

(2) Complete metamorphosis consists of four stages: egg, larva, pupa and adult. The egg hatches into a larva that does not resemble the adult. The larva lives in a different habitat and when it has finished feeding and growing, it rests in the pupal stage. The body is reorganized and the adult emerges. Show a model of a butterfly going through metamorphosis. Ask the students if they can name the different developmental stages (egg, caterpillar, chrysalis and butterfly). Explain that 87% of insects undergo complete metamorphosis.

(3) Frogs, toads, newts and salamanders undergo amphibian metamorphosis. See if the children know the different growth stages. Use a puppet to show how a tadpole hatches from an egg and breathes with gills, grows back legs and then front legs, develops lungs and loses its tail. Be sure to point out how the drab colored tadpole is adapted to conditions at the bottom of the pond where it scrapes algae with its round mouth. An adult frog with its large gaping mouth and eyes on top of its head hunts for live prey at the water's edge. It can take more than five years for a bullfrog tadpole to reach maturity.

CLASSROOM ACTIVITY TWO

Title: What Is Water?
Objectives: Students will learn about the composition of water.
Time: 5 minutes
Materials: None
Preparation: None
Procedure:

- Explain that now that they have learned about the structure and function of pond habitats it is important to take a closer look at the water that pond inhabitants depend on for survival.
- Tell the students that the chemical equation for water is H_2O. Water is made up of two elements: hydrogen and oxygen. Hydrogen is symbolized with an "H", oxygen is symbolized with an "O". Water has more hydrogen than oxygen. In fact, there are twice as many hydrogen atoms as oxygen atoms in a water molecule (H "2" O). A water molecule is the unit of all three atoms. Draw a picture of the molecule to show how it looks like a teddy bear – the face is the oxygen atom and the ears are the two hydrogen atoms.

- Remind the students how temperature affects water causing it to be a liquid, solid or gas. Heat makes water molecules move about rapidly. As the molecules collide with one another, individual particles are thrust into the air as water vapor. Cool temperatures cause water molecules to move about more slowly, packing them together. Water molecules gather in clouds until they fall to the ground as precipitation. When water freezes, molecules bond together and form ice.

CLASSROOM ACTIVITY THREE

Title: (N)ice Trick
Objective: Students will examine how animals can live in a frozen pond.
Time: 5 minutes
Materials: Clear plastic cups, water and ice cubes
Preparation: Fill plastic cups with water.
Procedure:
- Students work in small groups. Give each group an ice cube and a glass of water. Ask the children what will happen when they place an ice cube in the glass of water. Have them see that the ice cube stays near the top of the water. Ice floats because it is less dense than water. The water molecules expand and lock together to form ice crystals when they freeze. The empty space between the molecules makes ice less dense (or lighter) than water.
- Ask the children if they have ever gone fishing in the winter. Explain that only the top layer of the pond/lake is frozen allowing animals to swim under the protection of the ice. If ice were denser than water it would sink and the pond/lake would freeze from the bottom up. Pond life would not be able to survive cold winter months.

Adapted from Water Science, p. 18

CLASSROOM ACTIVITY FOUR

Title: The Disappearing Trick
Objective: Children will learn that water is a solvent.
Time: 5 minutes
Materials: Clear plastic cups, water, sugar and plastic spoons
Preparation: Fill cups with water.
Procedure:
- Students work in small groups. Distribute cups, spoons and sugar to each group. Explain that a solvent helps dissolve things, and water is a useful solvent. Ask the children what they think will happen when they add a teaspoon of sugar to a glass of water and stir (the sugar will disappear). Have them check if it really disappears by tasting the water. They can tell that the sugar is hidden in the water because the water tastes sweet. Water cannot dissolve things without a limit and will get "full" when it

becomes saturated. Ask the children what will happen when they add another spoon of sugar. And another? And another? Eventually, the sugar will settle to the bottom and the water will become cloudy.

- Explain that water dissolves both helpful and harmful substances. Plants use the nutrients dissolved in water to grow but toxic chemicals can be a hidden threat when they are dissolved in water. Sometimes the poisons are only detected when the water is saturated.

Adapted from Water Science, pp. 20-21

CLASSROOM ACTIVITY FIVE

Title: Drink Some Air
Objectives: Students will understand that the solvency of water is vital to aquatic life.
Time: 5 minutes
Materials: Plastic cup and cold water
Preparation: Fill a cup with cold water
Procedure:

- Place a glass of cold water in a sunny spot. Tell the children to look at it in an hour or so. The children will see bubbles coming out of the water. This is the oxygen being released by the warm water.
- Explain that bubbling water (water in a racing river) holds more oxygen because it is constantly being mixed with air. Fish breathe underwater by inhaling dissolved oxygen. Oxygen is a gas and the water dissolves it. Cold, fast moving water holds more dissolved oxygen than warm water. That is why certain fish (salmon, trout etc.) need cold, running water to survive.

Adapted from Water Science, pp. 20-21

CLASSROOM ACTIVITY SIX

Title: Water Bookmarks
Objectives: Students will learn about capillary action.
Time: 5 minutes
Materials: Scissors, coffee filters, water soluble felt-tip markers, tape, clear plastic cups and water
Preparation: Cut coffee filters into long strips and fill plastic cups with water
Procedure:

- Ask the children what a plant needs to survive (water, air, sunlight, nutrients and space). Ask them how a tall tree takes the water to its leaves (through its roots). Explain that trees have “straws” inside of them that “suck up” the water from the tree’s roots. These “straws” are really narrow tubes in the roots and stems of plants.

Water is attracted to the cell walls of the tubes and sticks to the sides. At the same time, water molecules are attracted to each other, creating an upward movement as the molecules follow each other up the cell wall. This movement in the tubes, called capillary action, takes water and dissolved nutrients from the roots to other parts of the tree.

- Tell the students to use a felt-tip marker to put a big dot or design about one inch from the bottom of the strip. Fold the paper over the edge of a plastic cup of water so that the end of the paper just touches the water. Watch the water climb up the strips and spread the design.
- Explain that paper is made of tiny fibers with little air spaces between them. Water molecules move up these air spaces in the same way that molecules are pulled up by capillary action in the tubes of a plant.

Adapted from Water Science, pp. 28-29

CLASSROOM ACTIVITY SEVEN

Title: Water's Tense Skin
Objectives: Students will examine surface tension and understand how certain aquatic invertebrates can walk on water.
Time: 5 minutes
Materials: Plastic cups, water, pennies, eyedroppers, pie tins, pepper shakers and liquid detergent
Preparation: Fill plastic cups and pie tin half full with water.
Procedure:

- Discuss how water has a high surface tension. Water molecules are attracted to each other, cling together and are not easily broken apart. Because of this, some objects can lay on top of water without breaking through the surface.
- Demonstrate how water molecules cling to one another by giving each student a penny and some water. Ask the children how many drops of water they think can fit on a penny. Use the eyedropper to slowly add water on top of a penny. The droplets keep adding up until they bulge, in a convex shape, over the top of the penny. Eventually, the force of gravity becomes greater than the surface tension and the water spills over on the side of the penny.
- Describe water tension in a pond. Remind the students of the four pond habitats (surface film, water's edge, bottom and open water). Inhabitants of the surface film live above and below the top of the water, relying on surface tension to keep them suspended. Many invertebrates (water strider, marsh treader, fish spider etc.) can walk on the surface of a pond without breaking through the water's skin because they are very light and have long legs to help distribute their weight. Other surface inhabitants (mosquito larvae etc.) cling to the surface film, hanging from below.
- Show how liquid detergent can break the bond between water molecules. Sprinkle pepper on top of a pie tin filled with water to illustrate how surface tension keeps the pepper afloat. Pour a small amount of liquid soap down the side of the pan and watch

the pepper sink. The soap is hydrophilic (water loving) causing the water molecules to grab on to the soap instead of each other and the surface tension is broken.

