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Pond Ecology

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The subject of ecology is particularly important for our students today because we as Americans have finally realized that in order for our planet to remain alive, we must take preventive measures to save it. Pond Ecology takes into account one aspect of planet—ponds. Through experiments, readings and discussions, the students will learn to look critically at ecosystems, and ecology especially as they relate to ponds.

Upon completion of the unit, the students will realize that man is highly dependent on the planet Earth for survival just as Earth depends on man. Therefore, this unit can be used as one of many activities which focuses on the significance of saving our planet.

This curriculum unit is designed to be used with fifth grade students. It is particularly designed to provide students with “hands-on” scientific activities in order to reinforce all the concepts presented throughout the unit. Secondly, it provides the students with the basic knowledge needed in order to design their own scientific investigations. Finally, and probably the first objective, the unit will help students become aware of the importance of keeping ponds safe from pollutants while witnessing the actual devastation that oil or gas spills cause to our pond communities.

As a science teacher, and PIMMS fellow, I have focused on making this unit readily accessible for teacher usage. With the exception of the microscopic activities, all of the experiments throughout this curriculum can be performed inexpensively. I have also included a list of possible field trips available within the New Haven area. Clearly stated objectives have been listed with each lesson plan in order to eliminate some of the burden for teachers using the curriculum. Therefore, get ready to teach “ecology” from a “hands-on” perspective and watch your students desire for performing science strengthen.

The curriculum, “Pond Ecology”, will involve the following components:

I. Introduction

The origin of a pond and its characteristics will be discussed in this section of the paper.

II. The Scientific Method

Since one of my goals in this unit is to encourage students to perform and design their own experiment, I feel that it is necessary to include a summary of the proper method of writing a scientific investigation. Therefore I will list and briefly explain the five basic steps of the scientific method.

III. The Water Cycle

Here, I will discuss the water cycle. The students will identify the water cycle as the continuous movement of water from the atmosphere to the earth and from the earth back to the atmosphere.

IV. Fundamentals of Pond ecology

This section of the paper will concentrate on giving the students background information on ecology in order for them to understand fully ecosystems. Therefore, the following ecological concepts will be discussed, including but not limited to: (a) food webs, chains and pyramids; (b) biotic verses abiotic components of the environment; (c) ecological relationships, communities, population and organism that are found in ponds; (d) ecological succession of the pond community.

V. Constructing a Pond Community

The students will set up one or two aquariums in the classroom. Once the aquariums are ready, the student will take a trip to a nearby pond and collect water, plants, animal life, soil, etc... The specimen collected will be placed in the aquarium located in your classroom. I will also include a lesson plan for constructing a pond outside your school if you can receive permission to do so.

VI. Listing Factors Within A Pond Community

This section of the paper will include experimentation relating to the biotic and abiotic components of the pond community. Students will perform simple experiments to see how water, temperature, light and minerals affect the biotic community that exist within the pond.

I. Introduction

A pond is characterized as being a small body of water that is shallow enough for sunlight to reach the bottom, permitting the growth of rooted plants at its deepest point. Seldom do ponds reach more that 3.6-4.5 meters (12 to 15 feet) in depth.

An undisturbed pond will age. Even though at first a pond will appear to be lifeless, a new pond will acquire both plants and animals by the different forms of inflowing water. Large deposits of rootless stoneworts and hornworts become established; microscopic plankton form drifting masses; water boatmen and winged whirligig beetles alight on the surface to swim. Plants colonize all of the zones and provide food and shelter to a wide variety of animals. Frogs begin to visit and lay eggs.

Ponds are considered to be part of the freshwater habitat-which are divided into flowing water and standing water. The flowing water habitat is divided into rapid and slow streams. The standing water habitat are divided into lakes, ponds, and swamps. Ponds can be even further divided into those with bare bottoms and those whose bottom contain vegetation.

Ponds are noted for their abundant and rich varieties of plant and animal life, which all are maintained in a delicate ecological balance. Life forms range from microscopic bacteria to insects, fish, small animals, and birds. As ponds age, the number of species living in it steadily increases until, finally, the growth of larger plants, algae, and the accumulation of wastes convert it into a marsh or cause it to dry up. This process is known as ecological succession.

The study of the relationships between living things and their environment is known as ecology. However, the curriculum, “The Ecological Relationships That Exist Within A Pond Community” actually covers a smaller division of ecology called limnology—the science that deals with the interrelationships of plant and animals in aquatic environments. Since the pond represents a stable environment where living things interact, and materials are used over and over again, it is considered an ecosystem.

