FOOD CHAIN GAME

Concepts

1. The sun is the source of all energy in the food chain.
2. A food chain represents the transfer of energy from producers to consumers.
3. All organisms in a food chain are interconnected: that is, they depend on each other for energy.
4. There are many more organisms at the bottom of the food chain than at the top.

Introduction

This is a tag game which illustrates how members of a food chain obtain energy. It is designed for grades 3 - 6. Students wear tags which identify them as Algae, Scuds, Sunfish or Bass. Depending on their tag, they must chase the organism below them on the food chain, while avoiding being caught by the organism at the next higher level. Energy is represented by peanuts, which are exchanged when an organism is tagged. The object of the game is for each individual to get as many peanuts as possible.

The student's section has instructions for making the tags students wear to identify them as specific organisms. The ratio of Algae: Scuds: Sunfish: Bass should be 6: 4: 2: 1.

Materials

- ☐ Peanuts, unshelled - 1 lb
- ☐ Posterboard - Four different colors
- ☐ String
- ☐ Scissors
- ☐ Markers or crayons

Site

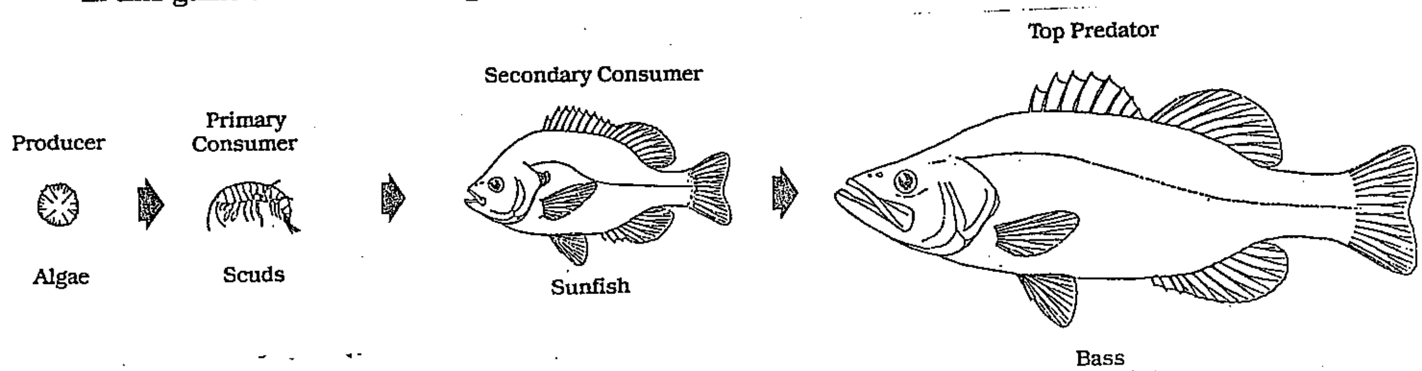
A large field, playground or gymnasium

Procedure

Explaining the Game:

Establish with students that the sun is the source of energy for all living things. Plants have the ability to convert sunlight into food which is available as energy for other organisms. Since we either eat plants or eat animals which eat plants, all our food comes indirectly from the sun. Ask students if they can think of any food which does not ultimately come from the sun.

In this game we will be looking at an aquatic food chain which looks like this:



The Food Chain

The "Sun" in this game will be played by a teacher with a bag of peanuts. He or she remains stationary, doling out peanuts to students with tags saying "Algae." Algae may go to the Sun at any time during the game and get four peanuts of energy. It is important to remember that only the Algae may receive energy directly from the Sun.

So what eats algae? Small crustaceans called amphipods or "Scuds" are one organism which feeds on algae. Students with tags saying "Scuds" may chase and tag Algae and receive two of their peanuts every time they tag one.

But what eats Scuds? Sunfish are one carnivore which eats Scuds. Students with tags saying "Sunfish" may chase and tag Scuds and get two of their peanuts every time they tag one. Sunfish may not tag Algae and neither Scuds nor Sunfish may go to the Sun for energy.

What might eat a Sunfish? Bass eat many fish, including Sunfish. In this food chain, Bass are the top predator. Students with tags saying "Bass" can chase and tag Sunfish and receive two peanuts. Bass, of course, may not go to the Sun, or chase Scuds or Algae.

Death

In real life fish like Bass and Sunfish have many predators, including humans, but in this game only "Death" can chase them. When Death catches these carnivores, they have to give up all their peanuts. Of course, death comes to plants and zooplankton too, but in this game Death should mostly chase the Bass because they don't have any other predators. Because Death is such an efficient hunter, there should be only one person playing Death, preferably an adult.

A variation which makes the game more fun for the Algae is to allow them to chase Death. They receive one peanut each time they catch Death. This represents the nutrients that plants get from decaying matter. It should be noted that these nutrients are not the same as the chemical energy flowing through the food web, although they do help the plant grow in much the same way that vitamins help us.

A Pyramid of Numbers

It is important to keep a 6:4:2:1 ratio between each group in this game. There have to be more Algae than Scuds, more Scuds than Sunfish and more Sunfish than Bass. If there were more Bass than Sunfish, for instance, the Bass wouldn't get enough peanuts and would starve. After you have played the game once, it might be interesting to play it again with equal numbers of each group and see what happens.