Adapted from Water Science, p. 25 and Mudpies to Magnets, p. 40

CLASSROOM ACTIVITY EIGHT

Title: Erupting Colors
Objectives: Students will learn about hydrophobic and hydrophilic substances.
Time: 5 minutes
Materials: Pie tin, whole milk, food coloring and liquid detergent
Preparation: None
Procedure:

- Having students work in small groups, give each group a pie tin and a box of food coloring. Pour milk in the pie tins until the bottom is covered. Ask the students to add three to four drops of each color of the dye to the milk. Caution them not to shake the tin.
- Create an explosion of color by adding a drop of detergent to the center of the drops of food coloring. The activity is nicknamed, "The OOH AHH Experiment" because there is a wave of eruptions that goes on and on.
- Explain to the students that milk contains both water and fat. Fat is hydrophobic (water hating) and does not mix well with water. Detergent is both hydrophobic and hydrophilic. One side of detergent grabs on to water and the other side grabs on to fat. The detergent's affinity for both water and fat creates a churning motion that results in an explosion of color.

Adapted from Science Arts, p. 98

CLASSROOM ACTIVITY NINE

Title: Water Volcano
Objectives: Students will learn about density variation with temperature.
Time: 5 minutes
Materials: Plastic aquarium, food coloring, boiling hot water, thermos, cold water, ice cubes and an ink bottle with a cap
Preparation: Add boiling water to the thermos. Fill the aquarium three quarters full with cold water and add some ice cubes to make the water even colder.
Procedure:

- Show the students that hot water is less dense than cold water with an experiment. Fill the small bottle with hot water and add a few drops of food coloring. Screw on the cap and shake the bottle well. Place the bottle on the bottom of the tank. Ask the children what will happen when the hot water is released into the tank. Unscrew the

cap and watch the colored hot water rise to the surface. The hot water from the bottle is lighter, or less dense, than the cold water, so it shoots to the top of the tank.

- Relate the experiment to a pond that undergoes fall and spring overturns. Tell the children that water is the densest at 39.2 degrees Fahrenheit (4.0 degrees Celsius). Remind them that less dense things float and those that are denser sink. In winter, an ice-covered pond is coldest at the top. As spring approaches, the ice melts and the cold surface water sinks to the bottom of the pond. The spring overturn stirs up nutrients from the bottom of the pond and brings down oxygenated water from the surface. Ask the children if they have gone swimming in a pond or lake during the summer and noticed that the water is warmer at the top. As temperatures turn colder during the fall months, the surface water cools to 39.2 degrees. This temperature is when water is the densest so it sinks to the bottom of the pond. The fall overturn churns up the water, mixing nutrients and oxygen once again.
- Check the tank to see if the hot water has cooled, mixed with the cold water and sunk.

Adapted from The Science Book Of Water, pp. 14-15

At the end of this lesson the teacher may choose to assign the Pond Parts and Magical Metamorphosis Review Sheets.

CLASSROOM ACTIVITY EXTENSIONS

***Note:** There may be more activities listed as the Pond Unit's Classroom Activities than can be completed during a regular class period. Make a note of which activities your class did not get to or which activities you would like to expand upon and consider using some of these activities as extensions at a later date.

1. Hatch a Toad: Collect a string of toad eggs to bring into the classroom to hatch. You will need to place them in a large jar or aquarium along with some fresh, cold pond water that has plenty of plant materials and algae in it for the toad to eat once it has hatched. Keep the pond water fresh and cold, adding more plants as needed. Once you begin to see legs immediately take the tadpole back to the pond and release it--they don't fair well cooped up! Use the activity to continue the discussion on metamorphosis.

2. Metamorphosis Models: Assign students the task of demonstrating how one specific type of amphibian or insect undergoes metamorphosis. Ask students to create models of the different life cycles of their chosen animal. Encourage students to be creative in their use of materials, using anything from paper mache to wood to fibers. After the models have been completed, have students create a habitat for their animals to rest on. Suggest the use of shoeboxes or other cardboard surfaces that might be sturdy enough to decorate yet light enough to transport. Have a class presentation once projects are completed.

POND UNIT:
OUTDOOR ACTIVITIES

OUTDOOR ACTIVITY ONE

Title: Pond Study Introduction
Objectives: Students will be introduced to different physical, biological and chemical indicators of water quality.
Time: 10 minutes
Materials: None
Preparation: None
Procedure:

- Provide an overview of the pond study by explaining that the students will investigate the water quality of a pond. Explain that they will sample and measure the pond to gather information about the health of the ecosystem. The students will use physical, biological and chemical indicators to determine the water quality of the pond. The results will be compiled and analyzed back in the classroom.
- Explain about the methods students will use. One half of the class will gather physical information by measuring temperature, depth and turbidity, and chemical data by testing the water for dissolved oxygen, nitrates, ammonia and pH (Outdoor Activities Two and Three). The other half of the class will obtain biological information by sampling the pond with nets to determine species composition and diversity (Outdoor Activity Four). The roles will then be reversed.
- Pond study continues back in the classroom where an aquarium will be set up for long-term observation of pond life.

OUTDOOR ACTIVITY TWO

Title: Let's Get Physical
Objectives: Students will learn about the physical indicators of pond system health.
Time: 15 minutes
Materials: Thermometer, Secchi disc, hip boots, Pond Study worksheet (Worksheet 5.1), pencils, canoe, measuring tape, small weight and measuring stick
Preparation: Drop off canoe before class or perform center pond measurements ahead of time.
Procedure:

- The facilitator should take the measurements and quickly talk the students through the activity. Tell the students that together, the group will start out gathering data about the physical conditions of the pond by measuring the depth, temperature and turbidity near the shore, one quarter of the way across and in the middle of the pond. The data will be recorded and analyzed back in the classroom.

- Describe how depth influences what can live and grow in a pond. In shallow waters, temperature is higher, oxygen is lower and rooted plants take hold. In deeper conditions, floating plants replace emergent plants and there is more of a temperature gradient with colder water retaining more dissolved oxygen. Have the students guess the depth of the pond. Use the measuring stick and weighted measuring tape to determine the depth at the three locations. Ask the students to think about how depth affects the types of animals that live in the pond. Remind them of the pond habitats, explaining that larger animals live in the open water zone where the water is deepest. At the water's edge, a variety of organisms including those undergoing metamorphosis find cover in the thick vegetation. The conditions at the bottom vary according to depth with sunlight unable to penetrate deeper waters. The surface of a pond changes too as emergent plants thrive in shallow waters.
- Temperature is another physical indicator. Many organisms can only survive in a narrow range of temperatures. Ask the children to guess the temperature of the water at the three data collection locations and compare their estimates with the actual readings after measuring the water. Talk about the different factors that influence water temperature (air temperature, overhanging vegetation, depth etc.). Animals need oxygen for respiration. Cold water retains dissolved oxygen better than warm water but there is actually the greatest demand for oxygen in warm, shallow waters where activity is the highest.
- Discuss why turbid or cloudy water is harmful to pond life. When water is very cloudy the sun cannot penetrate through the surface, thereby precluding plant growth. Because plants produce oxygen that pond life needs for respiration, water clarity is important for system health. Turbid water generally has a great deal of suspended particulate matter. These materials can cover the gills of fish, amphibians and invertebrates, which inhibits breathing. As suspended particles fall, they can cause a pond to fill in. Remind the students of succession and the pattern of development that causes natural systems to change over time. Determine the turbidity of the water by lowering the Secchi disc until it can no longer be seen clearly and measure the distance. Discuss the results and ask the students what would make a pond cloudy (erosion, run off, algae, decaying materials etc.)
- Point out to the students that the pond ecosystem illustrates natural dynamics and the interrelatedness of abiotic and biotic components. Everything is connected!