Limnologists have identified five different types of ponds as follows:

(1) Cypress Ponds which are commonly found in the central or lower Mississippi Basin and along the coastal plain of the Southeastern United States. Their waters are described as being brownish in color, and many dry out during parts of the year. Willows, bay trees mixed with cypress trees, grows along the shore and are often found out in the waters.
(2) Bog Ponds are often found in the moist temperature regions of North America. The water is highly acidic and often muddy. Alders grow profusely on the shore and cedar trees dominate the high ground. Thick beds of sphagnum extend outward from the shore and floating-leaf plants usually cover the surface.
(3) Meadow-Stream Ponds form where streams widen and the speeds of its currents slow down tremendously. The shallow part of the pond usually has an abundance of pondweeds, cattails, stoneworts and other plants with emergent leaves. They also have plants with floating leaves on the surface of the water, such as lilies and water shields.
(4) Mountain Ponds, which are often formed by glaciers, are another type of pond. The bottoms of these ponds range from being rocky, graveled or muddy. Most of the time Mountain Ponds have ice in them and they usually dry up at some point during the summer. Sedges grow along its margins. In spite of the pond’s short summer season, a variety of animals and plants live in these icy waters.
(5) Farm Ponds are man-made ponds built to help keep the farmlands fertile. Farm ponds are at least three feet deep at the shoreline in order to prevent plant growth that would lead to the early succession of the pond. It should also have a spillway to control the water level. Farm ponds usually become abundant in fish, and are usually good waters for swimming and boating. They should also fill from seepage, not from another stream which would fill the basin of the pond with silt and eventually kill the pond.

II. The Scientific Method

In order to prepare students to eventually design their own experiment, the instructor should insist on having their students write up their scientific investigations using the proper method. Since one of my goals is to heighten students interest in science, I feel that it is necessary to include this small segment explaining the

scientific method so that you can show your students how scientists work.

The first step of the scientific method is to come up with a good title for the experiment. Titles are often stated in the form of a question. Just from reading the title, anyone should automatically know the problem that a child is trying to solve in their experiment. For example: “What Effect Does Temperature Have on the Respiration Rate of a Fish”. From the title we know that the student is trying to find out if the temperature of water changes the rate at which a fish breathes.

Thinking scientifically, the student should try to find possible solutions the problem through researching information about the problem he is trying to solve. The information that he finds should aid the child in forming an hypothesis during the third stage of the scientific method, and help the child in writing the introduction.

The second stage of the scientific method should be titled the introduction. The student, in paragraph format, should briefly write some sort of introductory statement which addresses such questions as, why he chose to do the particular experiment and why is it worth spending time on. The child should also include some background information about how the fish breathes or how they react in warm verses cold water, or how they are cold-blooded animals, etc....

The third step of the scientific method requires the child making an educated guess about what he is experimenting on. The educated guess is called an hypothesis. Using the previous example, a typical hypothesis for this experiment would be: As the temperature of the water increases, the fish respiration rate would increase also.

In the fourth step called the procedure, have the student to list the material that is needed to do the experiment as well as provide the basic details as to how the experiment will be performed. This should be a detailed description and a step by step procedure of how the student could test his problem. Anyone reading the experiment should be able to collect the materials needed to perform the investigation and duplicate the experiment by reading the procedures.

The fifth step called observations. The student records any pertinent information about their findings while performing the experiment. Whenever possible the student should use charts, graphs, tables or pictures to depict information.

The final step of the scientific method is the conclusion. Here the student analyzes the data the he has placed in his observations and formulates a conclusion. This section is also be done in a paragraph format. The student should also state whether or not his hypothesis was correct.

Keep in mind that in order for the student to fully understand how this method is employed, the instructor must walk the child through a sample experiment explaining how each step is done. It is also important the student realizes that once the hypothesis is made it should not be changed during the experiment. Remember that it is only a guess as to the outcome of the experiment, the important thing is that the conclusion at the end is correct. The conclusion either proves or disproves the hypothesis.

During any experiment or scientific research the teacher should constantly encourage students to ask questions, reach an educated guess, and to design some type of experiment to figure out if their hypothesis is correct.

III. The Hydrologic Cycle

The hydrologic cycle, commonly referred to as the water cycle, is closely related to the interrelationship of the biotic and physical environment. Man can not survive without water nor would we have lakes, ponds or streams. The water cycle is continuous movement of water from the atmosphere to the earth and from the earth back to the atmosphere. The water that moves from the atmosphere to the earth is called precipitation. However, the water will return to the atmosphere through evaporation.

During a rain storm, some of the rainwater evaporates as it falls to the ground. But most of the rainwater runs along the surface of the ground and travels to the rivers, streams and ponds. The water running along the surface is known as runoff water. Large amounts of precipitation also enter the soil to become ground water. This water can reach a pond, lake or ocean through springs or underground streams; or it may move upward through the soil during dry periods and pass again into the atmosphere as water vapor. The warm air that rises through the atmosphere contains tiny droplets of water. This water cools as it climbs higher into the atmosphere causing the water vapor to condense into droplets of water which forms clouds. The droplets collect to form drops that eventually fall from the clouds as rain. If the water vapor condenses at a temperature below the freezing point of water, then snow is formed.

Ground water is also a part of the water cycle. The ground holds and receives water from precipitation. However, some of the water moves downward into subsoil and fills the spaces around the rock particles. The upper level of the soil where it is saturated with water is known as the water table. If the soil is over saturated with water, the water will run off the surface instead of penetrating into the soil. The depth of the water table depends on the amount of precipitation, the nature of the rock layer under the soil, the proximity of large bodies of water, and the condition of the soil surface for receiving water.

IV. Fundamentals of Pond Ecology

A. Habitats In the Pond Community

The place where an organisms live is considered its habitat. Four distinctive habitats can be found within the pond community. These four habitats are the surface film habitat, open water habitat, bottom habitat and the shore habitat.

