TEACHING KATE
TEACHING KIDS ABOUT THE ENVIRONMENT

ECOLOGY OF A FRESH WATER POND

Grade Level: 10-12 **Time Required: 5 class periods**

SC Science Standards

This lesson plan was correlated with only the grade level specified unless otherwise noted.

9-12th:
I. B. 1, 2, 4, 5, 9, 10
II. D. 2. a
II. D. 4. b
IV. B. 4. c
IV. C. 3. a. 1, 2

Purpose

Students will observe and identify some of the plant and animal life forms found in a fresh water pond. They will perform chemical tests to determine water quality.

Skills

Analyzing, identifying, measuring, observing, predicting, recording.

Concepts

Investigation of basic survival needs of aquatic organisms, components of the habitat, food chain, and limiting factors using sampling and analysis techniques.

Materials Needed

- sampling jars
- magnifying lenses
- compound scopes
- nets
- water quality test kit such as the Hach kit
- guide books for pond life such as Golden Guide books or Audubon books
- thermometers with string marked for depth
- sieves
- dissecting scopes
- seines

Definition of Terms

Acidic	A solution that contains a high concentration of hydrogen ions. Acidic solutions have a pH of less than 7.
Basic	A solution that contains a high concentration of hydroxide ions. Basic solutions have a pH greater than 7.
Biological Niche	Ecological role played by organism.
Dystrophic	A body of water with high amounts of humic organic material. They are low in plankton production but have highly productive littoral zones.
Ecology	Scientific study of the relationship of living things to one another and to the environment.
Environment	Sum of all external conditions and influences that affect the development and ultimately, the survival of an organism.
Eutrophic	A body of water with high nutrient content and high productivity.
Food Chain	Transfer of food energy from organisms in one trophic level to those in another.
Food Web	Complex and interlocking series of food chains.
Habitat	The locality where a plant or animal normally lives and grows.
Hydrophyte	Any plant growing in water or hydric substrate; wetland plant.
Hypertrophic	A body of water with an excessive nutrient content.

Macroorganisms	Organisms large enough to be seen with the naked eye.
Microorganisms	Organisms too small to be seen with the naked eye.
Oligotrophic	A body of water low in nutrients and productivity.
pH Scale	A scale of numbers from 0-14 used to indicate the level of acidity or alkalinity of a substance. A pH of 7 is considered neutral. A pH below 7 is acidic and above 7 is basic.
ppm	Parts per million. Same as mg/l (milligrams per liter).

Before the Session

Gather together all materials and make copies of handouts. Find location for and plan field trip.

Background Information

Fresh water habitats are important in many ways. They help keep our environment in balance and provide habitat to numerous species of wildlife. Fresh water ponds are very productive and provide a strong base for plants and animals important to the world's food web. Ponds serve as homes for many plants and animals, as resting places for migrating water fowl, to help control floods, as nurseries for young animals, to provide shelter, and as an area to allow sediment to settle out of the water system. They also provide for recreational activities such as boating, fishing and swimming.

The amount of dissolved oxygen in the water is very important to the survival of aquatic animals since they must acquire oxygen from the water. Dissolved oxygen content is highest in cool water moving rapidly over obstructions in the water course such as rocks, riffles and falls. The rapid movement acts to mix oxygen into the water and the cooler the temperature the more oxygen the water can hold. Still water acquires oxygen from aquatic plants as well as by direct transference at the surface and this is highest if a breeze is blowing over the surface. When water is heated the solubility of oxygen in water decreases. If the water becomes too warm, oxygen levels will decrease leaving too little oxygen for animals to survive. This will result in animals with oxygen requirements higher than the available oxygen levels dying. In lakes and ponds, oxygen can be a limiting factor especially in the summer because only a small portion of the water is on the surface and in direct contact with oxygen-rejuvenating air. The temperature is warmer and decomposition on the bottom consumes much of the oxygen in the water. Some aquatic animals have very low tolerance to changes in temperature and oxygen levels (trout) while others show a high level of tolerance (mostly bottom dwellers such as catfish). Dissolved oxygen requirements for fish range from 4 ppm for carp (bottom dweller) to 8 ppm for trout.

