A BRIEF DESCRIPTION OF A BAY AS AN ECOSYSTEM

An *ecosystem is composed of* all the living and non living things that interact in a particular area.

A bay can be defined as an area of water mostly surrounded by land. Bays generally have calmer waters than the ocean near them because the land blocks the wave action of the ocean. Larger areas of water surrounded by land are called a gulf, a sound, a sea or a bight. In the bays along the Atlantic Coast there is water that varies in the amount of salt as you go toward the rivers that drain into them. There are many things that influence the composition of the water of bays from the amount of rainfall to various human uses of the river and the land that surrounds the river and the bay. The lower the rainfall in a given year the saltier the water is. Salty water can travel up the river in years with low rainfall because not much fresh water mixes with it. Saltwater organisms can travel further up river in search of food and breeding grounds.

There are thousands of organisms that live in and around a bay. Still others, such as migratory shore birds, only come to the bay at certain times of the year. One of the largest staging grounds for migratory shorebirds in the world is the Delaware Bay. It is bordered on the west by the state of Delaware and on the east by New Jersey. The birds stop in the Delaware Bay on their way to breeding grounds in the arctic. Some of these birds fly non-stop from southern South America before they reach the bay. They stop in the bay for one reason, to feed on horseshoe crab eggs.

The horseshoe crab is a very ancient type of organism that is still around today. One of its main breeding grounds in the world is the Delaware Bay. This is another type of organism that lives in and influences the bay. The horseshoe crab eats clams and mussels, for instance, so the bay must support the clams and mussels in order to support the horseshoe crab.

The clams and mussels filter microscopic plants and animals called plankton from the water. Plant-like plankton (phytoplankton) need sunlight, water and dissolved carbon dioxide to make "food" through photosynthesis. They need nutrients dissolved in the water as well. The animal-like plankton (zooplankton) eats the phytoplankton, so the bay must support these to support the clams, to support the horseshoe crabs, to support the shorebirds. There is even a huge variety of bacteria and fungi that decompose the dead organisms and wastes. All of the organisms mentioned need oxygen and can only live within a certain range of temperature. Hence there are complex relationships among the organisms and the physical world in which they live.

The living parts of an ecosystem are called *biotic factors.* In the bay description above, the biotic factors are the shorebirds, the horseshoe crab, the clams, the mussels, and the plankton. All of these organisms have an effect on each other. The non-living parts of the ecosystem are called *abiotic factors.* In the bay description above, the abiotic factors are things like the water, temperature, salt, nutrients, sunlight, and gases (like carbon dioxide and oxygen). The temperature of the bay influences the organisms that can live there. Much of the nutrients found in the water dissolve from soil on shore and run-off into the bay, therefore soil is an abiotic factor influencing the Delaware Bay Ecosystem as well.

An organism must get food, shelter, water and other things from the area in which it lives in order to live, grow and reproduce. The place that an organism obtains these things is called its *habitat.* An ecosystem can have many habitats for many different types of organisms. Can you think of at least two different habitats from the brief description above?

The bay is home to thousands of different kinds of plankton. There are dozens of different types of shorebirds that visit here. There is one type of horseshoe crab that lives in the bay. Each of these different types of organisms is called a species. A *species* is a group of organisms that are similar and can reproduce with each other and produce offspring that can themselves reproduce. All members of a species that live in a given habitat are called a *population.* All of the populations of organisms that live in an area interact with each other to form a *community.* The smallest level of organization is a single organism, which belongs to a population of other members of its own species. The population belongs to a community made up of many different species. The community and abiotic factors together form an *ecosystem.*

A population of organisms cannot grow forever! It should be obvious that something will limit the size to which it can grow. These things are called *limiting factors.* Some limiting factors include food, nutrients, space, and weather conditions. When a population has reached the maximum that the given habitat can support it has reached its *carrying capacity.*

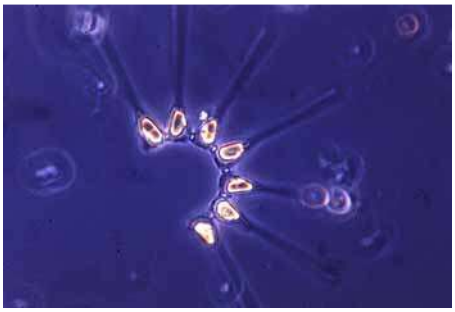
MOVEMENT OF ENERGY AND MATERIALS THROUGH AN ECOSYSTEM

Organisms on this planet are essentially after only one thing…the energy they need to live, grow and reproduce. All of the ecosystem interrelationships evolved so that an organism can be successful at getting the energy it needs to reproduce. Let's look at energy relationships among organisms.