Playing the Game

Before handing out tags, ask the students to predict which group will have the most energy (peanuts) at the end of the game. Remind them not to eat the peanuts during the game, as you will need them to tally the numbers each group gets. Explain the rules and set boundaries before handing out tags. It saves time to hand out tags yourself, without letting students pick what they want to be. That way you can control the ratio of Algae: Scud: Sunfish: Bass.

After you have handed out tags, have the Algae go to the Sun to receive their first four peanuts. Remind them that they can return to the Sun at any time to get more peanuts. Scud, Sunfish and Bass wait until the Algae have their peanuts. Scuds enter the game next, then Sunfish and then Bass. Death enters last and collects all his or her victims' peanuts.

Whenever students are tagged, even by Death, they are not out of the game, only out of peanuts.

UNDERSTANDING FOOD WEBS

Concepts

1. We are all part of a food web.
2. Food energy comes from the sun.
3. All animals require energy to live.
4. Energy flow is one-way.
5. Energy is lost as it travels up the food chain.
6. There are many more organisms at the bottom of a food chain than at the top.

Vocabulary

producer
primary consumer
secondary consumer
predator
omnivore
habitat
ecosystem
herbivore

Introduction

The process by which organisms obtain energy is actually much more complex than the simple system depicted in the Food Chain Game. When we talk about food chains, we are referring to a one-to-one relationship in which an animal eats another organism, and is in turn eaten itself. The concept of a "web" better describes the more complicated relationships found in nature, in which animals usually eat a variety of plants and/or animals and are themselves eaten by several predators.

This lesson reinforces some of the ideas in the Food Chain Game and introduces new concepts about how a food web operates. The lesson is broken up into different sections, each of which introduces a specific concept. These activities can be done without first playing the game, but the concepts will be more meaningful to students who have actively participated in this food chain.

The lesson can be done in 20-30 minutes. The amount of class time it takes depends partly on how much time students spend on the drawing exercises. The students' questions are in boldface. Students may either write the answer or answer verbally. The last two pages are a worksheet called "Pathways of Energy." This lesson is designed for grades 3-6.

Materials

Each student should have:

- ☐ A copy of student "Understanding Food Webs" lesson
- ☐ A pencil
- ☐ Crayons or markers, optional

Procedure

Begin by asking the students where they get energy. They should understand the concept that all animals get energy indirectly from the sun, either by eating plants or eating animals which eat plants.

This lesson works best if the teacher goes through the lesson with the students. Doing most of the exercises as a group insures that the students really understand each concept before proceeding. Older students may not need this reinforcement.

Discussion

Food webs are the basic system used by living things to transfer energy. Study of ecology begins with an understanding of the dynamics of food webs. It is important for students to realize that they are participants of a food web too. Humans are not preyed upon by many animals in this day and age, but we are certainly consumers.

Understanding food webs is also vital if you are going to study environmental pollution. Harming such seemingly unimportant organisms as zooplankton can mean death for the fish which depend on them for food.

It should be noted that the relationships in the "Pathways of Energy" exercise are simplified. Although insect larvae provide food for fish, this relationship is reversed when fish are tiny larvae. Also, when fish die they become food for bacteria. As these creatures grow and change, their place (niche) in the ecosystem can also change.

Further Explorations

Discuss what would happen to the ecosystem if there were no predators. A good example of this is the recent rise in the deer population in the Northeast where land use changes have benefited deer, and humans have destroyed the deer's natural predators. What happens to the ecosystem when we destroy a whole species or a whole trophic level (like all the primary consumers)? Brainstorm with the students to understand the repercussions of different scenarios.

With older students you may want to study the role of decomposers and the nitrogen cycle. Decomposers play a vital role in keeping the ecosystem healthy. The nitrogen cycle is different from the food webs described in this lesson in that nitrogen and other elements are reused in a continuous cycle as animals die and decompose. In a food web the energy flow is one-way, and energy is lost each time energy is exchanged.

Study the phenomenon of how an organism can fit into more than one niche in its lifetime. For example, at the beginning of a fish's life it is preyed upon by many organisms, but as it grows, it is often able to prey upon its previous predators.

Further Activities

You may want to continue your study of food webs, by drawing a food web you might find in a forest habitat.

There must be PRODUCERS, PRIMARY CONSUMERS, SECONDARY CONSUMERS, and TOP PREDATORS.

Here are some suggestions of plants and animals found in a forest habitat:

PRODUCERS: oak tree (leaves and acorns), berries, seeds

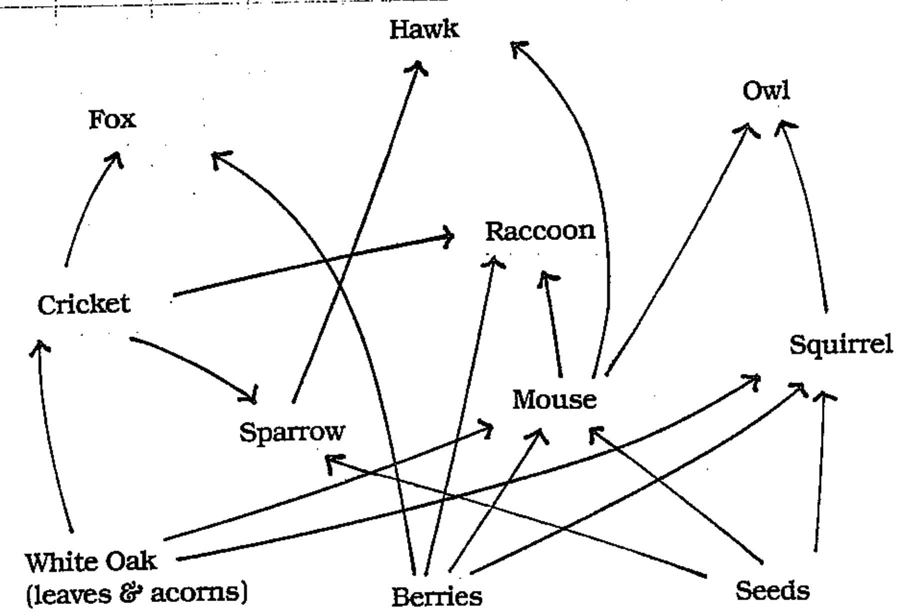
PRIMARY CONSUMERS: crickets, mice, squirrels

SECONDARY CONSUMERS: foxes, weasels, sparrows

TOP PREDATORS: owls, hawks, lynxes

Do some research with your students to discover what each of these animals eats and then draw a food web.

The finished web should look like this:



Bibliography

Andrews, William, ed., *A Guide to the Study of Freshwater Ecology*, Prentice-Hall, NJ 1972

Caduto, Michael, *Pond and Brook — A Guide to Nature Study in Freshwater Environments*, Prentice-Hall, NJ 1985

Zim, Herbert, ed. *Pond Life*, Golden Press, Western Printing, WI, 1967

Rules

- Students should remember that this is a tag game; anyone tackling or pulling another player is out.
- While an exchange is taking place, the players are "safe" and may not be tagged.
- The teacher should set boundaries in the area.
- After about 15 minutes, or when the Sun is out of peanuts, the game is over and it is time for each group to count their peanuts.

Discussion

Usually the Algae get the most peanuts, and the Bass get the least. Discuss why this is true. The next lesson should help students understand some of these concepts more fully.

COLLECTING INVERTEBRATES

Concepts

1. **Following written instructions.**
2. Basic **construction methods** (measuring, using simple tools).
3. **Diversity** among aquatic organisms.
4. **Plankton are free-floating aquatic plants and animals which drift with the current.**

Vocabulary

Aquatic
Benthic
Ecosystem
Environment
Habitat
Invertebrate
Larva
Nektonic
Organism
Phytoplankton
Planktonic
Sediment
Zooplankton

Introduction

Sampling equipment used by scientists can be quite expensive, but similar collecting devices can be made with easy-to-find materials. This lesson contains instructions for making four sampling devices (**Dip Net, Plankton Tow, Hand Screen, Sifting Screen**) which will allow students to collect aquatic organisms in streams, ponds and rivers. Most of the materials needed in this lesson can be found in a hardware store.

After students have constructed the equipment, a field trip will give them the opportunity to use their equipment to catch a variety of small organisms. You may want to go on more than one field trip because you will catch different animals in different environments and at different times of the year.

Once your students collect aquatic creatures, some additional equipment is helpful if you want to study them. Below is a list of equipment which will help students closely observe their specimens.

Materials

The materials needed for making each sampling device are listed in the student section. The following is a list of equipment needed to study the organisms once they are caught:

- ☐ **White enamel trays.** A white background makes the organisms easier to see. White enamel trays can be bought from a biological supply house, but you might find inexpensive substitutes in the kitchenwares department of some stores.
- ☐ **Eye droppers.** Look for blunt-tipped droppers. They generally have large openings which are kinder to small animals and more resistant to breakage.
- ☐ **Forceps or tweezers.** For picking up large invertebrates, like insect larvae.
- ☐ **Collecting containers.** Small unbreakable plastic containers are helpful if you are going to bring back small quantities of water and organisms.

- ☐ **Magnifying glass(es).** A simple magnifying lens will be sufficient for observing many of the larger invertebrates, but a microscope is necessary to observe the intricacies of a smaller organism's structures.
- ☐ **Microscope(s).** If your school doesn't own a microscope, one can sometimes be borrowed from a local high school. A projecting microscope, also called a "bioscope," is a useful tool for showing small organisms to a group. Ask around; many schools have bioscopes gathering dust in closets.
- ☐ **Concavity microscope slides.** These have a shallow, concave depression which holds a drop of water for microscope viewing. Thicker slides are more durable, thinner ones are better for bioscope viewing.
- ☐ **Buckets.** Donut shops often sell the plastic buckets which hold donut fillings. They are usually a good bargain.

The bibliography lists biological supply houses which carry these and other useful items.

Procedure

In Class

Begin by reviewing with your students why zooplankton and other small aquatic organisms are important in the food web (see "Understanding Food Webs," also in this packet). Encourage your students to think of different aquatic habitats, then find out what kind of organisms might be found in each.

Before constructing any sampling equipment, you may want to read through the instructions with your students to make sure that they know what to do. Impress on them that they are making **scientific collecting equipment**; it must be well made or it will be ineffective in the field. If you are planning to create equipment for use at a site your students know well, ask them what equipment will be most suited for use there.

