Aquatic Science

For Students in Grades 7 through 8
Recommended April through October

A 45-minute program designed to help students learn about the diverse life found in local ponds. This program involves the students working cooperatively in discovery groups and allows them to investigate living organisms at their desks as a scientific team.

Goal

Bring pond life into your classroom. Many students are familiar with the larger animals that live in our ponds and streams, such as fish, turtles, geese and frogs; but often are unfamiliar with the smaller life forms. By bringing pond organisms into the class, you will introduce your students to these small animals, scientific methods, and cooperative learning. You will introduce stewardship concepts to the students, including non-point source pollution, bioaccumulation and conservation of natural resources.

NYS Intermediate Level Science Core Curriculum
Standard 1: *Scientific Inquiry*
Key Idea 1: The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Standard 4: *The Living Environment*
Key Idea 4: The continuity of life is sustained through reproduction and development.
Key Idea 5: Organisms maintain a dynamic equilibrium that sustains life.
Key Idea 6: Plants and animals depend on each other and their physical environment.

Process Skills:
General Skills 6: Use a dichotomous key
Living Environment Skills 7: Interpret and/or illustrate the energy flow in a food chain, energy pyramid, or food web.

Materials

Dip nets, Petri dishes, plastic spoons, hand lenses, plastic pipettes, pond invertebrate guides, worksheets, pond water, live pond invertebrates, low flat basin, pencils (colored pencils optional), chalkboard or whiteboard

Vocabulary

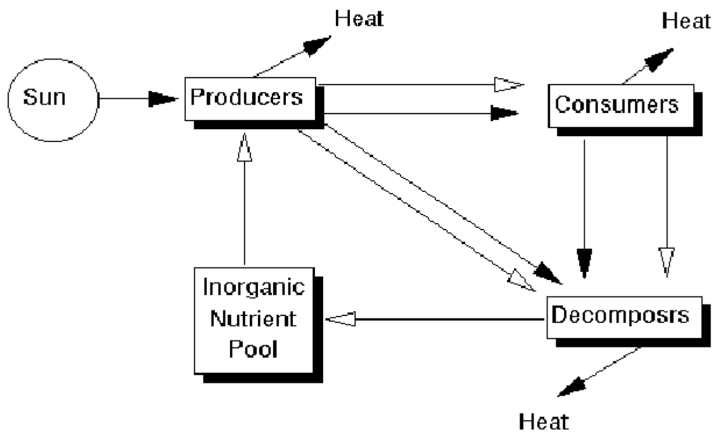
Bioaccumulation	The increase in concentration of a pollutant from the environment to the first organism in a food chain
Biomagnification	The increase in concentration of a pollutant from one link in a food chain to another
Consumer	An organism that cannot make its own energy and needs to eat other organisms
Decomposer	An organism that helps breakdown and decay dead organisms and waste products, returning nutrients to the water or the soil
Producer	An organism that uses energy from the sun, water and carbon dioxide to produce its own food through the process of photosynthesis
Ecology	The study of living and non-living things in a given community
Habitat	The physical and biological surroundings needed for survival, which include food, shelter, water, and space.
Niche	The role an animal plays in its ecosystem
Limiting Factor	Any non-living thing that limits populations because too much or too little of it is present; such as water, temperature, light or nutrients
Population	A population is a group of interbreeding organisms living in the same place and same time
Community	A community is made up of populations that depend on one another living in the same area or habitat
Photosynthesis	A chemical process plants use to convert solar energy, water and carbon dioxide into chemical energy
Scavenger	An organism that consumes dead organisms

Background

Long Island encompasses a large variety of important ecosystems. Freshwater wetlands are abundant in many areas in our local environment and provide a multitude of communities with wetland habitats nearby. Long Island has four major rivers, and many smaller streams and creeks. There are countless small ponds, both natural and man-made. Many bodies of water have outlets that join salt water, creating salt marshes and estuaries on most of Long Island's shores. These bodies of water hold an immense number and variety of living things.