Adapted from Wonders Of Wetlands, pp. 174-187

OUTDOOR ACTIVITY THREE

Title: Cool Chemistry
Objectives: Students will test chemical indicators of pond health.
Time: 15 minutes
Materials: Kitchen basters, Pond Study worksheet (Worksheet 5.1), pencils, litmus paper and Pond Water Tour test kits
Preparation: None
Procedure:

- Tell the students that together, the group will perform chemical tests on the pond water to determine dissolved oxygen, nitrate, ammonia and pH levels.
- Students test for dissolved oxygen (DO) in the water using the procedure and materials in Pond Water Tour. Explain the importance of DO in the pond. Remind them that DO is vital for respiration and that cold water retains DO better than warm water. DO levels vary throughout the year and tend to be lower in the summer because they are temperature dependent. DO also fluctuates during a 24 hour period with levels being higher during the day when plants release oxygen through photosynthesis. A high DO number is a sign of a healthier pond.
- Students test for nitrates in the water using the procedure and materials in Pond Water Tour. Describe how an influx of nutrients such as nitrates (NO_3) from fertilizer run off causes plants to grow at an enormous rate. This is called an algal bloom. The algae release a lot of oxygen at first. As the algae continue to grow, they block out sunlight, preventing photosynthesis. When algal growth exceeds nutrient availability, there is a rapid die-off. Bacteria that rely on oxygen for survival decompose the dead plants and animals. The decomposers' heavy use of oxygen creates an oxygen debt in the water. Water with no DO is anoxic. No organisms can survive in anoxic waters. This excessive input of nutrients is called eutrophication. Although excessive nutrients are detrimental, nutrients are vital for plant growth. A healthy pond will have an intermediate level of nitrates.
- Students test for ammonia in the water using the procedure and materials in Pond Water Tour. Explain the implications of high ammonia in the water. Decomposition of plant material and human and animal waste produces ammonia (NH_3) as nutrients are released. Like nitrates, moderate ammonia levels are important to fuel plant growth. Excessive levels of ammonia (raw sewage, animal waste etc.) can cause algal blooms.
- Students test for pH using litmus paper test kits. Explain that pH values are important chemical indicators of water quality. The pH measures the percentage of hydrogen ions in the solution. When water has a pH below 7, it is considered acidic. Acid rain lowers pH levels. It is caused by the mixing of sulfur dioxide and nitrogen oxides from automobiles and factories with water from the atmosphere. Alkaline water has a pH between 8 and 14. A pH of 7 is neutral. Most organisms prefer water with a pH between 6.5 and 8.5. Have students compare the pH of water to lemon juice and soapy water (or any other acidic and basic solutions).

Adapted from Pond Water Tour and Wonders of Wetlands, pp. 174-187

OUTDOOR ACTIVITY FOUR

Title: Best Biology
Objectives: Students will examine biological diversity and indicator species.
Time: 30 minutes
Materials: Pond nets, strainers, plastic buckets with lids, disposable gloves, Pond Life handouts (Handout 5.1), Pond Study worksheet (Worksheet 5.1), pond life flashcards, pencils and magnifying boxes
Preparation: None
Procedure:
The facilitator should take the samples and quickly talk the students through the activity.

- Tell the students that together, the group will use nets and strainers to determine what lives in the pond. They will sample the different pond habitats to obtain a good representation of pond inhabitants.
  (1) Explain that the different organisms in the water are a biological indicator of water quality. Water quality is measured by classifying organisms according to their pollution tolerance. Some species can live only in clean water. The presence of these organisms is an indicator of good water quality. Students will use the biotic index as they sort through their samples:
    - Class 1 (pollution intolerant) animals include stoneflies, clams, caddisflies, aquatic beetles and mayfly nymphs.
    - Class 2 (moderately tolerant) animals include black flies, crayfish, damselfly nymphs, dragonfly nymphs, fingernail clams and flatworms.
    - Class 3 (pollution tolerant) animals include leeches, midges, limpets, rat-tailed maggots and mosquito larva.
  (2) Biological diversity is another indicator of water quality. Diverse systems have a wide range of plants and animals. Biological diversity is important because it allows for more complex food webs and ecosystem interactions.
- Set limits for the activity and demonstrate the proper "sweeping and scooping" technique for sampling the different pond habitats. Show pond life flashcards to give the students an idea of what they might catch. Caution them to think small! Frogs and turtles are wonderful but aquatic invertebrates are even more exciting because they reveal valuable information about water quality. If the students still need more convincing, tell them they will be using the samples to set up an aquarium in the classroom and in order for the tank to look like the pond, it should contain a wide range of specimens.
- Fill the large buckets with clear pond water. Tell the children to bring their nets over to the bucket when they think they have caught something. The facilitator or the student will carefully remove the organism from the net and add it to the bucket.
- Distribute nets and disposable gloves to the students and let them start sampling. Float among the children, instructing them to look for the slightest movement in the net as well as actual creatures. If the sampling becomes chaotic, start looking through the buckets with the students to keep them focused.
- Using the handouts and worksheets, record the results and assess the health of the pond from the diversity and class of organisms caught. Explain that a summary of the findings will be reported to the rest of the class back at school.

Adapted from Education Goes Outdoors, pp. 173-178

OUTDOOR ACTIVITY FIVE

Title: On Edge From Fairway To Forest
Objectives: Students will study wildlife diversity in ecotones to gain a better understanding of the importance of edge in overlapping ecosystems.
Time: 10 minutes
Materials: None
Preparation: None
Procedure:

- Use the walk around the pond as an opportunity to introduce the concept of ecotone. Explain that where two ecosystems meet, there is an overlap of living and non-living components from the different areas. The process and results of this interaction is called "the edge effect". At the golf course, for example, there are several places where ecosystems come together: pond and field; pond and forest; and, field and forest. The greatest wildlife diversity often occurs in overlapping sections or ecotones where organisms common to both ecosystems are brought together.
- Point out ecotones to the students and see if the students can spot signs, living and non-living, of overlap between the two ecosystems. Explain that some open green spaces have been changed greatly by landscaping. The habitat is a uniform, grassy area with less diversity than a more natural field ecosystem. The overlap with adjacent ecosystems accounts for the wide range of wildlife observed. Ask the children what landscaped areas would look like if they were not maintained. Discuss succession and be sure the students understand that if these areas had not been built or if you stopped maintaining them, the area would look like the surrounding forest area.
- Relate the discussion to other open space field trips. Have them think about ecotones at the schoolyard, greenspace, park and river by giving examples of overlapping plants and animals from adjacent ecosystems (plants growing in cracks in the concrete school pathway, street tree seedlings sprouting in the rich greenspace soil, urban wildlife venturing out from the park to take advantage of human hand outs in the built environment, trees growing in the meandering river and then toppling over etc.). Interactions within and between ecosystems are very important.
- Explain that humans tend to create harsh boundaries between ecosystems by mowing right up to the edge of a forest or a pond. A softer edge that connects ecosystems with low-growing shrubs, tall grass and other vegetation provides important cover for wildlife near more open areas. Ask the students to find examples of hard and soft edge by the pond. Have them search for signs of wildlife in the underbrush (tracks, trails, scat, feeding signs, homes etc.).
- Explain to the children that the green open space and adjacent forest around the pond are very important to wildlife because they are connected to other open space areas. They are a part of a huge wildlife corridor covering thousands of acres of land that includes Water Company property, school campuses, public parks and preserves.