Aquatic animals prefer a pH range between 6.8 and 7.2. The degree of acidity or alkalinity reflects the health of a body of water. A high pH indicates high levels of carbon dioxide which occurs as carbonates, bicarbonates and associated salts. Streams with a higher pH are richer in nutrients and support more abundant aquatic life, higher diversity of aquatic life and higher fish populations. Streams with acid waters are generally low in nutrients and therefore have lower diversity of aquatic life and lower fish populations. In acidic waters, sulfate and nitrogen ions replace the bicarbonate ions, and solutions once dominated by Ca^{++} and HCO^{-} become dominated by SO^{-}. Although adult fish of most species can tolerate relatively high acidity levels (5.5 or lower) in rivers, streams, ponds or lakes, juvenile fish, amphibians, crustacean and other invertebrates cannot. With the loss of recruitment and decline of food, fish life also disappears.

Oligotrophic systems have a high dissolved oxygen content and bottom sediments which are primarily inorganic. Nutrient levels are low, therefore, the dissolved oxygen concentration is relatively high at the bottom. Although biomass or the total number of organisms may be low in this system, species diversity is often high. Nutrient rich aquatic systems are referred to as eutrophic. A typical eutrophic system has abundant nutrients, especially nitrogen and phosphorous, that stimulate a heavy growth of algae and other aquatic plants. The bottom of eutrophic lakes or ponds are high in organic material (the accumulation of algae, dead plant material and dead aquatic organisms). Dissolved oxygen levels at the bottom of this type of lake or pond is depleted by the activity of decomposers. The number of species is low, but the biomass or number of organisms is high. A hypertrophic system usually results from the addition of nutrients to a eutrophic system. This enrichment caused major shifts in plant and animal life. One result is algal blooms.

Suggested Lesson Plan

<u>Day 1</u>

1. Brief students on the ethical guide lines and environmental courtesies to be observed at the lake.

2. Use appropriate charts and posters to help them become aware of plants and animals which may be seen on day 2.

3. Explain how to use seines, sieves and jars in collecting organisms.

4. Have students give ideas as to why fresh water ponds are important. Be sure that the following reasons are included: they are homes for many plants and animals, they serve as a resting places for migrating waterfowl, they help control floods, they serve as nurseries for young organisms, they provide shelter and they are recreational areas.

Day 2

1. Take students to the pond or lake.

2. Have them identify and sketch organisms which they observe in or around the pond. Worksheet I provides two pages for the identification and sketching of observed organisms. As an aid in identifying animal forms, students may utilize Appendices A and B or one of the appropriate field guides. Hand lenses might be used in identifying immature insect forms such as stonefly nymphs, caddisfly larva, dragonfly nymphs and whirligig larva.

3. Have students collect containers of water from various locations in the pond. These collections are to be brought back to the classroom.

Day 3

1. Use charts or the text to identify what kinds of microscopic forms are likely to be found in the water collected on day 2.

2. Provide students with compound and dissecting microscopes, and show them how to prepare slides of the collected water.

3. As a student finds an aquatic organism such as a paramecium, amoeba, spirogyra, diatom, euglena, etc.; he is to show it to the teacher and to other students. All students are to sketch all microflora and microfauna found on Worksheet I.

4. Have students refer to Appendix C for a discussion of the water quality tests to be performed on day 4.

Day 4

1. Return to the pond with students in order to perform the water quality tests for dissolved oxygen, pH and temperatures. Chemistry students might also perform dissolved carbon dioxide test, phosphate test and nitrate test.

2. Assist students in performing the dissolved oxygen test by following the procedures of Appendix C. Record results on Worksheet II.

3. Perform the pH test using the procedures of Appendix C and record results on Worksheet II.

4. Have students take and record the water temperature (at 2-3 different depths if possible) and air temperatures.

5. Perform and record results of the dissolved carbon dioxide test, phosphate test and nitrate test if feasible.

Day 5

1. Refer to Appendix D. Explain to students that the pH range is from 0-14 with 7 being neutral. Tell them that below 7 is acidic and above 7 is basic; and that most aquatic organisms prefer a pH range between 6.8 and 7.2. Have students refer to Worksheet II.

2. Explain to students how the dissolved oxygen content requirements of fish vary from around 4 ppm for carp to 8 ppm for trout. Refer to Appendix D for oxygen requirements for other organisms.