Ultimately ALL energy in an ecosystem comes from the sun. We have learned that plants capture the energy in light from the sun to run a reaction called photosynthesis. During photosynthesis, the plant produces sugar (glucose) to store energy for later use. In this way, plants transform the electromagnetic energy in light from the sun into chemical energy in the form of a sugar. The approach that an organism uses to get nutrients and energy for itself corresponds to its TROPHIC LEVEL. Within these three trophic levels there are special classes of organisms. Terms with the ending "-vore" indicate the primary food source. For example a carnivore's primary nutrient source comes from eating other animals. An herbivore's primary nutrient source is plant material. Humans are yet another example. Humans are omnivores, meaning we are able to get nutrients from eating both plants and animals. The trophic level we feed at depends upon what we are eating at the time. For instance when we eat bread we eat plant material and are therefore feeding as a primary consumer but when we eat a hamburger we are feeding as a secondary consumer because we are eating an animal that ate plant material. The following section should make these relationships more clear.

TROPHIC LEVELS:

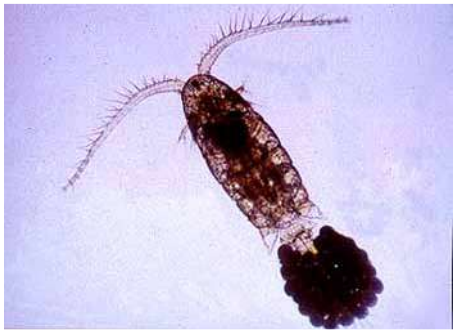
1. AUTOTROPHS: ("self-feeder") Autotrophs are organisms that can produce their own food. Plants are autotrophs since they produce their own "food" through photosynthesis. They are commonly referred to as PRODUCERS.



Diatom- Phytoplankton
Photo by George Rowland

PRODUCERS: Plants are producers. They capture the energy of light from the sun to make "food" (sugar) for themselves through the process of photosynthesis. In a bay ecosystem, phytoplankton are producers because they are plants that use photosynthesis to make "food" for themselves. Grass is another example of a producer.

2. HETEROTROPHS: ("other-feeders") Heterotrophs are organisms that depend on others to produce food. Since heterotrophs eat other organisms we can refer to all heterotrophs as CONSUMERS. There are several levels of heterotrophs/consumers:



PRIMARY CONSUMERS: THE FIRST LEVEL CONSUMERS. When an organism eats plants, they act as primary consumers. When you eat a salad or a piece of bread, you are acting as a primary consumer because you are eating a producer. In the Delaware Bay, the zooplankton eat the phytoplankton so they are feeding as primary (1st level) consumers. A mouse eating grass seeds would be another example of an organism feeding as a primary consumer.

HERBIVORES: a special class of primary consumer that eats only plants. A copepod is a type of zoo-plankton that is an herbivore because it eats only phytoplankton. A deer is another example of an herbivore.

Soft shelled Clams
Photo by Garth Stubbolo

SECONDARY CONSUMERS: THE SECOND LEVEL CONSUMERS. Secondary consumers are organisms that eat primary consumers. When you eat a hamburger, you are acting as a secondary consumer. You have eaten a cow that ate some grain or grass. In the bay, the clams act as a secondary (2nd level) consumers when they eat the zooplankton. A snake eating a mouse that ate a grass seed would be another example of an organism feeding as a secondary consumer.

Horseshoe Crab
Photo by Garth Stubbolo

TERTIARY CONSUMERS: THE THIRD LEVEL CONSUMERS. An organism that eats something, that ate something that ate a plant! When you eat a tuna fish sandwich you act as a tertiary consumer. A Tuna eats smaller fish that eat smaller fish that eat plants and plankton. In the Bay, the horseshoe crab eats the clam that ate the plants (phytoplankton) so in this instance the horseshoe crab would be feeding as a tertiary (3rd level) consumer. A hawk eating a snake that ate a mouse that ate grass seeds would be another example of an organism feeding as a tertiary consumer.