Explain that these open space areas are connected to rivers by watersheds, providing natural pathways for wildlife reaching from Long Island Sound to distant towns.

Adapted from Project Wild Aquatic, pp. 61-64

At the end of this lesson the teacher may choose to assign the Pond Measurement Review Sheets.

OUTDOOR ACTIVITY EXTENSIONS

1. Water Testing: Now that students have had practice testing the dissolved oxygen, nitrate, ammonia and pH levels of pond water, they are ready to refine their skills. Take a class period to test various types of water found in and around New Haven. Ask students the day before class for their ideas on what different types of water the class might test, then bring in containers of water from these various sources. Examples might include the school's tap water, two different types of bottled water (name brand and generic), water from a few local rivers, water from a public restroom, a pond, etc. You might consider asking students to bring in a jug of the water from their taps at home as well. After testing the various levels in an orderly fashion, lead a class discussion that explores the characteristics of the water tested and the tests' implications on human health, aquatic life's health, etc.

2. Schoolyard Ecotones: If your schoolyard permits, go outside on a hunt for places where two ecosystems meet. Give students a simple map of the schoolyard with geographic features they will recognize. Ask students to identify where the overlapping ecosystems are on their maps and to circle them. Next to the circle they have made, ask students to describe the two ecosystems that converge there and to answer the question, "Which ecosystem do you think supports more wildlife?" Discuss the importance of the edge effect in providing habitat for urban wildlife.

POND UNIT:
FOCUS ACTIVITIES

FOCUS ACTIVITY ONE

Title: Water Quality Analysis
Objectives: Students will assess the health of the pond ecosystems through a water quality analysis of physical, chemical and biological indicators.
Time: 15 minutes
Materials: Pond Study worksheets (Worksheet 5.1) and Pond Life handouts (Handout 5.1)
Preparation: None
Procedure:

- Organize the students into pond study groups and have them present their water quality data to the rest of the class. Analyze and compare the results of the physical, chemical and biological studies. Talk about human and natural influences on the two sites and relate the discussion to the pond findings. Draw conclusions from the data analysis about the health of the pond ecosystems.

FOCUS ACTIVITY TWO

Title: Creature Feature
Objectives: Students will learn about pond adaptations for survival through direct contact with and careful observation of pond inhabitants.
Time: 45 minutes
Materials: Live animals (aquatic invertebrates, snakes, turtles, toads, frogs, salamanders etc.), pond life flashcards, Pond Animals handouts (Handout 5.2), Pond Life Observation Sheets (Worksheets 5.2) nature artifacts (snake skin, turtle shell, pelts, skulls, skeletons, stuffed specimens etc.), magnifying containers, bioscope and microscope slides
Preparation: Organize animals for display using pond study samples and newly collected specimens. Sort through samples, being careful to separate predators from prey.
Procedure:

- Discuss the challenges of a pond and how pond life is adapted to the habitat in which it lives. Living creatures improve their chance of survival with special behavioral and structural features that make them better suited to their environment (variations in color, protection, movement, feeding, breathing, reproduction, etc.).
- Starting with larger animals, show students pelts, skulls and stuffed specimens. Hold live reptiles and amphibians while displaying corresponding nature artifacts (snake skins, turtle shells, skeletons, etc.) Allow students to touch specimens whenever

possible. Classify the animals, describing their special characteristics and habitat requirements.

- Use the bioscope, magnifying boxes and pond life flashcards to show off smaller specimens. Categorize the animals by pond habitat to give students a deeper understanding of their adaptations to the different pond zones. Point out specific features as larger than life creatures projected up on a wall, crawl across the classroom. Relate animal adaptations to human inventions (snorkel, oars, jet ski, scuba gear, etc.), letting the students know that nature did it first.
- Create stations by spreading the critters around the classroom. Have the students rotate through the stations and closely observe the samples. When the students are at their final station, have them select one critter that is at that station (alternatively, you can let them pick any critter but the children may all want to draw the same thing). Distribute the Pond Observation Worksheets and have the students fill them out.

FOCUS ACTIVITY THREE

Title: Show Me The Light
Objectives: Students will use an underwater viewing table to observe pond life adaptations.
Time: 10 minutes
Materials: Clear-bottomed water table, pond water, pond specimens, black poster board and a flashlight
Preparation: None
Procedure:

- Place pond life specimens in a see-through water table with legs to give students a chance to observe animals from all angles. Point out the different pond creatures, reminding students of their special adaptations.
- Tell the students they are going to play a trick on the air-breathing invertebrates (water boatmen, backswimmers, diving beetles, giant water bugs etc.) by placing black poster board on top of the container and shining a flashlight from below. They are trying to fool the aquatic invertebrates into thinking that the bottom of the viewing tank with the light shining on it is the surface of the indoor pond. Ask the students how they will know if their trick worked (the air-breathing invertebrates will follow the light and swim to the bottom).
- Set up the experiment and watch the water boatmen, diving beetles, backswimmers, giant water bugs and other air-breathing invertebrates go to the bottom in search of oxygen. Be sure not to humiliate the pond creatures for too long.

Adapted from The Nature Book, p. 64

FOCUS ACTIVITY FOUR

Title: Indoor Pond

Objectives: Students will set up an aquarium for long-term observation of a pond ecosystem.

Time: 20 minutes

Materials: Glass aquarium, pump, tube, filter, gravel, full spectrum lighting, pond life poster, pond life books, Pond Life handouts (Handout 5.1), scissors, tape, poster board, large rocks, pond plants and animals

Preparation: Fill the tank with water the day before the activity. Collect rocks, plants and animals. Create a pond life challenge poster by mounting and labeling pond life pictures of all the plants and animals in the aquarium. Set up observation schedule for the worksheet.

Procedure:

- Tell students that they are going to help set up an indoor pond for their classroom. They will be adding samples from different pond habitats. These animals have the best chance of survival if the tank closely resembles their natural environment. Ask the students what needs to be added to the water in the aquarium so it provides the animals with their habitat needs (plants, rocks, gravel, light, oxygen and food). Explain to the students that if their classroom tank functions like a real pond ecosystem, they should observe interactions among the living and non-living components. The students should expect to see predator-prey relationships, food chains and a complex food web. In other words, some of the animals will get eaten! By limiting the tank to smaller creatures, they can control the interactions to a certain extent. Adding outside food sources (crickets, tubifex worms, reptomin, fish food, etc.) would help as well.
- Set up the tank with the help of the students, describing the function of each addition to the tank. If frogs, turtles and newts are being added to the aquarium, be sure a surface resting spot is included. Add the living creatures, reminding the students of special characteristics and habitat needs as the animals are placed in the tank.
- Explain to the children that they should observe the aquarium very closely watching for interactions and change (predator-prey behavior, amphibian development, algal growth, decomposition, reproduction, etc.). Show them how to record observations on the worksheet. Tell them it is important to keep to the observation schedule for accurate data collection. Place a pond life poster next to the aquarium that challenges the students to find specific plants and animals in the tank. Lay out pond life books and handouts for children in search of additional information.
- Maintain the tank, cleaning and adding food as needed. Make sure that you release the animals before the tank deteriorates.