3. Have students offer explanations for differences between air and water temperatures. Explain to them the inverse correlation between dissolved oxygen and temperature. Offer an explanation as to why better fishing grounds are found in colder waters. Use Appendix E to show the direct relationship between dissolved oxygen and atmospheric pressure.

4. Discuss the role played by plants in removing carbon dioxide from the environment. Explain how high nitrate and phosphate concentrations cause algal blooms.

Application

It is important that students understand the important role of abiotic factors in regard to the types of plants and animals found in an aquatic environment. This type of study lends itself to promoting an awareness of our total environment and its impact on our lives. Ponds are important for many types of wildlife. Beaver, muskrat, otter, alligator, snakes, frogs, fish, turtles, insects and spiders are some of the animals which can be found in a pond. Birds use ponds as resting areas, or homes where feeding, breeding and nesting occurs. Rookeries containing hundreds to thousands of nesting birds such as Great Blue Herons, Little Blue Herons, Tricolored Herons, Great White Egrets, Snowy Egrets and Anhingas are found in ponds. Many duck species as well as the Canada Goose find homes in South Carolina ponds. Bald Eagles nest near and feed in ponds. Ponds also serve as nurseries for many amphibian and insect species. Many terrestrial animals use ponds as feeding grounds and/or watering areas. A pond is a rich environment where a great diversity of animal life can be seen and observed.

Extension

Trips to other aquatic environments such as rivers, wetlands and marshes would be helpful in comparing and contrasting the various forms of wildlife and vegetation.

Resources Available

Aquatic and Wetland Plants of South Carolina. South Carolina Aquatic Plant Management Council.

Aquatic Project Wild. Western Regional Environmental Education Council, P.O. Box 18060, Boulder, CO 80308-8060.

Elements of Ecology, 3rd edition. 1992. R. L. Smith. Harper Collins Publishers Inc., New York, N.Y.

Hach Water Analysis Handbook, 2nd ed. 1992. Hach Co., Loveland, CO. p. 17.

Teaching KATE. 1995. Coalition for Natural Resource Education.
(Aquatic Ecology Curriculum)

The Golden Guide to Pond Life. 1987. Golden Press, N.Y.

Prepared by: Jerry Hass

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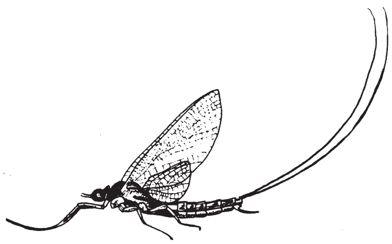
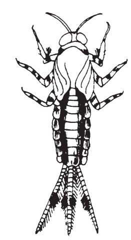
APPENDIX A

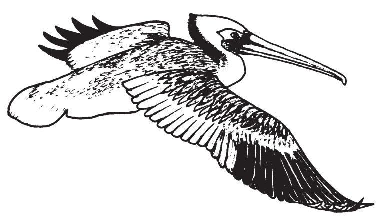
Mayfly





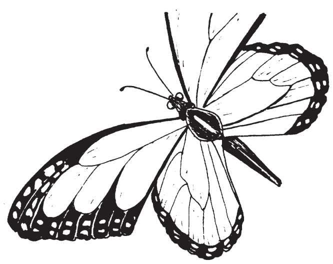
Mayfly Nymph

Pelican



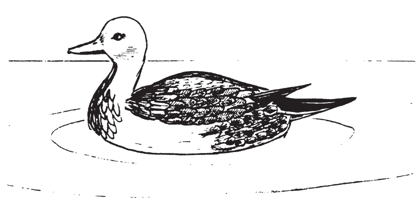
Pelican Nest and Eggs

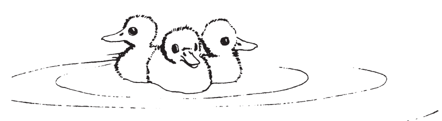
Butterfly



Butterfly Larvae

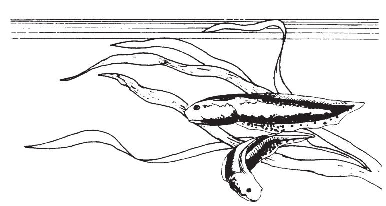
Duck





Ducklings

Frog



Tadpoles

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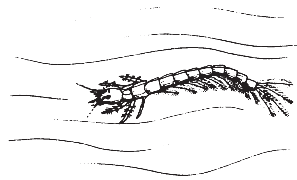
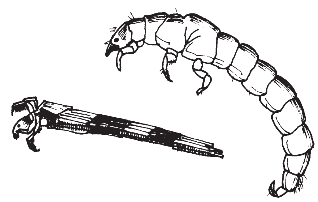
APPENDIX B