Wetlands support a vast diversity of species. These habitats can be used as great examples of food webs and biological interdependence. Many local large species are at or near the top of the food chain, and the success of smaller prey organisms effect the success of larger ones, and often vice versa. If, for example, dragonflies disappear from a water body because of contamination, a population surge in mosquitoes and biting midges may be a consequence because both species are food for predatory dragonflies. If homes are provided to encourage bat colonies, the density of mosquitoes and moths will be reduced due to the presence of a new predator.

Energy Flow through the Ecosystem



Producers are living organisms that make sugars from solar energy through the process of photosynthesis. The producers are fed upon by herbivores through complete consumption or grazing. Carnivores eat the herbivores. Both herbivores and carnivores are considered "consumers." All trophic levels (producers, herbivores, carnivores) decompose when they die. The remains of their bodies are fed upon by decomposers. This process returns nutrients to the system which in turn is used by producers to continue the cycle.

In a wetland, producers are particularly abundant. There are emergent plants, aquatic plants, plankton and many plants that grow by the edges of the water. Herbivores include a vast array of invertebrates, fish, snails, tadpoles, birds, and mammals. Carnivores include fish, beetles, dragonflies, other insects, turtles, frogs, birds, and mammals. Decomposers include bacteria, worms, fungi, snails and scavengers.

Pollution in the Wetland

Litter is an obvious form of pollution and generally has negative effects on both the health of the ecosystem and the aesthetics of the scenery. Most litter gets into waterways through carelessness, and a large portion of plastic and other floatable trash can find their way into ponds and streams through storm water runoff. During heavy rains litter on land may wash down storm drains and streets and can enter the natural water systems.

Chemical pollution is harder to spot, and often more dangerous to organisms in wetlands. Lawn pesticides and fertilizers entering natural water communities through storm water can seriously affect bodies of water and wetland life, killing off portions of the food chain or causing algal blooms that can suffocate other organisms. Motor oil can seal the oxygen out of the water, and coat the feathers of water birds, hampering their ability to swim, fly, and regulate their body temperature. Other chemicals alter the pH of the water, making the stream or pond too acidic for life to persist.

Bioaccumulation and Biomagnification

This section of background borrowed from www.marietta.edu ecology lesson plans

Many types of chemicals stay in the environment for many years after they are introduced. Chemicals like mercury, dioxins or PCBs can settle into sediments or be taken up by animals (bioaccumulation) and cause problems for years. Some of these chemicals get concentrated as they enter the food chain (biomagnification), and effect top predators disproportionately.

Classic example: DDT

DDT stands for *d*ichloro-*d*iphenyl *t*richloroethane. It is a chlorinated hydrocarbon, a class of chemicals which often fit the characteristics necessary for biomagnification. DDT has a half-life of 15 years, which means if you use 100 kg (about 220 lbs) of DDT it will break down as shown in the table below:

Year	Amount Remaining
0	100 kg
15	50 kg
30	25 kg
45	12.5 kg
60	6.25 kg
75	3.13 kg
90	1.56 kg
105	0.78 kg
120	0.39 kg

This means that after 100 years, there will still be over a pound of DDT in the environment. If it does bioaccumulate and biomagnify, much of the DDT will be in the bodies of organisms. DDT actually has rather low toxicity to humans (but high toxicity to insects, hence its use as an insecticide). Because it could be safely handled by humans, it was extensively used shortly after its discovery just before WWII. During the war, it was used to reduce mosquito populations and thus control malaria in areas where US troops were fighting (particularly in the tropics). It was also used in civilian populations in Europe, to prevent the spread of lice and the diseases they carried. Refugee populations and those living in destroyed cities would have otherwise faced epidemics of louse-born diseases. After the war, DDT became popular not only to protect humans from insect-borne diseases, but to protect crops as well. As the first of the modern pesticides, it was overused, and soon led to the discovery of the phenomena of insect resistance to pesticides, bioaccumulation, and biomagnification.