At the end of this lesson the teacher may choose to assign the Amazing Adaptations Review Sheets.

FOCUS ACTIVITY EXTENSIONS

1. Make a Net: Together with students make nets in the classroom that students can use for field explorations and collecting of insects or aquatic life. All of the materials necessary can be bought at a fabric store. You will need nylon netting (with holes less than 1/4 inch around), wooden dowels (4 feet long; 2" around), iron on seam tape, a hot iron, and one coat hanger per student. To make a field net you will need to:

a) Bend your coat hanger into a loop, leaving a tail on each end.
b) Cut the netting into a large rectangle and fold one short end over 1 1/2" so that the coat hanger can slip into the opening.
c) Line the inside of the overlapped section of netting with the iron on seam tape and iron until the netting seals.
d) Cut the rectangle in half so that a triangle shape remains and seal up the loose ends with the iron on seam tape.
e) Slip the coat hanger wire through the hem opening and twist the loose tails around the dowel.
f) Securely tape the ends of the wire to the handle.

2. Vernal Pools: Explain to students about another important aquatic home--the vernal pool. These seasonal basins are often found in the woods of Connecticut and are unique in that they are depressions in the ground that have no outlet for the water that collects in them during the rainy fall and spring snowmelts. Species such as Wood frogs and Mole Salamanders go to vernal pools to lay their eggs, while fairy shrimp spend their entire lives in the pools. Vernal pools are so special, in fact, that they can be certified under the Natural Heritage & Endangered Species Program which places them under the Wetlands Protection Act. Do some more reading as a class on the subject of Connecticut's vernal pools in order to learn more about these treasured habitats. Check out www.vernalpool.org, as well as field guides on vernal pools, for more information.

POND UNIT:
NATURE JOURNAL

ASSIGNMENT FIVE

Title: Neighborhood Pond
Objectives: Students will design a neighborhood pond and describe ecosystem interactions within their pond and between adjacent areas.
Time: Conducted between last day of Pond Unit and first day of Cemetery Unit.
Materials: Nature journal and a pencil
Preparation: None
Procedure:

Ask the students to pretend that there is a pond near their special tree. They can choose the plants and animals that they would like to live in their pond ecosystem. They need to be sure the pond satisfies the habitat needs (food, water, shelter and space) of the living creatures they selected for their pond. They also must think about the area around their pond and the interactions with human and natural factors from adjacent ecosystems. The students should:

- Draw a picture and write a short description of their pond.
- They should include the area surrounding their pond and note specific ways that overlapping ecosystems impact their pond.
- They should be sure to think about connections between their special tree, their imaginary creature and the pond.
- Have the children describe how they would use the pond. Ask them to think of ways they might enhance the pond for people and wildlife.

***Note:** Facilitator/Teacher should have students write assignment in notebooks on the last day of the Pond Unit. Assignments should be collected, corrected, and a classroom discussion should be held before the start of the next unit.

POND UNIT:
HANDOUTS, WORKSHEETS & REVIEW SHEETS

POND HANDOUT 5.1 Pond Life

WATER'S EDGE		
Name	**Adaptation**	**Description**
Giant Water Bug	Reproduction	Male carries eggs on his back to protect them. (Also found on the Surface Film)
Sunfish	Coloration Protection Shape	Speckled pattern serves as camouflage. Spiky lateral fin wards off predators.
Water Boatman	Movement Coloration Breathing	Oar-like legs propel the boatman through the water. Air taken at the surface makes the boatman appear silvery. Captures an air bubble which serves as an underwater oxygen tank.
Scud	Movement	Swims on its side.
Pond Snail	Protection	Hard shell protects snail from predators and fast-moving water.
Mayfly and Damslfly Nymphs	Breathing	Gills on their backs help with underwater breathing.
Frog	Breathing Movement Coloration Reproduction	Absorb oxygen through their porous skin. Tadpoles have gills for underwater breathing. Webbed feet help propel through water. Natural colors serve as camouflage. Many eggs ensure survival of some offspring. Deposits on vegetation keep eggs stable.
Water Snake	Movement Coloration	Streamlined body allows snake to slither though water. Color patter helps the snake blend in with vegetation.
Pond Lily	Breathing	Stomata (responsible for gas exchange) on the top, rather than on the bottom of the leaf allow for breathing in water. Greasy surface prevents water from entering stomata. "Straws" transfer oxygen from the leaf to the submerged parts of the plant.
Great Blue Heron	Movement Feeding	Long legs are good for wading. Dagger-like beak pierces prey.
Arrowhead	Breathing	Tubes extend through stem to transfer oxygen.

POND HANDOUT 5.1 Pond Life (cont.)

SURFACE FILM		
Name	**Adaptation**	**Description**
Water Scorpion	Feeding	A stinger is used to paralyze prey before eating.
Water Scorpion	Feeding Breathing	Strong front legs for seizing prey. Snorkle-like tube for breathing underwater.
Water Strider	Movement	Body is lighter than the water's surface, allowing the strider to "walk on water". Legs are spread out to better distribute the strider's weight.
Diving Beetle	Breathing	Beetle gathers a bubble of air to take underwater. This bubble is like a "scuba tank".
Whirligig Beetle	Vision	The eye is divided into tow parts so that the beetle can see above and below the water at the same time.
Mosquito Larva	Breathing	Larva hangs from the water's surface, extending a breathing tube above the water.
Duckweed	Movement	Duckweed are free-floating plants. They can "go with the flow" of the water.

BOTTOM		
Name	**Adaptation**	**Description**
Leech	Movement Coloration	Move by "looping" – alternately attaching the mouth sucker and the tail sucker to the surface. Dull color camouflages the leech against the bottom silt.
Dragonfly Nymph	Feeding Movement	Scoop-like mouth covers chewing mouthparts and extends to capture prey. Moves through the water via anal propulsion (sucks water through its mouth and expels it).
Bullhead Catfish	Protection Feeding	Sharp spine on the top and side fins. Barbels (chin whiskers) act as sensory organs to help fish find food.
Crayfish	Coloration Reproduction	Dull color helps camouflage the nocturnal bottom-dwellers. Female carries fertilized eggs.
Tadpole	Breathing Coloration	Tadpoles have gills for underwater breathing. These are lost during metamorphosis. Drab color and limited movement keep tadpoles well camouflaged.
Caddisfly Larva	Protection	Larvae live in tube-like encasements made from leaves, sand twigs or bark.

GOLF COURSE HANDOUT 5.1 Pond Life (cont.)

OPEN WATER		
Name	**Adaptation**	**Description**
Large Mouth Bass	Feeding	Large mouth allows fish to surround prey with its mouth.
Yellow Perch	Coloration	Two-toned coloration protects perch from predators above and below (light colored belly and dark back).
Northern Pike	Movement	Torpedo-shaped body allows the pike to move rapidly through the water.
Turtle	Protection	Hard shell protects the turtle.
Kingfisher	Feeding	Dagger-like beak helps with feeding.
Ducks	Movement	Webbed feet help with swimming in water.
	Feeding	Sieve-like beak filters out aquatic plants and animals.

POND HANDOUT 5.2 Pond Animals

Painted Turtle (Chrysemys picta)

The eastern painted turtle is a water turtle commonly found in ponds, lakes, marshes and slow flowing rivers. It is a basking turtle often seen in large groups, sunbathing on logs and rocks. The red and yellow markings on its 4-7 inch top shell or carapace give it a painted appearance and its webbed feet make it an excellent swimmer. The painted turtle is an omnivore, eating both animals (insects, snails, slugs, crayfish, leeches, mussels, tadpoles, frogs, fish and dead animals) as well as plants (duckweed, algae and lily pads). The young eat mostly meat.