Whirligig Beetle



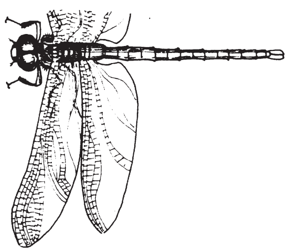
Whirligig Larva

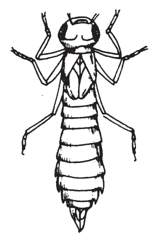
Caddisfly



Caddisfly Larvae

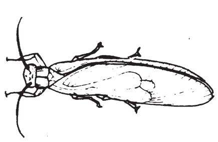
Dragonfly

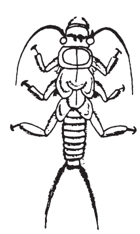




Dragonfly Nymph

Stonefly





Stonefly Nymph

Osprey

Osprey Hatchlings

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APPENDIX C
PROCEDURES FOR WATER QUALITY TESTING

Using the Hach Water Ecology Kit
(Model AL-36B)

Dissolved Oxygen Test

1. Fill the glass stoppered Dissolved Oxygen (DO) bottle to the top with the water to be tested. Be certain there are no air bubbles present in the bottle.

2. Use the clippers to open one foil pack each of the Dissolved Oxygen 1 Reagent Powder and the Dissolved Oxygen Reagent 2 Powder. Empty the contents of each of these packets, in numerical order, into the bottle. Keep the reagents as far from the sides of the bottle as possible during the pouring process. Stopper the bottle carefully to eliminate any trapped air:

    Tilt the DO bottle slightly and insert the glass stopper with a quick thrust. This should force the air bubbles out of the bottle.

    Ensure that all students are wearing safety goggles during this test and that the open end of the DO bottle is not pointed in anyone's direction during the stoppering procedure.

3. Grip the bottle securely between the middle and ring fingers (with palm up) and, with the thumb of that same hand holding the glass stopper down, shake the bottle vigorously. A flocculent precipitate will form. If oxygen is present in the water sample the precipitate will be a brownish-orange color.

4. Allow the sample to stand undisturbed until the flocculent has settled halfway, leaving the upper half of the sample clear. Shake the bottle again (as in 3. above) and let it stand until the upper half of the sample is again clear. A small amount of undissolved powdered reagent may remain stuck to the bottom of the bottle. This should be of no concern as it will not affect the test results.

5. Carefully remove the glass stopper and add the contents of one Dissolved Oxygen 3 Reagent Powder pillow to the sample. Restopper the bottle, taking care to eliminate any air bubbles that

might have formed, and shake vigorously as before. The floc will dissolve and, if oxygen is present, the sample will take on a yellow color. The sample has now been prepared for the DO Test.

6. Fill the small plastic measuring tube level full with the prepared sample. Pour this sub-sample into the flat-sided mixing bottle by inverting the mixing bottle over the vertically held measuring tube and, with a quick twist of the wrist, turning them upside-down so that the liquid flows into the mixing bottle.

7. Very carefully add Sodium Thiosulfate Solution, one drop at a time, to the, flat-sided mixing bottle by holding the dropper vertically above the bottle. Swirl the bottle between drops to ensure complete mixing, and count each drop as it is added. Continue to add drops until the color of the sample changes from yellow to colorless. Each drop of the Sodium Thiosulfate Solution used to bring about the color change is equal to 1 mg/L of Dissolved Oxygen.

<u>pH Test</u>

1. Repeatedly rinse the two glass (or plastic) pre-marked sample tubes with the water to be tested. Fill both tubes to the 5 ml mark with the water sample.

2. Carefully add six drops of Wide Range 4 pH Indicator Solution to one of the tubes and swirl to mix.

3. Insert the tube of prepared sample into the right (inside) top opening of the Color Comparator.

4. Insert the tube of untreated water sample into the left (outside) top opening of the Color Comparator.

5. Hold the Color Comparator up to a light source such as the sky, a window or lamp, and view through the openings in front. Rotate the disc until a color match is obtained. The pH of the sample is shown in the scale window.