If you want to make all four kinds of sampling equipment, you might divide the class into four groups and assign each group a different device. Each group could also make all four types; that way more people will be able to use them in the field. You could also choose to make only the equipment suitable to your needs. All four of these devices are easy to make, though the plankton tow is a little more complicated than the others.

In the Field

There is life in the water all year round, but the best collecting times are late spring through fall. If you are going to the Hudson, look for shallow areas with plenty of submerged weeds. Getting to the weeds will be much easier at low tide. Many newspapers have a daily listing of tides in your area, or you can buy tide tables (see Bibliography) for the Hudson River (For more tide-related lessons, see Clearwater's Lesson Packet II).

It is possible to collect aquatic organisms without getting too wet, providing students are dressed correctly and exercise caution when near the water. Some organisms, especially amphipods, can be collected by turning over rocks along the shore. A long-handled net allows students to stand on the shore and reach into the weeds where many invertebrates live. Buckets of water, collected by someone with boots, can also be poured through a plankton tow. Older students with waders or high boots can wade in shallow areas with a dip net or plankton tow. In warm weather, old sneakers are fine footgear for wading.

Especially along the Hudson, do not allow students to wade barefoot.

Safety

Whenever you are working around open water, it is best to develop a "buddy" system. Common sense rules should be explained before the students are split into groups to collect their animals. If groups of students work as teams, it will be easier to supervise them.

Further explorations

You may want to keep planktonic organisms in your classroom. They are easy to care for and multiply rapidly, if you don't have too many predators in your tank. A jar of pond water placed in a well-lighted spot (avoid direct sun) may develop an interesting mini-ecosystem. The sunlight will encourage algae to grow, which will lead to an increased population of any zooplankton you may have caught. To keep your ecosystems healthy, just periodically add more pond water with a little organic debris (for food).

Why not start several ecosystems in jars and experiment with different variables? What happens to the populations of zooplankton if you raise or lower the temperature, or increase or decrease the available light? Always be sure that you keep a control ecosystem when designing an experiment.

Questions for discussion

The following questions may help students focus attention on the diversity and adaptations of the organisms they found:

1. **a.** What adaptations would animals living in a fast-moving stream need to have so as not to be washed downstream?

   b. Can you see any parts of these animals which help them attach themselves to rocks?

2. What do different invertebrates eat? Do some research and find out.

3. **a.** What are two good reasons why animals live among weeds?

   b. What would be a good color for an animal which lives among weeds?

4. **a.** Do you think that animals which live in bottom sediments need more or less oxygen than those caught in flowing water?

   b. Discuss whether or not animals living on the bottom need to be fast swimmers.

Bibliography

Brown, Vinson, *An Amateur Naturalist's Handbook;* Prentice-Hall, NJ 1980

Headstrom, Richard, *Adventures with Freshwater Animals;* Dover Press, NY 1964

Reid, G.K. and Zim, H.S., *Pond Life;* Golden Press, NY 1967

Tide and Current Data for the Hudson River; Sea Moment Press, published yearly as a fund-raising project of the Sea Scouts, Sea Explorer Ship 168. Available from Jack Feldborg, 63 South Gate Drive, Poughkeepsie, NY 12601, or from Clearwater. The cost is $4.50, plus $1.25 shipping.

Clearwater's "Zooplankton Sample of the Hudson River Estuary," a 20" by 30" chart, containing 16 commonly found invertebrates. Available from Clearwater's education department (cost: $5.00).

Biological Supply Houses

Carolina Biological Supply Company, 2700 York Road, Box 187, Burlington, NC 27215 (800/334-5551)

Connecticut Valley Biological Supply Company, Valley Road, P.O. Box 326, Southampton, MA 01073 (800/628-7748)

Glossary

Aquatic — Growing or living in water.

Benthic — A lifestyle spent on the bottom of a water body.

Ecosystem — An interacting system of living (organisms) and non-living (physical environment) components.

Environment — All the conditions, etc. surrounding and affecting the life and development of an organism.

Habitat — The place where a plant or animal lives.

Invertebrate — Animals without backbones.

Larva — A term used to denote any young animal which has to undergo a greater or lesser transformation to reach its adult form.

Nektonic — Free-swimming lifestyle, self-propelled.

Organism — Any living thing.

Phytoplankton — Small, suspended plants, which float unattached.

Planktonic — A lifestyle in which an organism drifts with the current.

Sediment — Sand, clay and the remains of dead plants and animals deposited in water. You and your students might call it MUD.

Zooplankton — Small, suspended animals found in open water.

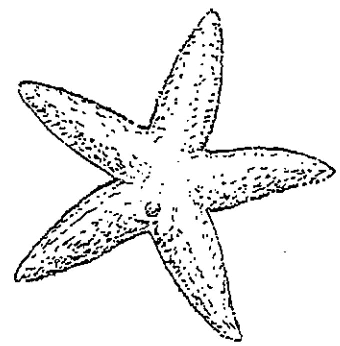
TEACHER'S APPENDIX

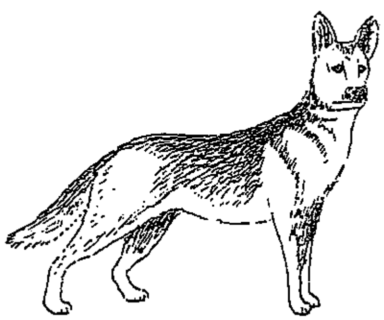
SO WHAT ARE THEY CALLED?