During cold winter months, the painted turtle hibernates, burying itself in the mud at the bottom of bodies of water. After mating in the spring, the female travels on shore to lay 5 to 10 eggs in a shallow hole that she digs with her hind legs. The young hatch in about 10 to 11 weeks and find their way to water. Painted turtles, especially the young, are vulnerable to predation by skunks, raccoons, opossums, birds, snakes and some other large turtles.

Garter Snake (Thamnophis sirtalis)

The eastern garter snake is a harmless, very common snake in North America that is found in a wide range of habitats including woodlands, fields, marshes, pond and stream edges. It is a diurnal snake that has adapted well to humans and can be spotted during daylight hours sunning itself or hunting for earthworms in gardens, yards, vacant lots and parks. The garter snake also feeds on frogs, toads, tadpoles, fish and small mammals.

It is a medium-sized gray, black or greenish snake with three yellowish stripes down its back. It is named for its resemblance to the striped garters men used to wear to hold up their socks. When frightened, garter snakes flatten their bodies to the ground or emit a foul smelling musk from their vent glands.

The garter snake hibernates in large groups during cold winter months, finding refuge in holes, mud, rock crevices, uprooted trees, rotted wood and house foundations. It mates soon after emergence in early spring and is viviparous, giving birth typically to 14 to 40 live young from June to August. As the snake grows, it molts periodically by rubbing against rough surfaces to pull off the old skin. Since the snake has no eyelids, the skin extends over its eyes, leaving eye imprints on the shed skin.

POND HANDOUT 5.2 Pond Animals (cont.)

Red-Spotted Newt (Notophthalmus viridescens)
The red-spotted newt is a rough skinned, brownish-green, 3 to 4 inch amphibian with black and red spots. It is found in weedy areas of ponds, lakes, marshes, ditches and shallow, slow-moving streams. The flattened tail, shaped like a keel, helps it swim through the water as it hunts for eggs, larvae and adult insects and other small aquatic animals.

Breeding takes place in the water with the female laying 200 to 375 eggs attached singly to aquatic plants. A gilled larva emerges after a few weeks and remains in the water for about 3 months. Eventually, gills are absorbed and it crawls onto land to begin its terrestrial stage as a red eft. The juvenile is bright red-orange with a few black spots. It lives in the moist litter, feeding on small insects and other animals. Highly toxic skin secretions of the red eft, ten times more toxic than that of an adult, protect it from predation on land. The eft hibernates under logs and debris during the winter. After 4 to 5 years, the red eft returns to its aquatic existence as a mature adult, staying active throughout the seasons except for particularly cold times when it becomes semi-active.

Bullfrog (Rana calesbeiana)
The bullfrog is the largest frog in North America, growing up to 8 inches in length. The bullfrog is moist skinned with a nearly all green body and fully webbed back feet for swimming and jumping. The sex of a bullfrog can be determined by comparing the size of the tympanum or external ear of the frog to the size of the eye. The tympanum is a round circle located on the side of the head near the eye. In males, it is much larger than the eye but, in females, it is the same size or smaller than the eye. During breeding season, the male bullfrog's throat is yellow while the female's is white.

The bullfrog lives in or close to the water its whole life, seeking out weedy areas with emergent vegetation along the edges of ponds and lakes. It hunts aggressively for small animals, fish, other frogs, salamanders, newts, young turtles, snakes, small birds, mice, crayfish, insects, snails and spiders. During the summer breeding season, the males defend territories and call to females with a booming "jug-o-rum". The females lay large jelly-like masses of 12,000 to 20,000 eggs that hatch as tadpoles in 5 to 20 days. The gilled young are wholly aquatic with flattened tails for swimming and small scraping mouths for feeding on algae. As the tadpole matures into an adult, it grows four legs, lungs replace the gills and it develops a large gaping mouth with a long, sticky tongue for catching prey. Metamorphosis takes up to three years. Tadpoles remain semi-active during the winter while adult frogs hibernate underground or underwater during colder months.

POND HANDOUT 5.2 Pond Animals (cont.)

Green Frog (Rana clamitans)
The green frog is a common frog in freshwater ponds, lakes, creeks and streams. It is 3 inches long, green to brown in color with dark blotches. A pair of ridges, one on each side of its back, distinguishes a green frog from a bullfrog. During breeding season in late spring, its "tchung" call sounds like the twang of a loose banjo string. Eggs are deposited in floating masses of jelly attached to underwater twigs and stems. The eggs hatch in just 3 to 6 days and remain as tadpoles for 1 to 2 years.

Green frogs can be spotted in or at the edge of water, hiding in shoreline vegetation during the daytime. They are terrestrial feeders, hunting mostly at night for insects and their larvae, worms, small fish, crayfish and other crustaceans, newts, spiders, small frogs and mollusks. Green frogs hibernate underground or underwater during the winter.

Crayfish (Cambarus bartoni)
The crayfish is a freshwater crustacean common in streams, lakes and ponds that is closely related to a lobster. A hard exoskeleton covers its head, thorax and its segmented body. The head has two pairs of sensory antennae and a pair of eyes on movable stalks. The appendages of the thorax include four pairs of walking legs. The crayfish also has a pair of claw-bearing pincers that are used for cutting, capturing food, attack and defense. Under its abdomen, the crayfish has specialized food handling "legs", bailers to cycle water over its gills and five pairs of swimmerets. These "legs" can be regenerated if broken off.

A crayfish hides itself under rocks or logs during the daytime and is most active at night when it feeds on snails, algae, insect larvae, worms, tadpoles and water plants. Crayfish often create burrows with above-ground mud chimneys. Most crayfish live only 2 years so there is a high volume of reproduction. In spring, fertilization and egg laying take place. A female is said to be "in berry" when she is carrying a cluster of 10 to 800 fertilized eggs on her swimmerets until they hatch a few weeks later. The young molt as they outgrow their hard outside skeleton. For a few days following each molt, crayfish have soft exoskeletons that offer little protection from predation.

Sunfish (Lepomis)
The sunfish is a flat-sided, deep-bodied, 4 to 6 inch fish that is widely distributed in North America. It feeds on insects, crustaceans and other small animals found in weedy, freshwater ponds and lakes. It spawns in colonies during the summer with males using their fins to fan out saucer-shaped nests on the water's bottom. Bluegill and Pumpkinseed sunfish are especially common and quite similar in appearance. Pumpkinseed's red spot on each gill cover distinguishes it from the Bluegill.

POND WORKSHEET 5.1 Pond Study

Class:_____

Let's Get Physical

It is important to describe the physical conditions of the pond, such as the depth, temperature and turbidity, as these things all affect the types of plants and animals that we will observe. We are going to use a tape measure to measure the *depth* of the pond, a thermometer to measure the *temperature* of the pond, and a secchi disk to measure the *cloudiness or tubidity* of the pond. Choose someone in the group to record your measurements in the table below.

While the teacher collects the measurements, you may want to think about the following questions:

Is shallow water cooler or warmer than deeper water? Where do you think the water is deepest in the pond?

What are some things that may influence the water temperature?

Do you think cloudy water affects plant growth? Why?

Do you think the pond has changed over time? How?