Modification of Instructions published 12/85 by the Hach Company,
P.O. Box 389, Loveland, Colorado 80539

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APPENDIX D

pH Ranges That Support Aquatic Life

MOST ACID ------------------------------------ NEUTRAL-------------------------------- MOST ALKALINE
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Bacteria	1.0	13.0
Plants (algae, rooted, etc.)	6.53	13.0
Carps, suckers. catfish, some insects	6.0	9.0
Bass, crappie	6.5	9.0
Snails, clams, mussels	7.0	9.0
Largest variety of animals (trout, mayfly, stonefly, caddisfly)	6.5	7.5

Temperature Ranges (Approximate) Required for Certain Organisms

Temperature	
Greater than 68 F. (20C) warm water	Much plant life, many fish diseases Most bass, crappie, bluegill, carp, catfish, caddisfly
Middle range: 55 - 68 F (12.8 - 20 C)	Some plant life, some fish diseases Salmon, trout, stonefly, mayfly, caddisfly, water beetles
Low range: Less than 55 F (12.8 C) - cold	Trout, caddisfly, stonefly, mayfly

Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life
D.O. In **parts per million**

(below 68 F.)	(above 68 F.)
Cold-water organisms, including salmon and trout	Warm-water organisms including fish such as bass. crappie, catfish and carp
6 ppm	5ppm

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APPENDIX E

Oxygen, Dissolved

The following table lists the mg/L dissolved oxygen in water at saturation for various temperatures and atmospheric pressures. The table was formulated in a laboratory using pure water; thus, the values given should be considered as only approximations when estimating the oxygen content of a particular body of surface water.

Accuracy and Precision

Accuracy is the nearness of a test result to the true value. Precision refers to the agreement of a set of replicate results or repeatability. Although good precision suggests good accuracy, precise results can be inaccurate. The following paragraphs describe techniques to improve accuracy and precision of analysis.

Reprinted from Hach Water Analysis Handbook, 2nd Edition. 1992. Hach Co., Loveland, CO. P. 17.