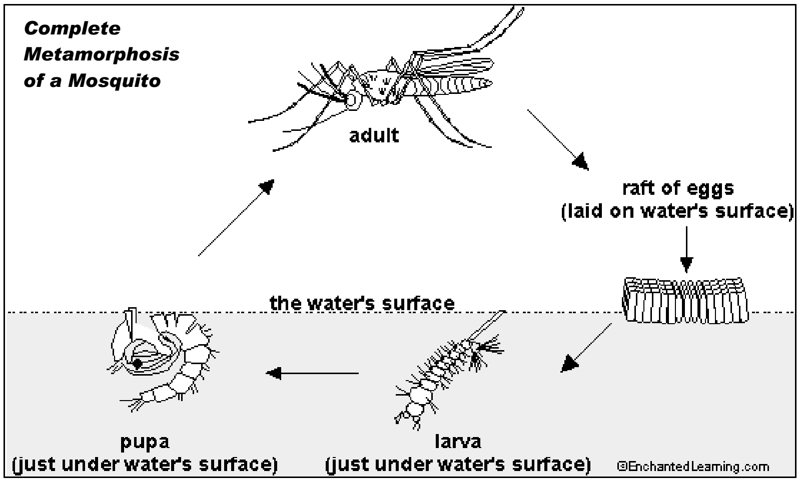
While DDT isn't particularly lethal (except to insects, and we need many of them around), it has a number of sub-lethal effects. Most prominent is the phenomenon of shell-thinning in birds, particularly carnivorous birds (raptors) - birds that eat other birds, birds that eat carrion (dead animals), and birds that eat fish. Ospreys are one of the raptors that have been adversely affected, as have bald eagles. Other fish-eating water birds have been affected as well. Because of the DDT, the shells are too thin to brood. Many populations have recovered following the banning of DDT in the US, but migratory birds may be exposed to pesticides in other countries. Recently, some studies have shown effects on sex ratios in some species of birds, with the males becoming "feminized," presumably the result of compounds in the environment mimicking the female hormone estrogen.

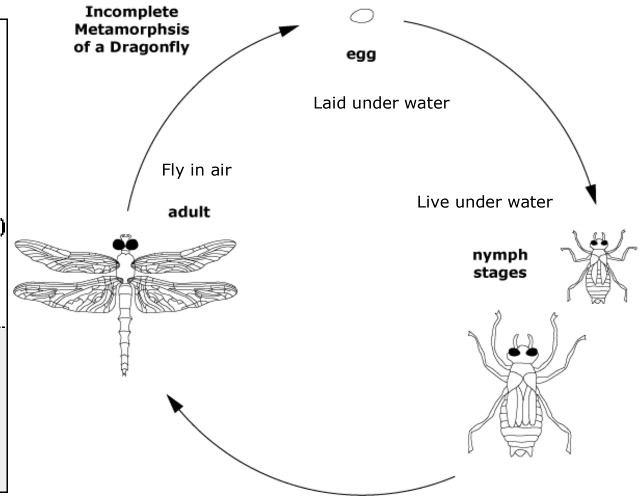
By the 1960s, global problems with DDT and other pesticides were becoming so pervasive that they began to attract much attention. Credit for sounding the warning about DDT and biomagnification usually goes to the scientist Rachel Carson, who wrote the influential book *Silent Spring* (1962). The “silent spring” alluded to in the title describes a world in which all the songbirds have been poisoned. Her book of course was attacked by many with vested interests.

Pond Food Webs

While herons and raccoons may get the most recognition in pond habitats, ponds are actually dominated by invertebrates. Some invertebrates like snails, flatworms, leeches and amphipods, live their entire lice cycle in pond waters. Many insects however, including beetles, dragonflies and mosquitoes, live in ponds for only part of their lives, and in the air and on land for other parts. Similarly, frogs, toads, salamanders and turtles may spend part of their lives in the pond habitat, and other parts on land or moving from habitat to habitat.

Many other animals visit ponds and other bodies of water occasionally. Raccoons, geese, and ducks are often associated with pond habitats, but have many other areas where they can be found. Deer will come to drink at ponds as well as feed on soft aquatic vegetation. People take the role of top predator in a food chain when they fish or hunt in aquatic habitats.