There are special classes of secondary and tertiary consumers:

CARNIVORES: organisms whose primary source of nutrient is eating other animals. A hawk or a lion are examples of carnivores. In the Bay Ecosystem many fish eat only other animals. For example flounder eat polycheate worms, fish eggs, HSC eggs and HSC larvae.

OMNIVORES: organisms that can and do eat meat, but also eat plants. A human or a bear is an example of an omnivore. In the Bay Ecosystem Horseshoe crabs eat primarily soft shelled clams, mussels and other mollusks, but at various stages of their lives they also consume plant material. This would make them omnivores.

SCAVENGERS: Carnivorous organisms that only eat dead animals. A vulture is a common example of a scavenger. In a bay ecosystem blue crabs mud snails are examples of scavengers

3. DECOMPOSERS: Decomposers are organisms that break down dead organic matter. Fungi, many insects and bacteria are decomposers. They "eat" the dead organic matter to derive energy and materials for growth and development. There are numerous decomposing bacteria even in the Bay Ecosystem.

Decomposers return nutrients to the ecosystem as abiotic factors to be used again by plants. If there were no decomposers, the plants would take nutrients out of the ecosystem and it would never be returned. Eventually there would be no more nutrients left, the plants would die. If the plants all died, animals would soon follow!

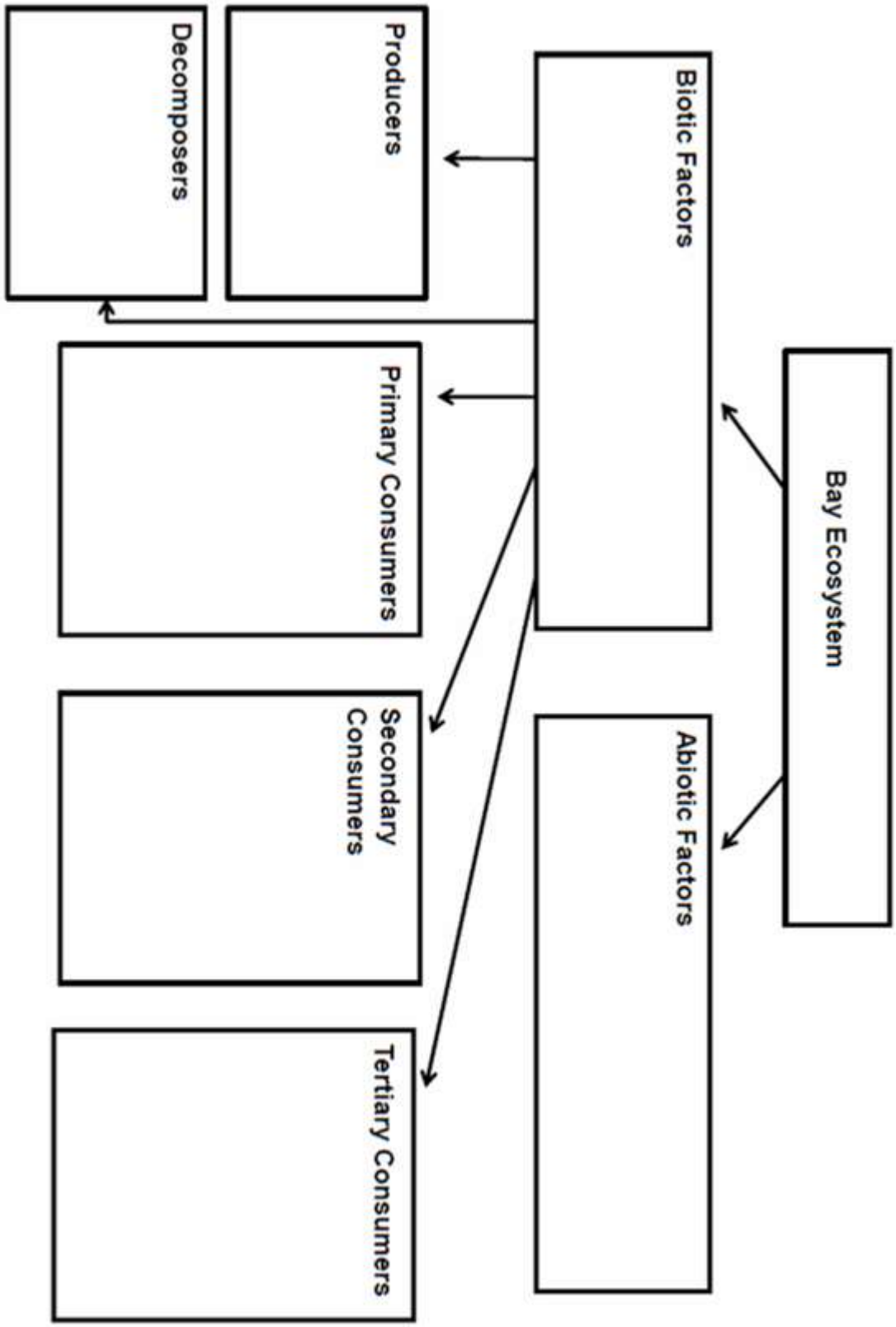
A BRIEF DESCRIPTION OF A BAY AS AN ECOSYSTEM