Once you and your students dip a net into the Hudson or Long Island Sound, you will soon discover that there is an astonishing variety of life in these waters. Describing all the life found in the Hudson River would take many lifetimes and many, many books. Scientists can list one hundred kinds of fish and over two-hundred kinds of algae found in the Hudson alone.

Part of the excitement of collecting aquatic life is the mystery of never knowing what you'll bring up from all that great variety. You can be sure of one thing, though: you will probably bring up organisms which you won't be able to name exactly. Sometimes the organism is a real mystery; you'll have no idea what it is, and only a well-trained specialist could tell you. Children are used to their teachers being able to answer most of their questions, and naming things is often important to young people. Don't be intimidated! Let's think instead about how things are named.

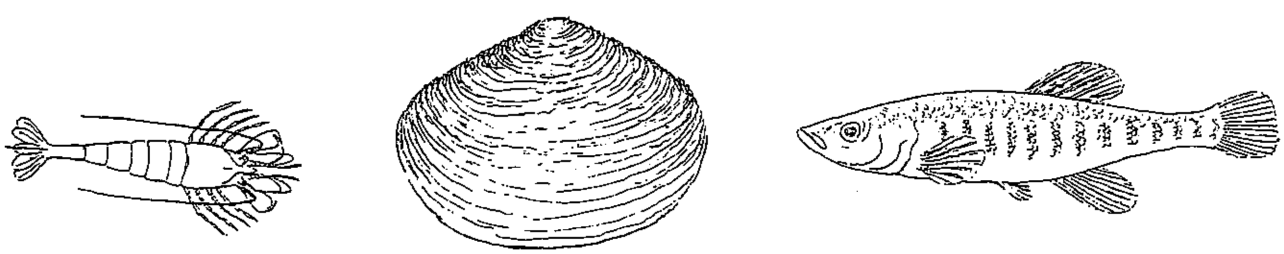
Consider the organism pictured on the right. Most of you could probably give this animal a name. It's a starfish, right? Good.





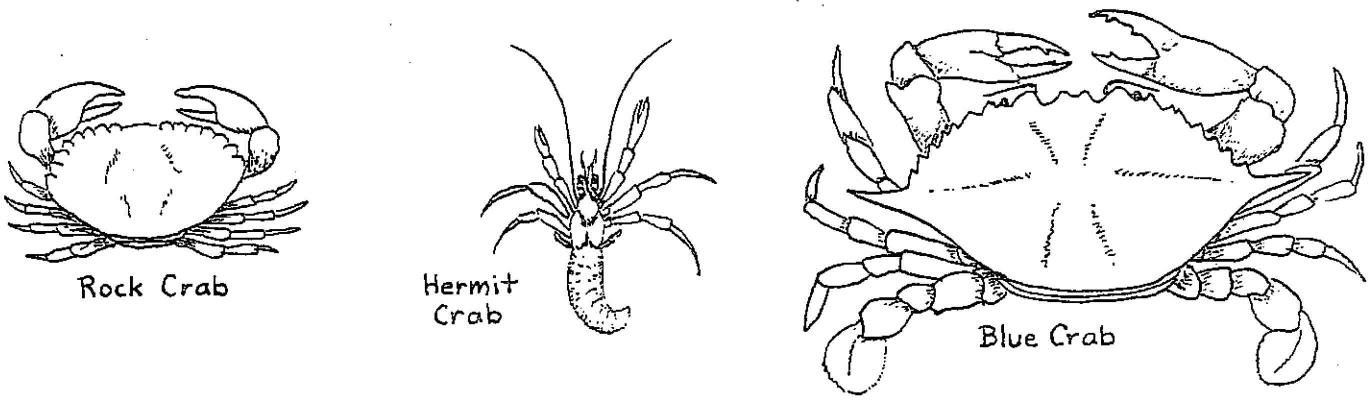
But calling it a starfish is only as exact as calling **this** animal a mammal. You can, of course, give it a more precise name: German shepherd dog. But it's hard to do that with the starfish, or many of the organisms you will catch with your nets or seine.

It's helpful but not always necessary to name things precisely. We can find out a great deal about a starfish without knowing exactly what kind it is. **More important than finding out the exact name of an animal or plant is discovering its relationships to other organisms and habitats, along with its adaptations for survival.** You might catch a mummichog, for example. That's a pretty exact name that probably means nothing to most of you. But if during your collecting trip you see this creature and study it carefully, you will probably be able to figure out how it moves and breathes, where it lives, what it eats, and what eats it. **You won't need to know it is called a mummichog to learn these things.**