Basic Insect Life Cycles

There is a huge variety of invertebrates in wetland habitats. There are copepods, amphipods, snails, flatworms and insects, just to name a few. They all have different survival strategies, and there are too many to explore here. It is important to understand the lives of insects in a wetland ecosystem because of their diversity, their role in the food chain, and their effect on humans.

Insects undergo metamorphosis. Some, like mosquitoes, undergo "complete metamorphosis," having four stages in a life cycle (egg, larva, pupa, and adult). Others, like dragonflies, undergo "incomplete metamorphosis." This means they have only three life cycle stages (there is no pupa- the larval stage, often called a nymph, changes directly to an adult).

Because the insects change form throughout their lives, they can move through the environment more readily than other invertebrates. Beetles, mosquitoes, dragonflies and many other insects can fly from pond to pond, and rapidly spread their populations. This also allows them to utilize temporary bodies of water, such as large puddles, vernal pools and even swimming pool covers. These temporary water bodies have few predators which and can allow a large portion of eggs to develop into adults.

Conservation of Resources

Wetlands not only serve as an important resource for wildlife, but also for humans. A pond creates an oasis for forest creatures to find water to drink, a location for amphibians such as toads and salamanders to lay eggs, and a refuge for ducks, geese or other waterfowl to stop over on migration routes. Wetlands also act as a great buffer for people, capable of holding vast amounts of water during storms and floods. According to some historical records, salt marshes in the Northeast United States have declined in acreage over 50% since 1750.

The following is a table compiled by the New York State Department of Environmental Conservation. This is representative of some of the tidal wetlands of Long Island over time. This is not a complete survey of all tidal wetlands, of course, but is indicative of the trends in this area.

Acreages of North Shore Targeted Tidal Wetlands in Nassau and Suffolk Counties						
	Targeted Wetland	**1974 acreage**	**1990s acreage**	**Acres Lost**	**% Loss**	**Acres Lost/Year**
Manhasset Bay	Kings Point	2.3	0.48	1.82	79	0.091
	Plum Point	7.36	4.23	3.13	42.5	0.15
	Manor Haven	8.91	3.42	5.49	61	0.25
	South Manhasset Bay	5.34	1.28	4.06	76	0.2
Nissequogue River	Center Island and East Shore	61.14	54.18	6.96	11.4	0.278
Stony Brook Harbor	Young's Island	70.58	29.96	40.62	57.5	1.62
Flax Pond	Entire Pond	73	58	15	20.5	0.75
Mount Sinai Harbor	Center Marsh Islands	95.32	48.65	46.67	48.96	1.86
Total Acres Lost		323.95	200.20	123.75	38.2	

Classroom Program

Introduction

What makes a pond a pond? Discuss the places where wetlands occur, asking the students if they have ever visited a pond, and what they observed there. Introduce the topics of life cycles and metamorphosis, comparing the life cycle of a frog to the life cycle of a dragonfly or mosquito.

Explain to the students that they will be participating in a science investigation and each student will be assigned a specific task.

Divide the class into teams of three. Each of the students has a vital role to play in this research:
Reader: This student scientist will read each question to the group, as well as any guides or scientific keys used.
Recorder: This student scientist will write down the answers that the group comes to a consensus on for each question on the worksheet.
Artist: This student scientist will sketch the organism, and draw any other features or illustrations needed.

Procedure

1) Introduce students to the equipment that they will be using. This will consist of a Petri dish lid or base (to hold the organism being studied), a plastic spoon (to collect larger organisms from the water), a pipette (to collect smaller organisms from the water) and a hand lens. Each team of researchers will have one of each item.

2) Select one student from each group (usually the artist) to collect the organism from the pond water basin. Demonstrate the proper technique to catch and not hurt the animals. Explain that though the organisms are small, they are still living specimens and should be respected. There are many species of invertebrates possible, but the point of the exercise at this moment is to observe characteristics and behaviors, not identify and name the organism. Once an animal is caught in the Petri dish basin, the students can begin their research. The collector will carefully carry the Petri dish with the organism back to the other students in the study area.