The surface film habitat is located on the top (surface) of the pond water. It is the habitat of air-breathing floating animals (insects) such as marsh treaders, broad-shouldered water striders, and animals that have special devices that allow them to walk on the surface of water without breaking through such as water striders. Some insects and free-floating animals are adapted to live only on the upper side of the surface film. The animals that dwells on the surface usually feed on the floating plans, insects and other animals that may have been killed or drown and floated to the surface. The surface dwelling animals may even feed on one another. Other animals, along with the larvae of some beetles and flies spend much of their life on the underside of the film beneath the floating plants.

The open-water area mainly consist of the water surrounded by plant life. It ends where vegetation is dense and rooted into the soil. The open water habitat is composed of large, free-swimming organism such as fish,

and small microscopic plants and animals called plankton that drift suspended in the water. Phytoplankton (small suspended plants), mostly consisting of algae, are the basic food in lakes. Small suspended animals such as tiny crustaceans, insect larvae, rotifers, and other invertebrates called zooplankton also live in the open-water habitat and are basic food for pond animals. The availability of plankton vary from season to season, but are most abundant during the spring.

Other animals such as turtles, birds and larger fish comes to the open-water area for food. Some insects, insect larvae, and crustaceans migrate from the bottom towards the surface, but return to the bottom as daylight appears.

Life in the bottom habitat of a pond depends upon the type of bottom a pond may have. For example, if the pond is shallow and has a sandy bottom it could be inhabited by sponges, earthworms, snails and insects. The bottom of quiet, standing water ponds are characterized as muddy or silty, and life represented in these types of ponds are crayfish, and the nymphs of mayflies, dragonflies, and microorganisms. These animals usually burrow into the bottom muds.

If the water in the pond is turbid, conditions at the bottom of the sea is extremely different from that in the opened waters because light does not penetrate to the bottom and plants cannot grow. Due to the lack of vegetation, the availability of shelter for animals is almost null. The amount of dissolved oxygen will be low, and the concentration of carbon dioxide will be high. Despite all of the previously mentioned conditions, animals such as earthworms, small clams, and fly larvae such as bloodworms and phantoms can survive in the deep bottom zone. There is usually a large amount of bacteria in this zone because they can survive off of dead organic matter.

The littoral habitat extends from the waters edge outward as far as rooted plants grow. This is the richest area in the pond community because of the plant life that exist in this area. The observer will find unlimited amounts of biotic life. Typically, there are three distinct borders of flowering plants that makes up the littoral habitat: the emergent plant zone; floating plant zone; and submersed plant zone. If the shore is rocky, plants may not grow in this area. Therefore, some ponds may have two distinct borders of flowering plants.

The emergent plant zone is closest to the shore. The observer will find plants that are rooted to the bottom. Their stems and leaves appear above the surface. The emergent zone should be bountiful with grasses, sedges, rushes, and algae. Along with the plant life, the observer will find animals such as protozoans, worms, insects, snails, and small fishes.

The floating-leaf plant zone is made up of broad, flat-leaved water lilies, water ferns, and duckweed. If the observer picks up one of the leaves, animals such as snails, bugs, and mayflies, larvae and eggs may be located underneath them. A variety of algae can be found in this zone. Most water animals use this area for breeding and nesting.

The submersed plant zone is the area of vegetation that surrounds the center of the pond. The plants in this area all have leaves that are long and slender, or bushy and branched leaves. Pondweed, waterweeds, and hornworts are some of the flowering plants found in this zone. The flowers of these plants are pollinated above the water surface. The seeds of these plants germinate and the plants develop underneath the water.

B. Food Webs and Chains

As ecosystems have living and nonliving parts. The living, or biotic part, of an ecosystem is known as the

ecological community. Living things interact with each other by feeding on one another. Therefore, energy, compounds, and chemical elements are transferred from creature to creature along the food chains.

Food chains group organisms into trophic levels. A trophic level include all the organisms in a food chain that are the same number of steps away from the original source of energy. Therefore, green plants are in the first trophic level and plant eating animals (herbivores) are placed in the second level. The third trophic level consists of carnivores (meat eating animals) that feed on herbivores. The fourth trophic level consists of carnivores that feed on the animals from the third trophic level, etc.

For example, trophic levels that exist within the pond community could be diagrammed as follows:

(1) First Trophic Level—green plants such as phytoplankton, algae, microscopic plants, pond lilies, etc. which manufactures food through photosynthesis.
(2) Second Trophic Level—herbivores such as mayflies, small crustaceans, nymphs, and certain types of beetles that feed on the plants in level one.
(3) Third Trophic Level—carnivores such as fish who consume plants and animals from the first and second trophic levels.

C. The Ecological Makeup Of A Pond

The components of a pond ecosystems are very diverse, but it can be divided into several basic units: (1) abiotic substances; (2) producer organisms; (3) macroconsumer organisms; and (4) saprotrophic organisms.

The abiotic substances that make up the pond includes basic inorganic and organic substances such as water, carbon dioxide, oxygen, phosphorus salts, amino acids and nitrogen. Small portions of the necessary nutrients that organisms need in order to survive in the water is always available. The rate at which these nutrients are released into the water are regulated by the temperature cycle (seasons), the amount and availability of sunlight, and the climatic regimes.