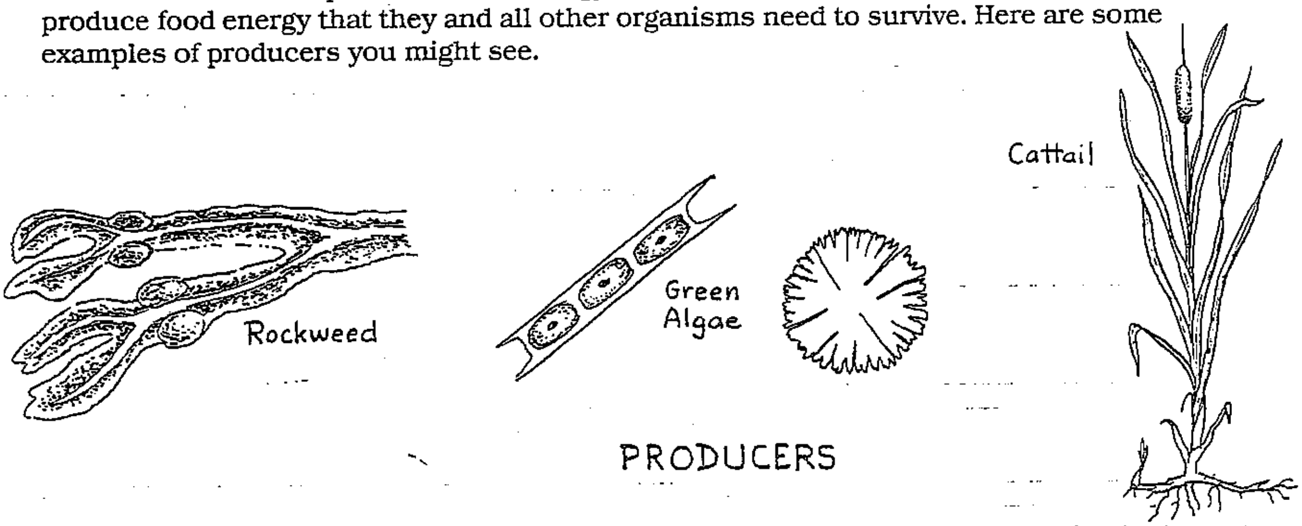


Will the real Mr. Mummichog please stand up?

You can generally sort out living things using three different systems of classification. The first is classifying animals and plants by the way each is put together — its body structure. This is the way in which science officially classifies and gives names to organisms. For example, how do you tell if a certain creepy-crawly animal is a spider or an insect? As many of you know, you could look to see how many legs it has. Spiders should have eight legs, insects only six. This method of classification often leads to close study of an organism's structural adaptations for survival. Looking at the body structure of these crabs, for example, might tell you a lot about differences in the ways each lives.

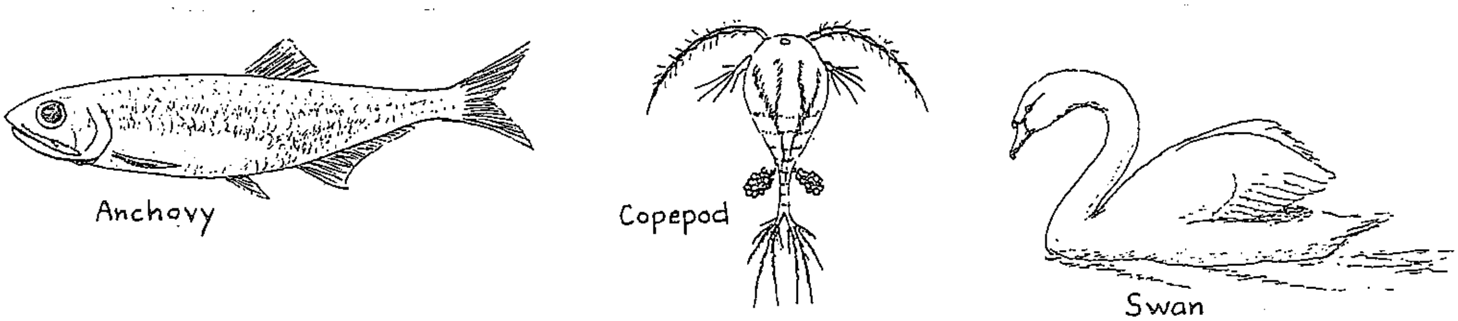


Our two other sorting methods are based on the ecology of each organism — the way it relates to its habitat and other living things around it. One of these classification systems is based on each organism's place in food chains. The starting links in virtually all food chains are green plants. Ecologists (scientists who study ecology) call green plants **producers.** That's because these plants use the energy of sunlight and some simple chemicals to produce food energy that they and all other organisms need to survive. Here are some examples of producers you might see.



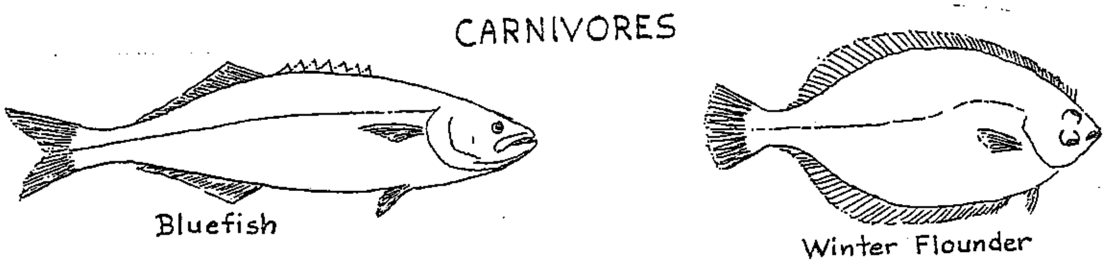
PRODUCERS

Perhaps you will catch copepods in your plankton tow. Copepods are tiny animals that eat even tinier plants. They and other animals which eat only plants belong to the vegetarian group, which scientists call **herbivores**, or **primary consumers**. Below are a few primary consumers you might see along the Hudson River or in Long Island Sound.