3) The recorder and the reader should sit adjacent to one another. The animal in the basin should be available for all of the students to make observations by sharing the hand lens. If the desks are dark, placing white paper under the dish will help the students to see small details. The reader will read each question to the group, the group can then observe and discuss possible solutions, and the recorder will transcribe the answer the group settles on.

4) When all of the questions are answered, the artist should render a sketch of the organism. The picture should be much larger than the organism and as detailed as possible. All of the students can make suggestions to the artist. The style of the sketch is entirely up to the artist.

5) The final task is to identify the organism. Older students can use a scientific dichotomous key to "key out" the animal. Younger students (or if pressed for time) can match their artist's drawing to the scientific illustrations.

6) Once the identification is confirmed, animals can be returned to the carrying bin.

Extensions:

- Students can use the library or internet to research other organisms or larger animals that live in or around ponds. The research team can create a food web or food chain that includes the organism they've studied; tying in foods that it eats and predators that feed on it. For example, if the students studied a damselfly nymph, a food chain might include: pond plankton, water fleas, **damselfly nymph**, bluegill sunfish, painted turtle and raccoon.

- Students can tell or write a story, *A Day in the Life of a Pond Critter*, describing what they imagine living in a pond might be like from the perspective of a near microscopic organism.

- Students can identify ponds and streams near their homes or school.

- Many schools have courtyards or gardens. The students in your class can help maintain an existing school pond or research the possibilities of developing a school wetland. This would allow the school many years of research possibilities.

- If the school does have a pond, the students could survey the pond to identify the populations of organisms in it. The students can identify whether the pond is under stress by comparing the population abundance of different species.

Activity Extensions:

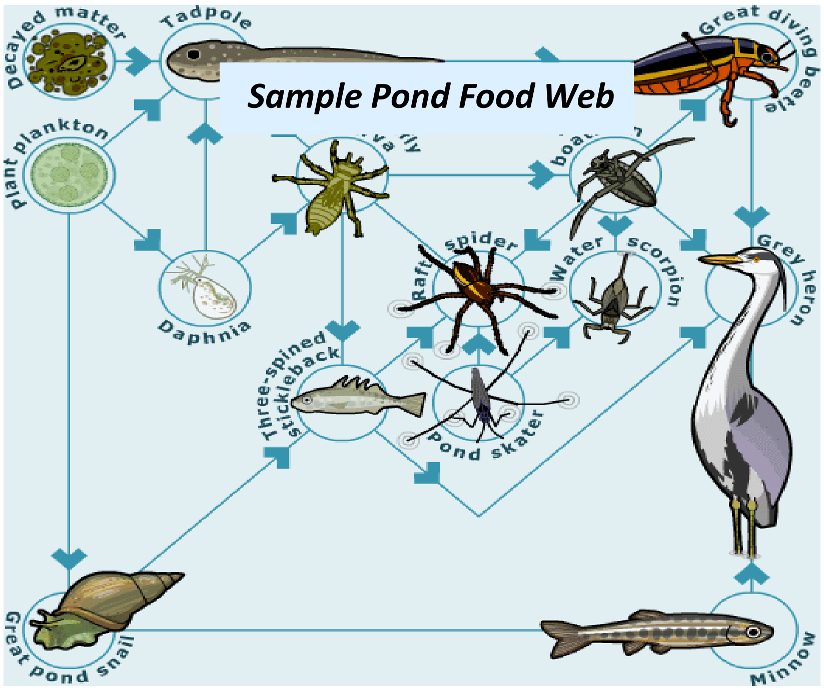
Project WET *Macroinvertebrate Mayhem*, lesson about the effects of environmental stresses on pond life
Project WET *A-maze-ing Water*, students create maze to identify ways to limit pollution runoff

Project WET *Life in the Fast Lane*, students use scavenger hunt to describe physical components of temporary wetlands

Project WILD *Quick Frozen Critters,* lesson illustrating the importance of adaptations in predator/prey relationships.