There are two different kinds of producer organisms that make up a pond: (1) small minute and/or microscopic floating plants call phytoplankton. The word phytoplankton comes from the prefix “phyto” which means plant and the suffix “plankton” which means floating. If the pond produces a large amount of algae, the water will have a green coloration. This can be hazardous to the pond community. Phytoplankton can be found all over the pond, as long as there is sunlight to sustain its life. Algae are a good example of phytoplankton. The second type of producer organism are the rooted or large floating plants which are found growing in the shallow water area.

Fish, crustaceans, and insect larvae is are examples of the macroconsumer organisms that can be found in a pond. The primary macroconsumers consist of zooplankton and benthos. They are herbivores that feeds directly on living plants and the remains of those plants. The secondary consumers consist of carnivores (insects and game fish) which feeds on the primary consumers.

Saprotrophic organisms are the aquatic bacteria, fungi, and flagellates which are widely distributed throughout the pond. Large numbers of these organisms can be found in the mud at the bottom of the pond

where dead plants and animals accumulate. Under the correct climatic conditions, decomposition of the dead matter occurs rapidly. Some saprotrophic organisms are pathogenic because they have the ability to cause diseases in other living organisms. However, most of these organisms only feed on dead organic matter.

V. Constructing a Pond Community

One of the major advantages of studying the ecosystems within a pond community is that you can capture different life forms and keep them in your classroom by setting up a pond community aquarium. An aquarium is one of the most fascinating nature projects because a large variety of pond animals can be maintained in captivity with a minimum amount of care and equipment. Keeping these animals in your classroom, under conditions approximating their natural habitat, will give students the opportunity of studying them at close range and in detail. However, the main problem with an aquarium is to see that it is balanced. This means that the animals, which give off carbon dioxide into the water, must be balanced with the plant life, which produce the oxygen in the tank for the animals to survive.

Before your trip to an actual pond, there are several things that must be done to the aquarium in order for it to be ready for the specimen that your class collects. The aquarium should be washed out thoroughly with clean, clear water. The gravel should be rinsed several times with clear water in a colander, this is to assure that the small rocks are free of any debris. If you choose to use the underwater filtration system (highly recommended), this should be rinsed and place in the bottom of the cleaned aquarium. Then the tubing should be placed in the aquarium along with the diffuser or airstone. Place the aquarium where you plan to keep it upon your return from the pond because once the water is added it will be too heavy to move. Direct sunlight is not necessary for the aquarium; the light from a north window is ideal. If the aquarium water becomes green from algae growth, cut down on the amount of light entering the aquarium by masking the sides towards the window with paper or paint. Since ponds are relatively cool anyway, a minimal amount of sunlight is needed. Now you are ready to take your trip to the pond. (See lesson plans at the end of the unit titled—"Visiting A Pond Community"—for preparatory notes for the trip.

Once you return to your classroom with the specimen collected from the pond, there are several steps that you should follow in placing the specimen in the aquarium. Fill about two-thirds of the aquarium with the pond water you collected. Then place the plants in the water. If some of the plants collected contain roots, advise the students to make sure they place the roots under the gravel. Other plants can be allowed to float or can be anchored underneath a rock. If the pond you visited was too deep for the children to get to the underwater plants, they can be purchased from a pet shop. Some of the possible plants that you can purchase to put in your pond aquarium are—Cabomba, Vallisneria, Anacharis, Nitella, Lemna, or Elodea.

The animals that your class collected should be added to the aquarium next. Some of the animal life collected should include-pond snails, crayfish, newts, tadpoles, water insects. Small fishes should also be included, but you must be careful not to overcrowd the fish. One inch of fish (not including the tail) per gallon of water is a good rule to follow. If the students collected some of the smaller animals such as daphnias or water fleas, they should be added to the tank also because they provide food for the larger animals. As the tadpoles develop into frogs, make sure they have some type of floating platform in the aquarium so that they may come out of the water. Once the tadpole has become a frog you may want to let it go, or place it into a second aquarium.

In the introductory notes, I suggested setting up two aquariums because if your class collects turtles, frogs or

salamanders because they should not be totally submerged underwater. If reptiles are collected, your class should set up the second aquarium like a terrarium. Make sure that there is a small area set aside in the aquarium like a pond so that the reptiles can keep their body moist. Rocks should be used to provide an area assimilating land for the animals. Also make sure that there is a variety of plant life in the terrarium for the animals as to provide some type of shelter or privacy for the reptiles.

Plant-eating animals (herbivores) such as fish, snails and tadpoles will nibble on the plants growing in the tank, but you may add a few pieces of spinach or lettuce to supplement their diets. Animal-eaters can feed on daphnias, small worms and insects, or in the case of fishes, prepared fish foods purchased from a pet shop.

VI. Listing Factors That Exist In the Pond Habitat

In order for an organism to live in any given habitat, it must have the necessary materials that it needs for growth and reproduction. Anything that is essential for an organism's survival, and for which there is competition, is called a limiting factor. A deficiency or an over-abundance of any kind can limit the survival of an organisms in a particular habitat. For example, cattails growing along the shore of a lake requires a marshy condition where the water is not too deep. In a pond where the bottom is soft and the water is shallow, cattails cannot survive. However, they can survive at the pond's edge.