	Near Shore	**One Quarter of the way across**	**Middle**
Depth of the Pond			
Temperature			
Secchi Disk Depth			

POND WORKSHEET 5.2 Pond Life

OBSERVATION SHEET

Select a pond critter and observe it closely with a magnifier. Draw a detailed picture of it with the correct number of legs, antennae, shape of the body etc.

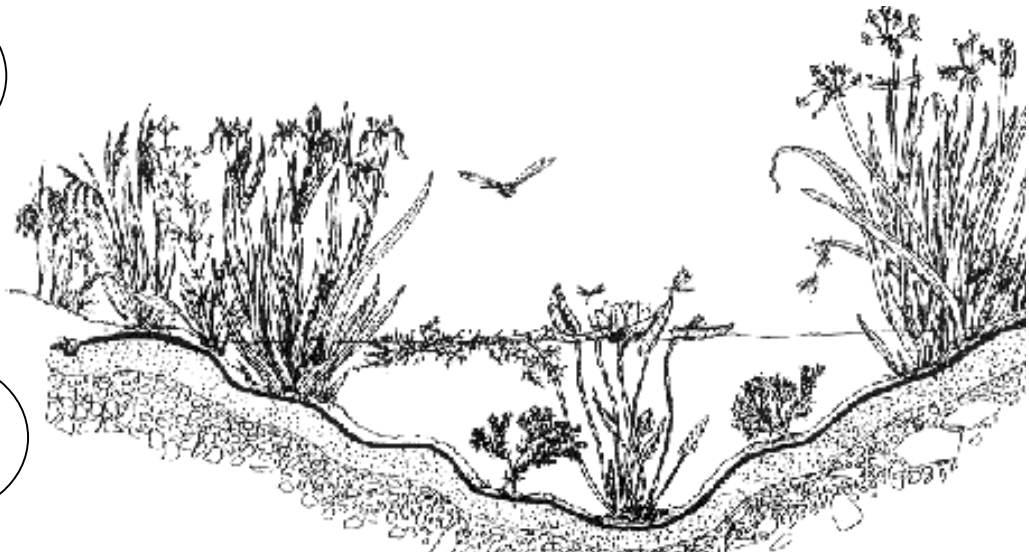
Describe any special features that make your pond creature better adapted to life in a pond. Be sure to think about how it moves, breathes, eats, stays safe etc.

POND REVIEW SHEET 5.1 Pond Parts

Draw a line from each habitat to the right part of the pond.

Surface Film

Open Water



Water's Edge

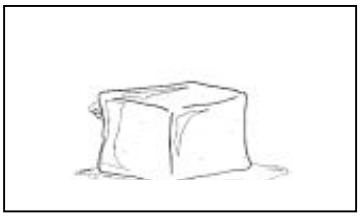
Pond Bottom

Which part of the pond do you think will have the highest temperature?

Wacky Water

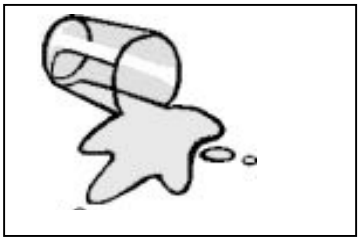
Depending on its temperature, water may be a solid, liquid or gas. Can you connect these pictures to the word that describes its state?

SOLID



LIQUID

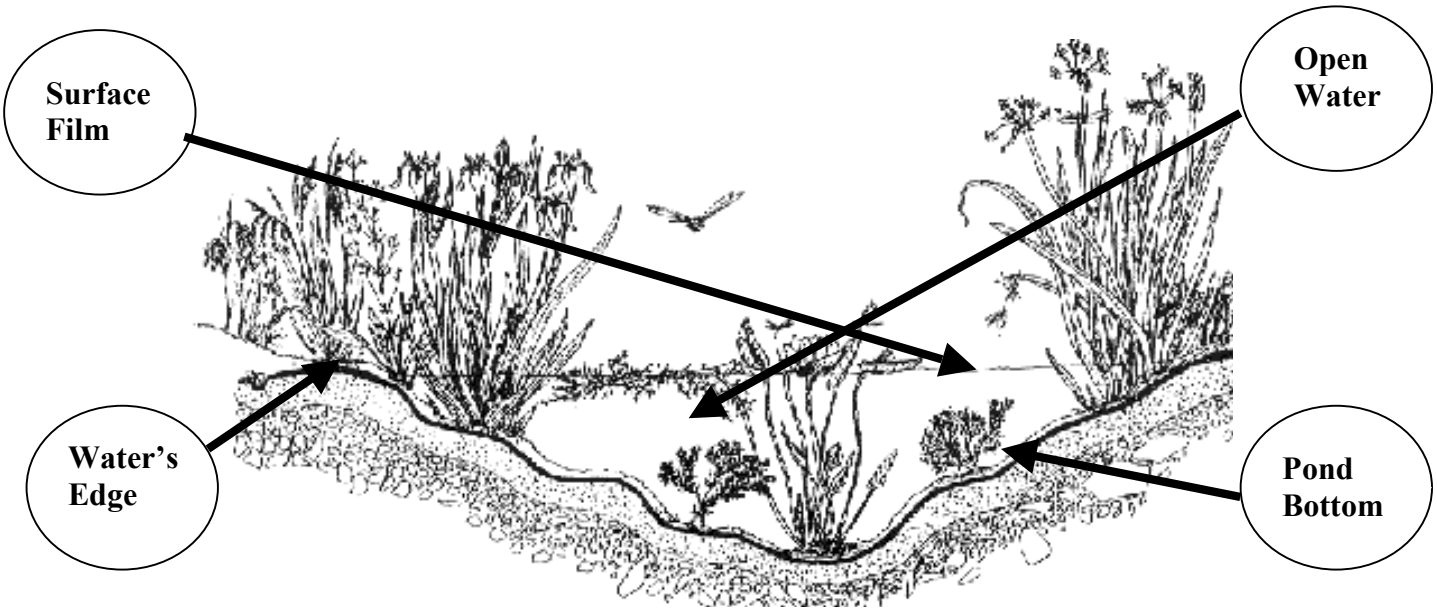
GAS



POND REVIEW SHEET 5.1 Pond Parts (cont.)

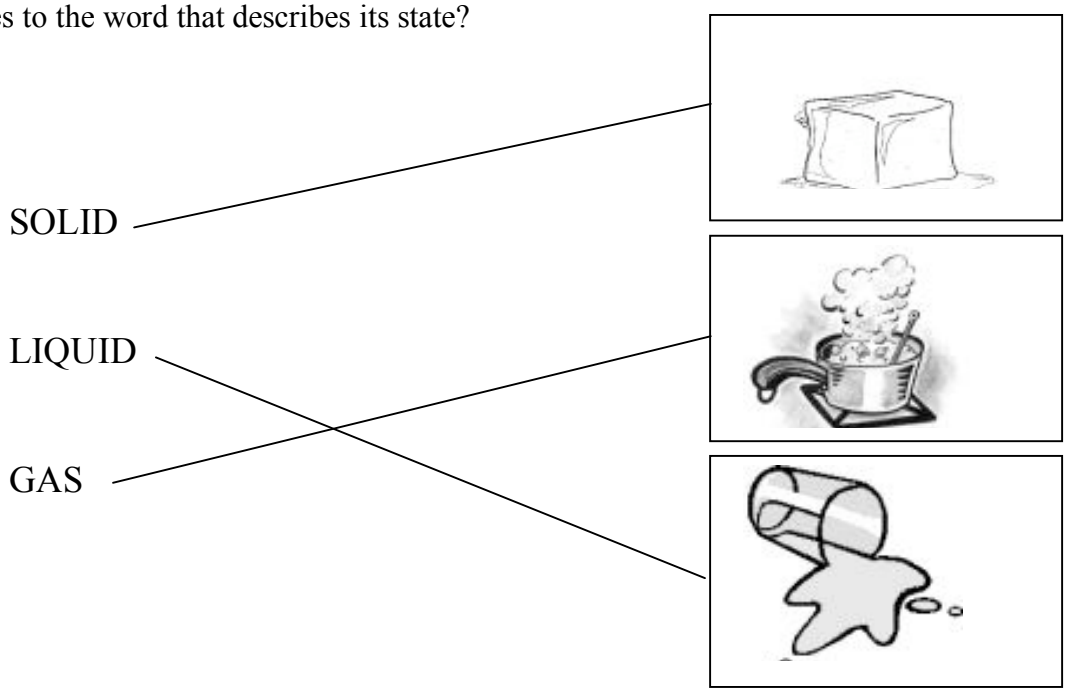
ANSWER SHEET

Draw a line from each habitat to the right part of the pond.