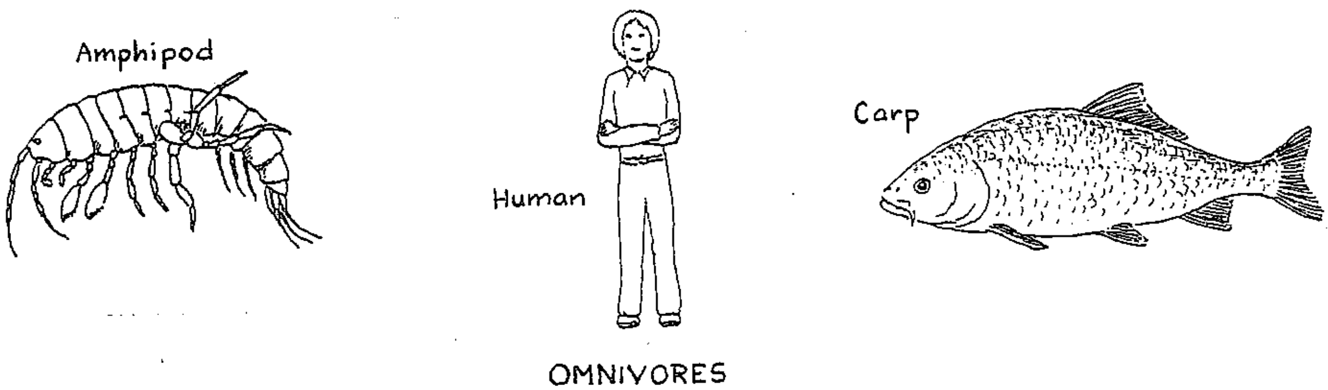


HERBIVORES

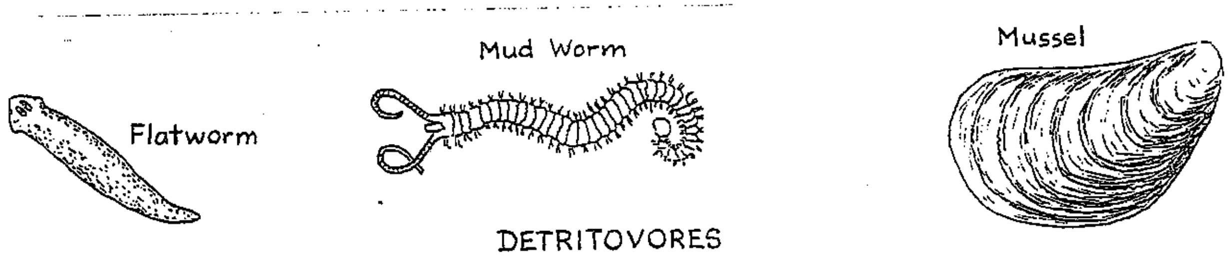
Many of you are familiar with animals that eat other animals. These meat-eaters are known as **carnivores**, or **secondary comsumers**. Most fish you catch are in this category.



Some animals, including humans, eat both animals and plants. They are classified as **omnivores.** Several are pictured below.

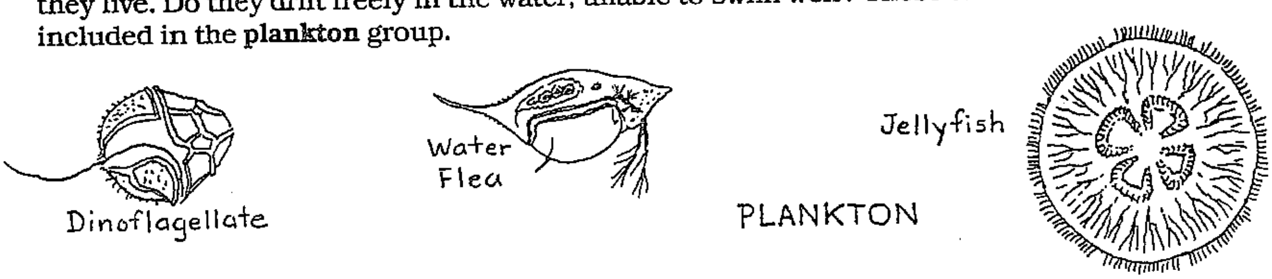


And finally, we may collect animals that eat the remains of dead animals and plants. These are often called scavengers. The ecologists' name for such creatures is **detritovores.**