Some limiting factors have to do with living things. These limiting factors are called biotic factors. Food is a good example of biotic factors because animals can live only where the kinds of food they eat are available. If limiting factors have to do with nonliving things such as air, temperature, sunlight and water, it is called an abiotic factor. At this time we will examine several biotic and abiotic limiting factors and discuss their affect on the habitats of plants and animals that exist within the pond ecosystem.

A. Temperature

Most aquatic organisms have a narrow tolerance to change in temperature and therefore cannot live where drastic temperature changes occur. However some animals are equipped with special mechanisms that helps them to adjust to temperature change. A primary example being cold blooded animals because they can adjust by temporarily reducing their metabolism which results in a suspended state of animation. Once normal temperatures reoccur the animal returns to its normal activity.

Some plants and animals adjust by developing special hibernation phases or forms. Some aquatic plants produce winter buds which breaks off and drop to the bottom of ponds. These winter buds realistically are terminal shoots in which leaves are very close together which acts as a stored food supply. Among animals, various devices are common in order for them to survive the wintry cold waters. Some examples include: winter eggs of certain microscopic animals such as rotifers, cladocerans and rhabdocoels and the cysts of many protists, copeds and annelids.

Other animals may adapt by moving into a different environment. Fishes and snails move away from the from the shore into the deeper water. Most insects go to the bottom of the pond and burrow into the substratum to hibernate. Reptiles and amphibians do the same, but some dig holes in the mud, trash and debris. The majority of freshwater fishes and some amphibians, can withstand fluctuations in temperature and survive temperatures well below freezing in winter and fairly high temperatures in the summer.

B. Light

The amounts of light that is able to penetrate water is restricted by the amount of suspended material in the water and the color of the water. Light is essential to all green plants in order for them to make food. Likewise, green plants and their stored energy are needed by animals in order to survive.

Excessive algae growth and turbid waters can have a devastating affect on a pond because it hinders the amount of light that can pass through the water. Since the green plants can not receive the necessary amount of sunlight, they will die off, thus causing a decrease of available oxygen and food in the water which will kill animal life in the water.

C. Carbon Dioxide

Most of the carbon dioxide in water comes from the decay of organic materials and from respiration that occurs in both plants and animals. Carbon dioxide is also supplied to ponds dissolved in groundwater and rain. The amount of dissolved carbon dioxide is usually higher at the bottom of ponds. Carbon dioxide is used by plants during photosynthesis. Photosynthesis is the process in which organisms containing chlorophyll are able to use the energy from the sunlight to unite carbon dioxide and water to form the sugar glucose, and other compounds that derived from it, and a source of energy. In doing this they use oxygen and release carbon dioxide in respiration. It is the source of carbon found in proteins, fats, and carbohydrates, the basic food substances of animals.

Carbon dioxide plays an important role in determining the pH, the degree of alkalininty or acidity, of water. It combines with water forming weak carbonic acid which reacts with limestone or dissolved lime to form carbonates and bicarbonates. These compounds serve as buffers that regulate pH. The pH of water often determines what types of aquatic life are found in ponds.

D. Oxygen

There are two ways in which oxygen enters the water. One method is through photosynthesis of green plants in the water. The second method is by diffusion of oxygen from the atmosphere. The amount of oxygen that the waters retain is dependent upon the temperature, pressure, decomposition and pollution. Clean shallow surface water averages an oxygen content of five to ten cubic centimeters per liter. Cold water will hold more oxygen than warm water; rapid moving waters contain more oxygen than stagnant waters. Water containing decaying organic matter will show a drop in oxygen content because the aerobic bacteria involved in decomposition uses the oxygen.

As the sunlight penetrates the water during the daylight, plants give off oxygen as a by-product of photosynthesis more rapidly than it is used in respiration by living things. Therefore there is a reserve of oxygen built up. At night when photosynthesis ceases, both plants and animals use the reserved oxygen. The oxygen content in ponds fluctuates greatly within a twenty-four hour period. If the oxygen content of water is suddenly reduced, fish will tend to come to the surface in order to gulp air.

E. Nutritional Relationships

Most of the biotic limiting factors involve food. The autotrophs require inorganic nutrients from the environment to synthesis organic compounds. These autotrophs are called food producers. There are three different types of food producers found in the pond: (l) the emergent, rooted plants like water lilies, and cattails found near the shore; (2) the submerged plants like hornworts and eelgrass; and (3) the suspended

algae which form the phytoplankton. Microscopic examination of a few drops of pond water usually reveals hundreds of one-celled algae.

Phytoplankton may increase so much that lake water turns to a dark green color. Small crustaceans such as ostracods and copepods feed well on the algae blooms. Since these animals feed on plants, they are called herbivores and are first food consumers of an ecosystem. The energy synthesized and stored by phytoplankton is transferred to the protoplasm of the herbivores. The carnivores, flesh-eating animals are divided into two groups: (l) the first-level carnivores, which eat and use the energy of the herbivores; and (2) the second-level carnivores, which prey on the first-level carnivores

The scavengers feed on dead organisms. They are important in the cycling of chemicals and the transfer of energy to the animals in the ecosystem that feed on them. Crayfish, some snails and fish are some examples of scavengers. The bacteria and yeast are representatives of decomposers in the pond. They break the excretions and tissues of organisms into simpler substances through the process of decay.