Which part of the pond do you think will have the highest temperature?
WATERS EDGE

Wacky Water
Depending on its temperature, water may be a solid, liquid or gas. Can you connect these pictures to the word that describes its state?



GOLF COURSE REVIEW SHEET 5.2 Magical Metamorphosis

We have talked about a number of different animals that go through metamorphosis. Some go through **complete metamorphosis** (like a butterfly) and others go through **incomplete metamorphosis** (like a dragonfly).
Below are pictures of the different stages of dragonfly metamorphosis and butterfly metamorphosis. You have two challenges:

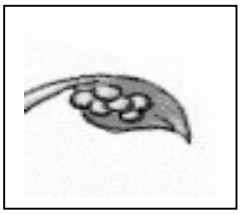
(1) Try to number the pictures so that they are in the correct order.
(2) Try to label each picture using the words in the box below.

Hint: The first stage of butterfly metamorphosis is done for you.

adult butterfly	**larva**	**pupa**
egg	**nymph**	**adult dragonfly**

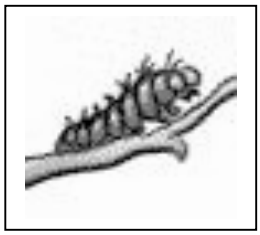
BUTTERFLY METAMORPHOSIS (complete metamorphosis)

#_____
This is called the chrysalis, or the
_____



1__
This is called the
egg_____

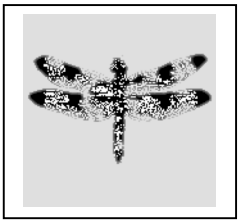
#_____
This is called the
_____



#_____
This is called the caterpillar, or the
_____

DRAGONFLY METAMORPHOSIS (incomplete metamorphosis)

#____
This is called the
_____



#____
This is called the
_____

#_____
This is called the
_____

POND REVIEW SHEET 5.2 Magical Metamorphosis (cont.)

ANSWER SHEET

We have talked about a number of different animals that go through metamorphosis. Some go through **complete metamorphosis** (like a butterfly) and others go through **incomplete metamorphosis** (like a dragonfly).
Below are pictures of the different stages of dragonfly metamorphosis and butterfly metamorphosis. You have two challenges:

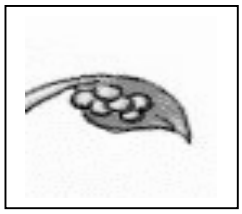
(1) Try to number the pictures so that they are in the correct order.
(2) Try to label each picture using the words in the box below.

Hint: The first stage of butterfly metamorphosis is done for you.

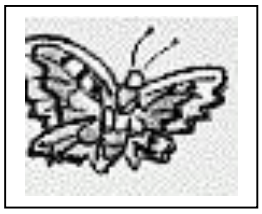
adult butterfly	**larva**	**pupa**
egg	**nymph**	**adult dragonfly**

BUTTERFLY METAMORPHOSIS (complete metamorphosis)

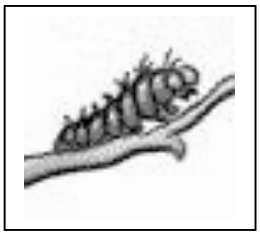
 # 3
This is called the chrysalis, or the *PUPA*



 # 1
This is called the **egg**



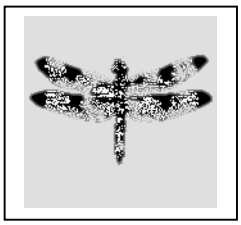
 # 4
This is called the *ADULT BUTTERFLY*



 # 2
This is called the caterpillar, or the *LARVA*

DRAGONFLY METAMORPHOSIS (incomplete metamorphosis)

 # 1
This is called the *EGG*



 # 3
This is called the *ADULT DRAGONFLY*

 # 2
This is called the *NYMPH*

POND REVIEW SHEET 5.3 Pond Measurement

When the class visited the pond, we used all kinds of special instruments to measure different things about the pond. See if you can remember which instrument was used for each measurement.

Match the instrument to what it measures.

The ***pH*** of the water (whether it is acidic or basic).

The ***temperature*** of the water.

The ***turbidity*** (or cloudiness) of the water.

The ***depth*** of the water**.**

POND REVIEW SHEET 5.3 Pond Measurement (cont.)

ANSWER SHEET

When the class visited the pond, we used all kinds of special instruments to measure different things about the pond. See if you can remember which instrument was used for each measurement.

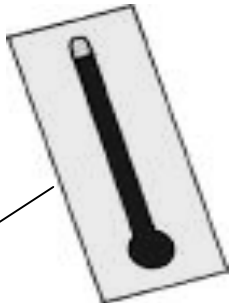
Match the instrument to what it measures.

The ***pH*** of the water (whether it is acidic or basic).

The ***temperature*** of the water.

The ***turbidity*** (or cloudiness) of the water.

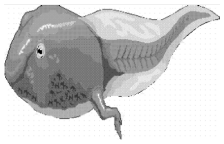
The ***depth*** of the water**.**



GOLF COURSE REVIEW SHEET 5.4 Amazing Adaptations

Name one *adaptation* that each of these pond critters has that helps it to live in the pond.

1. One of the adaptations that a tadpole has to help it survive in the pond is



_____

2. One of the adaptations that a pond snail has to help it survive in the pond is

_____

3. One of the adaptations that water boatman has that helps it to survive in the pond is

_____

4. One of the adaptations that the water strider has that helps it to survive in the pond is

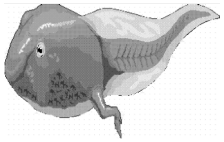
_____

GOLF COURSE REVIEW SHEET 5.4 Amazing Adaptations (cont.)

ANSWER SHEET

Name one *adaptation* that each of these pond critters has that helps it to live in the pond.

5. One of the adaptations that a tadpole has to help it survive in the pond is

   Tadpoles have gills for underwater breathing.
   Drab color and limited movement keep tadpoles well camouflaged.

6. One of the adaptations that a pond snail has to help it survive in the pond is

   Hard shell protects snail from predators and fast-moving water

7. One of the adaptations that water boatman has that helps it to survive in the pond is

   Oar-like legs propel the boatman through the water.
   Air taken at the surface makes the boatman appear silvery.
   Captures an air bubble which serves as an underwater oxygen tank.

8. One of the adaptations that the water strider has that helps it to survive in the pond is

   Body is light and allows the strider to "walk on water"
   Biting mouthparts allow it to catch prey
   Legs are spread out to better distribute the strider's weight