Temp		Pressure in Millimeters and Inches Hg								
		775	760	750	725	700	675	650	625	mm
°F	°C	30.51	29.92	29.53	28.54	27.56	26.57	25.59	24.61	inches
32.0	0	14.9	14.6	14.4	13.9	13.5	12.9	12.5	12.0	
33.8	1	14.5	14.2	14.1	13.6	13.1	12.6	12.2	11.7	
35.6	2	14.1	13.9	13.7	13.2	12.9	12.3	11.8	11.4	
37.4	3	13.8	13.5	13.3	12.9	12.4	12.0	11.5	11.1	
39.2	4	13.4	13.2	13.0	12.5	12.1	11.7	11.2	10.8	
41.0	5	13.1	12.8	12.6	12.2	11.8	11.4	10.9	10.5	
42.8	6	12.7	12.5	12.3	11.9	11.5	11.1	10.7	10.3	
44.6	7	12.4	12.2	12.0	11.6	11.2	10.8	10.4	10.0	
46.4	8	12.1	11.9	11.7	11.3	10.9	10.5	10.1	9.8	
48.2	9	11.8	11.6	11.5	11.1	10.7	10.3	9.9	9.5	
50.0	10	11.6	11.3	11.2	10.8	10.4	10.1	9.7	9.3	
51.8	11	11.3	11.1	10.9	10.6	10.2	9.8	9.5	9.1	
53.6	12	11.1	10.8	10.7	10.3	10.0	9.6	9.2	8.9	
55.4	13	10.8	10.6	10.5	10.1	9.8	9.4	9.1	8.7	
57.2	14	10.6	10.4	10.2	9.9	9.5	9.2	8.9	8.5	
59.0	15	10.4	10.2	10.0	9.7	9.3	9.0	8.7	8.3	
60.8	16	10.1	9.9	9.8	9.5	9.1	8.8	8.5	8.1	
62.6	17	9.9	9.7	9.5	9.3	9.0	8.6	8.3	8.0	
64.4	18	9.7	9.5	9.4	9.1	8.8	8.4	8.1	7.8	
66.2	19	9.5	9.3	9.2	8.9	8.6	8.3	8.0	7.6	
68.0	20	9.3	9.2	9.1	8.7	8.4	8.1	7.8	7.5	
69.8	21	9.2	9.0	8.9	8.6	8.3	8.0	7.7	7.4	
71.6	22	9.0	8.8	8.7	8.4	8.1	7.8	7.5	7.2	
73.4	23	8.8	8.7	8.5	8.2	8.0	7.7	7.4	7.1	
75.2	24	8.7	8.5	8.4	8.1	7.8	7.5	7.2	7.0	
77.0	25	8.5	8.4	8.3	8.0	7.7	7.4	7.1	6.8	
78.8	26	8.4	8.2	8.1	7.8	7.6	7.3	7.0	6.7	
80.6	27	8.2	8.1	8.0	7.7	7.4	7.1	6.9	6.6	
82.4	28	8.1	7.9	7.8	7.6	7.3	7.0	6.7	6.5	
84.2	29	7.9	7.8	7.7	7.4	7.2	6.9	6.6	6.4	
86.0	30	7.8	7.7	7.6	7.3	7.0	6.8	6.5	6.2	
87.8	31	7.7	7.5	7.4	7.2	6.9	6.7	6.4	6.1	
89.6	32	7.6	7.4	7.3	7.0	6.8	6.6	6.3	6.0	
91.4	33	7.4	7.3	7.2	6.9	6.7	6.4	6.2	5.9	
93.2	34	7.3	7.2	7.1	6.8	6.6	6.3	6.1	5.8	
95.0	35	7.2	7.1	7.0	6.7	6.5	6.2	6.0	5.7	
96.8	36	7.1	7.0	6.9	6.6	6.4	6.1	5.9	5.6	
98.6	37	7.0	6.8	6.7	6.5	6.3	6.0	5.8	5.6	
100.4	38	6.9	6.7	6.6	6.4	6.2	5.9	5.7	5.5	
102.2	39	6.8	6.6	6.5	6.3	6.1	5.8	5.6	5.4	
104.0	40	6.7	6.5	6.4	6.2	6.0	5.7	5.5	5.3	
105.8	41	6.6	6.4	6.3	6.1	5.9	5.6	5.4	5.2	
107.6	42	6.5	6.3	6.2	6.0	5.8	5.6	5.3	5.1	
109.4	43	6.4	6.2	6.1	5.9	5.7	5.5	5.2	5.0	
111.2	44	6.3	6.1	6.0	5.8	5.6	5.4	5.2	4.9	
113.0	45	6.2	6.0	5.9	5.7	5.5	5.3	5.1	4.8	
114.8	46	6.1	5.9	5.9	5.6	5.4	5.2	5.0	4.8	
116.6	47	6.0	5.9	5.8	5.6	5.3	5.1	4.8	4.7	
118.4	48	5.9	5.8	5.7	5.5	5.3	5.0	4.8	4.6	
120.2	49	5.8	5.7	5.6	5.4	5.2	5.0	4.7	4.5	
122.0	50	5.7	5.6	5.5	5.3	5.1	4.9	4.7	4.4	

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WORKSHEET I

Name:

Name of Organism	Sketch of Organism	Number of Organisms

ECOLOGY OF A FRESH WATER POND

WORKSHEET I - CONTINUED

Name:

Name of Organism	Sketch of Organism	Number of Organisms

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WORKSHEET II

Name:

I. Dissolved oxygen in parts per million (ppm)

a. At the edge of the pond ____________

b. At the end of the pier ____________

II. Acidity (pH)

a. At the edge of the pond ____________

b. At the end of the pier ____________

III. Water temperature (degrees celsius)

a. At the edge of the pond ____________

b. At the end of the pier ____________

1. Depth ____________

c. At the end of the pier ____________

1. Depth ____________

IV. Air temperature

a. At the edge of the pond ____________

b. At the end of the pier ____________

ECOLOGY OF A FRESH WATER POND

WORKSHEET II - CONTINUED

Name:

V. Dissolved carbon dioxide in ppm

a. At the edge of the pond ____________________

b. At the end of the pier ____________________

VI. Nitrates in ppm

a. At the edge of the pond ____________________

b. At the end of the pier ____________________

VII. Phosphates in ppm

a. At the edge of the pond ____________________

b. At the end of the pier ____________________