Other bacteria present in the mud bottom of the pond and in the soil convert the simpler substances left by the decomposers in to nitrogen compounds, which are used by plants. The bacteria that do this are called transformers. Both decomposers and transformers return nitrogen, phosphates, and other substances to the soil or water so that the plants can begin the cycle again. Matter would not be available for recycling, or reuse, in an ecosystem if decomposers did not exist.

F. Pollution

Small amounts of organic pollution may increase the fertility of a body of water if it can be decomposed without seriously reducing the oxygen content. However, if the oxygen content is seriously reduced, anaerobic decomposition will be initiated and undesirable gases will form. Even though ponds may be able to survive some forms of organic pollutions, it is practically impossible for a pond to survive inorganic pollutants such as those from chemical, radioactive wastes, etc... because of their potency.

Sticklebacks, carps, eels, stoneworts and duckweed can survive in polluted waters. Other animals show a wide range of tolerance to organic pollution. Most animals that can survive in highly polluted waters have a high tolerance level in the presence of waters with a reduced oxygen supply. Many of the protists can live in these type of conditions. Many of the bivalves and snails have a high tolerance level for pollution. However, the absence of these and other mollusks from ponds is often a warning of pollution.

People are often misled when they use certain physical conditions of ponds as indicators for pollution. Foamy area in ponds, fluorescence or distinctive odors may be good evidence that a pond may be polluted. However, foam may be due to certain harmless inorganic salts or some species of phytoplankton; the odors and fluorescence may be due to the presence of certain protozoans.

LESSON PLAN I: THE SCIENTIFIC METHOD

OBJECTIVES The student will:

(1) List the five steps of the scientific method.
(2) Perform an experiment incorporating each of the steps of the scientific method.
(3) Write a scientific report of the following experiment.
(4) Use a thermometer to record temperature.

BACKGROUND INFORMATION

In order for the student to fully understand how to use the scientific method when writing reports, I feel that they should be walked through an experiment to be performed during class. Therefore, the class will test how temperature affects the respiration rate of fish. If the reader follows the procedure listed below, this simple lesson should get your students excited and should set the pace for the remainder of this unit. Fish can be brought from any pet store at a relatively inexpensive price. Glass jars can be used for this experiment, and the children can take the fish home at the end of the experiment.

As the temperature of the water increases, so will the respiration rate of the fish. The respiration rate is check by counting the movement of the fish's gills for a certain amount of time (one minute intervals).

PROCEDURES

(1) Have the students list the steps of the scientific method orally as you write them on the board in the following format:

Title for the experiment

I. Introduction
II. Hypothesis
III. Procedure
    (A) Materials Used:
    (B) Procedure
IV. Observations
V. Conclusion

(2) Tell the students that they will perform an experiment to see if temperature affects the respiration rate of fish. Then ask the students for a possible title for the experiment. Write the best response on the board.
(3) Moving to the actual first step, give the students a library assignment, or duplicate the information for the children to speed up the process, and have the children read about how temperature affects the fish respiration rate. Then have them write a paragraph about fish and respiration rate. Explain to them that this is how the introductory part of any experiment is done.
(4) Have the students give you several hypothesis about the outcome of the experiment, and list them on the board.

(5) Explain to the students that the next step of the scientific method called the procedure requires them to list the materials used and the steps that they followed to complete the experiment.
(6) Since you have already explained the experiment to the students, place the letter “A” just like above on the board and write materials used. Have the students list all the materials they would need to use in order to successfully complete the experiment. Then have them list the procedures that they would follow in order to test their hypothesis. NOTE: let the students suggest ways to heat the water without harming the fish. Then have them to suggest ways to cool the water. The best possible solution is to place the individual jars with fish in them in the window to capture sunlight in order to warm the water, and to place ice cubes in the water order to cool the water.
(7) Inform the students that they are moving to the next step of the scientific method which requires them to record their observations. Then have them make a chart labeled temperature in one column, respiration rate in the next column, and behavior in the next. (Let the student know that it is best to use a chart or graph to record their observation whenever possible.) The chart should be as follows:
TEMPERATURE RESPIRATION RATE BEHAVIOR OF FISH
(8) As the students record the temperature and respiration rate on the chart, instruct them to record how the fish reacts to its environment as the temperature becomes colder.
(9) Have the student record about five to ten different temperatures. Allow the water to fall between three to five degrees between each reading.
(10) After the students complete the experiment, allow them to make several conclusions orally. Then let them know that they have just completed a scientific experiment.
(11) Instruct the students to write up a final draft of the experiment using the format in step one of the above for homework.
(12) You can also instruct the students to make an attractive title page for their experiment, which most students take pride in doing. Display the better experimental reports on a bulletin board.

EVALUATION The students final written report should be used as a evaluative tool. If the students placed the correct information in each section, you should conclude that they have a good understanding of the scientific method. NOTE: some students may have problems reaching an adequate conclusion. If so you may want to make up some charts or tables, and have students interpret the information being presented.