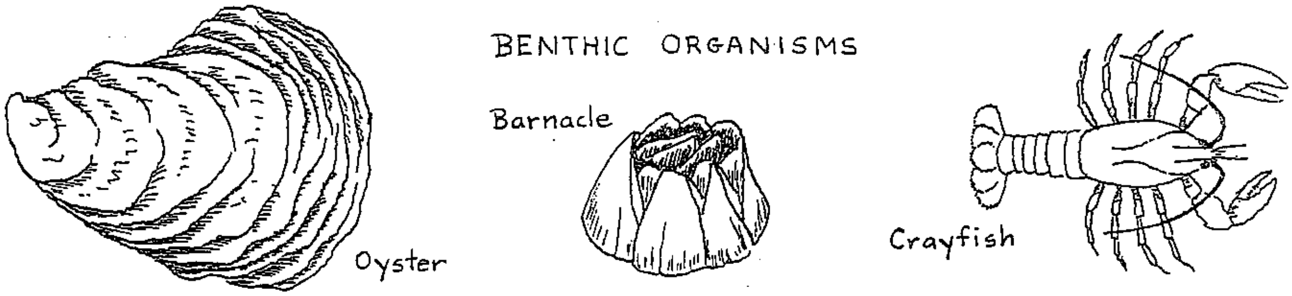


Herbivores (primary consumers), carnivores (secondary consumers), omnivores and detritovores are all grouped together and called **consumers** by scientists. They can't produce their own food energy as green plants do. Instead, they must get it by consuming other organisms. Classification by position in food chains gives us a very important understanding of each organism's role in the environment of the Hudson River or the Sound.

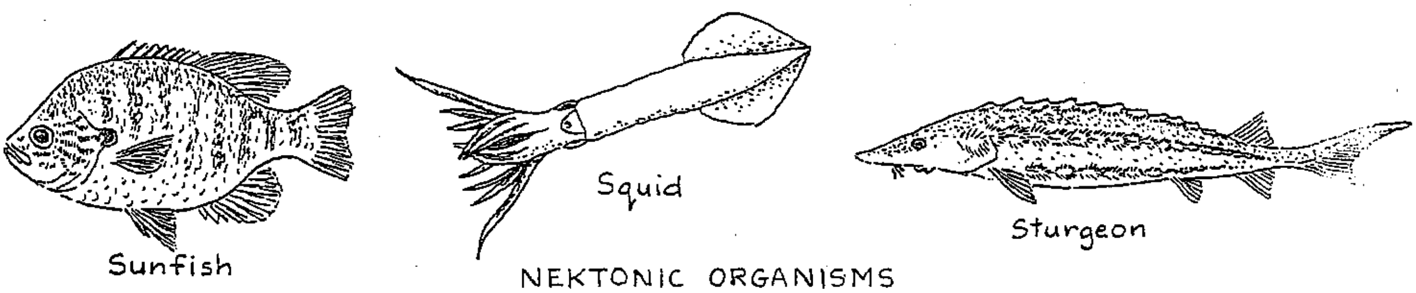
Our last system of classification, also based on ecology, is to group living things by where they live. Do they drift freely in the water, unable to swim well? These drifters would be included in the **plankton** group.



Do they live on the bottom? These are called **benthic** organisms. Some are shown here.

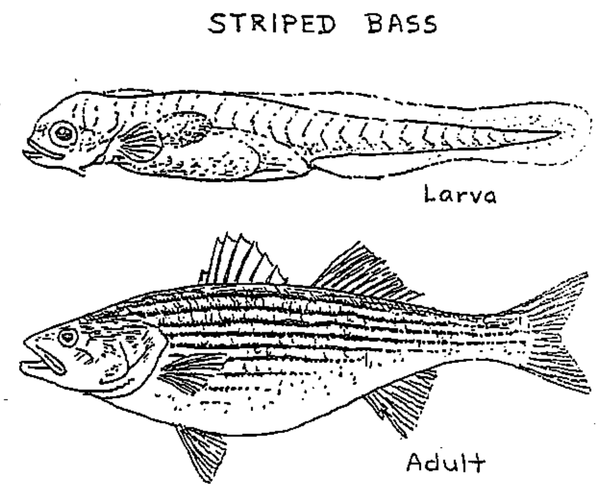


Which of our organisms swim freely and strongly? Fish and squid are among the members of this group, which ecologists call **nektonic** organisms.



It is also important to note whether organisms live in fresh water, salt water, or brackish water (a mixture of salt and fresh). Some spend different parts of their lives in all of these places.

This may seem quite confusing. To make it even more so, consider the striped bass. This fish begins life in fresh water as an egg, which hatches into a planktonic larva. As it grows in size it becomes a nektonic animal and moves into brackish water. After its second year of life it usually swims out into the ocean, becoming a salt-water fish.



"Now wait a minute," you may say. "What good is this classification system if a striped bass can be sorted into all these different categories?" **One important answer is that only by knowing all these different categories do we know how different factors might affect the population of this fish.** People value striped bass very highly. On the east coast of the United States the sport and food fishery for striped bass have a combined value of over $20,000,000 per year.

An instance: fishermen on Long Island notice that there are less bass than there were a few years ago. This fish being important to them, they want to restore its numbers. If they knew the striped bass only as a nektonic, salt-water fish, they might not be able to figure out what is reducing the population. The problem could be far away from Long Island Sound. Perhaps the planktonic eggs and larva, being unable to swim, are getting sucked into power plant cooling systems along freshwater rivers. This might destroy many of the eggs and young fish that would have been found later as adults near Long Island.

Thus we at CLEARWATER want to make people aware of the ecological groupings into which living things fit. In this way we can help them to understand the many ways in which human actions can affect life on the Hudson and Long Island Sound.

from "Taking Passage on the Hudson River Sloop Clearwater"
by Steve Stanne