Project WET is one of the most widely-used water conservation and environmental education programs among educators of students in kindergarten through high school. It is based on the premise that young people and educators have a vital interest in learning about our natural world. A national network of Educators **and Agencies ensures that Project WET is available nationwide --training educators in the many facets of the program. Emphasizing water conservation because of its intrinsic value, Project WET addresses the need for human beings to develop as responsible stewards of our planet.**

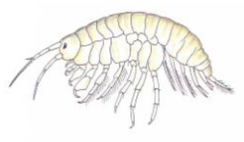
The NYSDEC Public Affairs and Education staff are available to teach Project WET workshops for educators. Please contact for a workshop at your school. Please call 518-402-8043 or via e-mail at projwet@gw.dec.state.ny.us**.**



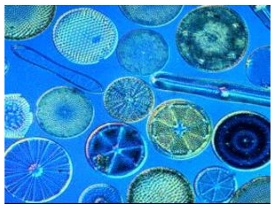
Sample Pond Food Web

Complete the food web below. **Draw arrows from the food to the animal that eats it**.
Use the information at the bottom to confirm the directions or arrows.

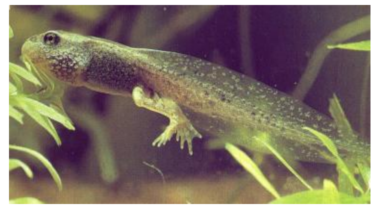
Decaying Plants



Amphipod

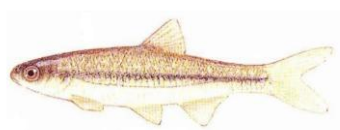


Phytoplankton

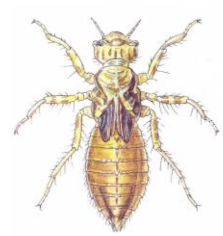


Tadpole

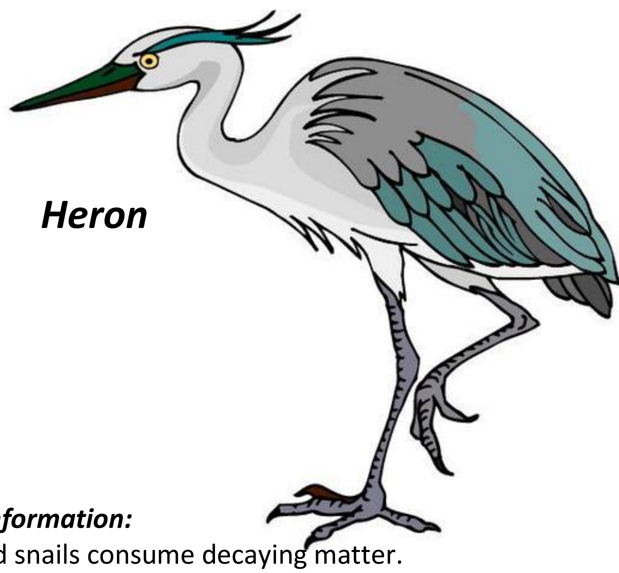
Snail



Minnow

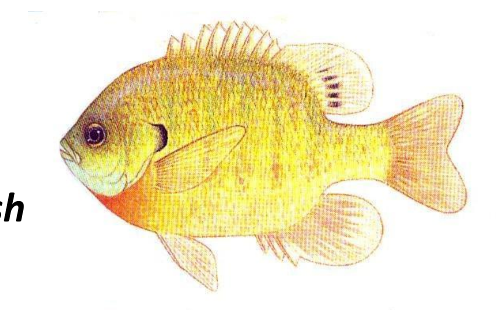


Dragonfly Nymph



Heron

Sunfish



Food Web Information:

Tadpoles and snails consume decaying matter.
Minnows consume all invertebrates.
Sunfish eat all of the animals smaller than them.
Herons eat all fish.
Phytoplankton is eaten by amphibians and amphipods.

Dragonfly nymphs must hide from sunfish.
Dragonfly nymphs eat amphipods.
Tadpoles are consumed by birds and large fish.
Amphipods, dragonflies and snails are invertebrates.