LESSON PLAN II: VISITING POND COMMUNITY

OBJECTIVES The student will:

(1) Collect a variety of living things found in and around the pond.
(2) Using textbook and field manuals, identify the animal and plant life discovered at the pond.
(3) With the assistance of the instructor, set up an aquarium in the classroom in order to observe a pond community in captivity.
(4) Keep a journal noting any changes that occurs in the aquarium.

BACKGROUND INFORMATION

A wide variety of pond animals can be maintained in captivity with a minimum amount of care and equipment. Keeping samples of plants and animals collected from a pond community in the classroom, under conditions approximating their habitat, will give students the opportunity of studying them at close range and in detail. Given adequate care and feeding, many of the animals collected will carry out their complete life cycles in captivity.

All the information needed to set up the aquarium can be found in the sectioned titled, “Constructing A Pond Community”.

PROCEDURES

(1) Find a pond located near your school. If a pond is not within walking distance arrange a bus to take you to a nearby pond. Some parks have park rangers working in them. Most of the time they will be happy to assist you if you contact them in advance.
(2) Tell your student to bring jars, gallon jugs, small plastic bags, etc... Let your students know that they will be going on a field trip to a pond so that they will dress appropriately.
(3) Set up the aquarium in class as mentioned previously. Bring back enough water from the pond to fill the aquarium.
(4) Have the students collect a variety of plants and animals from the pond’s edge.
(5) Upon your return to school, place the water and living organisms in the aquarium.

(6) Instruct students on how to keep a journal of observations made after viewing the aquarium each day.
(7) Also have students use field guides to identify as many of the plants and animals as possible.

LESSON PLAN III: Food Webs In The Pond Community

OBJECTIVES The student will:

(1) Explain that a community is a large group of diverse organisms that live together in an orderly interrelated fashion.
(2) Differentiate between food chains, pyramids and webs.
(3) Design a typical food web that could exist within a pond community using magazine pictures, or figures that they draw themselves.

BACKGROUND INFORMATION

The community of plants and animals that live in a pond make up a network of interconnected food chains called food webs. All of the food in the web eventually comes from photosynthesis of green plants using sunlight, water, carbon dioxide. Use the diagram at the end of this unit titled, “Food Web In A Freshwater Pond” as an example to show students what their food web should look like.

PROCEDURES

(1) Write the terms and definition for the following words on the board: (a) community (b) food chain, (c) food pyramid; and (d) food web.
(2) Have the student define the term community. Then have them to describe what a pond community would look like.
(3) Have the students explain the differences and similarities between the three concepts.
(4) Have the students orally state some examples of typical food chains that may occur in a pond community.
(5) Give each student a duplicate copy of handout, “Food Web In A Freshwater Pond” and have them add onto their previously mentioned responses.
(6) As a small scaled science project, have the students collect or draw pictures of a pond community on a poster board. You may want to give the students a few days to complete the assignment.

EVALUATION
The students finished project should be used as an evaluative tool. If the students food chain was done correctly, then they should have grasped the concepts of webbing.

LESSON PLAN IV: Exploring The Microscopic Pond World

OBJECTIVES The students will:

(1) Prepare a wet mount slide from a drop of pond water.
(2) Draw and identify any animals seen underneath the microscope.

BACKGROUND INFORMATION
A microscope will literally open up an entire new world for your students when exploring a pond. Each time a child place a drop of pond water on a slide and bring it into focus they venture into an world unknown to them. The movement and the animals themselves are amazing. NOTE: you may need to review the parts of the microscope and remind the children how to handle the microscope.

PROCEDURE:

(1) The teacher may want to collect water from a pond for this experiment or the water from their aquarium may be used. However, if you collect new pond water near an algae bloom the variety of microscopic life will be numerous.
(2) Review with the students how to properly prepare a wet mount slide.
(3) Have the students take a sample of pond water from the sample that you have prepared.
(4) Tell the students to draw the animals that they see in the microscope.
(5) Have the students look through library books, and identify the animals that they drew.

SPECIAL NOTE: The Regional Water Center will perform this activity with your students in their laboratory.

LESSON PLAN V: Science Projects

OBJECTIVE The students will either

(1) Design and implement an experiment relating to pond ecology.
(2) Design a poster relating to pond ecology.
(3) Write a research paper relating to pond ecology.

BACKGROUND INFORMATION

This science project can be used as an evaluative tool at the end of the unit. Students will turn in a science project using any one of the previously mentioned projects. As the teacher, you have the choice of letting students work in groups or individually on their science projects. I allow students to design experiments together, especially if they are using live animals. However, research papers and posters are to be done individually.

Notice how I give students the choice of doing an experiment, designing a poster or writing a research paper. This allow students to work from their strongest standpoint. Of course some students draw better than others, some perform scientific investigations better than other and some students enjoy writing. Giving students a choice usually motivate them to turn in award winning projects.

PROCEDURES

(1) Explain to the students that they will be doing a science project. Let them know that they have a choice of doing an experiment, designing a poster, or writing a research paper.
(2) Give the students a list of possible topics. Also brain storm with the class about other possible topics. Let the students know that the topic that they choose must be approved by the instructor.
(3) Place the following list of possible topics on the board, along with any others the students suggest:

Experiments

(1) What would happen if you place five fish, three snails, and four plants in a gallon jar? Explain what happened and why?
(2) How would a drop of gasoline or oil affect an ecosystem in a jar?
(3) What would happen if you placed three to five snails in a jar? Why did this occur?
(4) Make a terrarium using reptiles, plants, etc... Explain why this represents an ecosystem.
(5) Get samples of two different forms of pond water, draw and identify the microscopic life found? Do all ponds have the same kind of pond life?
(6) How long does it takes for a tadpole to turn into a frog?
(7) Can a fish survive frigid water temperatures?
(8) How can too much light or any other limiting factor discussed in class affect a pond community?

POSTERS

(1) Food chains in a pond
(2) Ecological succession in a pond community
(3) How an aquarium works
(4) The life cycle of a frog
(5)The hydrologic cycle
(6) Different types of plants found in the pond community
(7) Food pyramids within the pond community
(8) The ecological makeup of pond

RESEARCH PAPER TOPICS

(1) What is a pond?
(2) Different types of ponds
(3) Limiting factors in a pond community
(4) Food webs that exist within a pond community
(5) Ecological succession of a pond
(6) Different habitats found in the pond community
(7) The ecological makeup of a pond

STUDENT'S BIBLIOGRAPHY PAGE

Corelombe, DeBorah, "The Seaside Naturalist: Guide To Nature Study and The Seashore," 1984.

This book illustrates and discusses a variety of plant and animal life found in both fresh and salt water environments. This can be an excellent tool in helping students to identify plants and animals found during their pond visit.

Kane, Henry B., "The Tale of A Pond," 1960.

The author tells tales of pond life in a story telling format. An excellent intergration of reading and language arts into the science curriculum.

Reid, George K., PhD. "Pond Life," 1990.

A guide to common plants and animals that dwell in the ponds and lakes of North America. This is an excellent book to help students identify any specimen found during a pond survey.

Simon, Seymour, "Science Projects In Ecology," 1972.

This book contains ecological science projects in several habitats. It has several interesting projects related to the pond community.

Spurgeon, Richard. "Ecology: A Practical Introduction With Projects and Activities," 1988.

This is a very informative book which explains all the concepts and issues covered in the study of ecology. The book is packed with practical and livey activities, it investigates both the science of ecology and many of the world's most pressing environmental problems.

TEACHER'S BIBLIOGRAPHY PAGE

Amos, William H., "The Life of the Pond," 1967.

This book discusses the pond from a holistic standpoint It is an excellent source for teaching this unit. The author discusses the origin and characteristics of ponds. He illustrates and discusses the many life forms that exist within the pond community.

Brown, Vinson, "The Amateur Naturalist's Handbook," 1980.

This book is written specifically for the amateur naturalist. This book has a varlety of scientific activities and field studies for the naturalist ranging from botany to zoology. It also contains a section on ecology where it explores and observes the dynamic interaction among various types of ecosystems.

Botkin, Daniel B., and Keller, Edward A., "Environmental Studies: The Earth as a Living Planet," 1982.

This book introduces the fundamental principles of environmental studies, discusses the Earth's major resources, and examines the relationship of people in the environment.

Favre', Henri, "Larousse Dictionary of the Freshwater Aquarium," 1977.

This book is a comprehensive survey of plants, fishes and the equipment that is used in the aquarium. It explains in detail what type fish or plants you may place in the aquarium. It can also be used to identify specific plants and animals that you may find in a pond community.

Klots, Elsie B., “The New Field Book of Freshwater Life,” 1966.

This book discusses a variety of aquatic communities and characteristics that give them individuality. It describes and illustrates the many different group of animal, including microscopic organisms, that can be formed in the freshwater environment.

Maryland, Hans J., “The Complete Home Aquarium,” 1976.

This book is filled with beautiful illustrations of aquatic fish and plants that can be housed in an aquarium. It contains the necessary details for starting up a aquarium, and provides explanations of each piece of equipment used in setting up the aquarium.

Mills, Dick, “A Fishkeeper’s Guide to Community Fishes,” 1969.

This book is a necessity for starting up a successful fish tank. It has an illustrated guide of 60 fish that can be found in fresh water environments. The book also discusses the science of successful fish breeding.

Thompson, Gerald; Coldrey, Jennifer; and Bernard, George, “The Pond,” 1984.

This book discusses the pond from a holistic standpoint. The authors discuss the origin and characteristics of ponds. They discuss and illustrate the many lifeforms that exist within the pond. It is an excellent source to use for teaching this unit.

POSSIBLE FIELD TRIPS

Schooners, Inc. located in New Haven on 60 South Water Street can be one of your most useful resources because they will come to your class and bring animal life from Long Island Sound if you feel that your class cannot visit a community pond. If you have an aquarium set up in your class, they will also allow you to keep the animals. Contact Kristen Conway at 865-1737.

The Whitney Water Center is located in Hamden, Ct. on 945 Whitney Avenue. The center has a laboratory and will do hands-on scientific activities with the children using microscopes. This is an excellent opportunity for students to view the microscopic life forms in the freshwater habitat if you do not have microscopes in your school. Contact Kathy Granfield at 777-1142 for scheduling information.

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