Biotic and Abiotic Factor "T" chart

In the "T" chart below define the terms *biotic factor* and *abiotic factor* then list biotic and abiotic factors influencing a Bay ecosystem in the appropriate column.

Biotic Factors Definition:	**Abiotic Factors** Definition:

TROPHIC LEVEL GRAPHIC ORGANIZER FOR A BAY ECOSYSTEM



Investigation Reflection Questions

1. Where does the energy that runs an ecosystem come from? What form is it in?

2. What are organisms that can produce their own food called?

3. What are organisms that eat other organisms called?

4. Can an organism feed at different trophic levels and survive? Give an example.

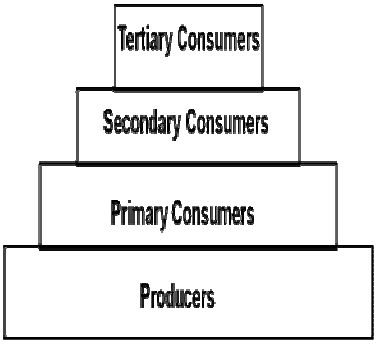
5. If you eat a salad, at which trophic level are you feeding? Explain why.

6. If you eat a hamburger (beef) at which trophic level are you feeding? Explain why.

7. Based upon the reading, what type of consumer is a horseshoe crab?

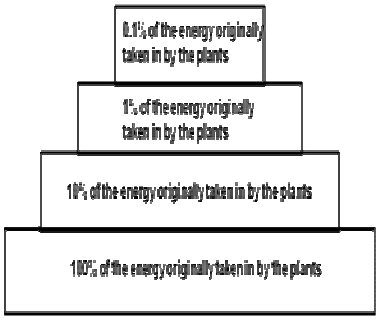
8. Why do you think some ecologists say that the decomposers are the most important type of consumers?

PYRAMIDS AS A MODEL: MATERIAL AND ENERGY MOVEMENT THROUGH ECOSYSTEMS



ECOLOGICAL PYRAMIDS: The concept of a pyramid is useful to describe the energy (trophic) levels of organisms, the amount of biomass (the mass of all the living material), and amount of energy transferred from one trophic level to another. The base of a pyramid is the widest part. *Producers* are at the base of the eco-pyramid. There are more producers than any type of organism in an ecosystem. 100% of the energy the producers capture from the sun is in the base. There is much more biomass in the base than anywhere else in the pyramid.

The second level up a pyramid is smaller than the base. Here is where the *primary consumers* are placed. There are fewer primary consumers than producers. Only 10% of the energy captured from the sun by the producers is passed up to this level because the plants used most of the energy they stored to run their own life processes. There is only about 10% of the biomass that is found in the base.



The third level up the pyramid is smaller than the second. Here is where the *secondary consumers* are placed. There is only about 1% of the biomass that is found in the base (That's 10% of the biomass in the level below it!). This level has only 1% of the energy that is captured from the sun. (That's 10% of the energy in the level below it.)

The fourth level is the last level. It is the last level because there is not enough energy left to pass up to another level. This is the level of the *tertiary consumer*. Only 0.1% of the energy captured by the producers makes it up to this level. (Once again that's 10% of the energy in the level below it!) Only 0.1% of the biomass in the ecosystem is contained in this level as well.

GENERAL PATTERNS IN THE ECOLOGICAL PYRAMID: "THE 10% RULE"

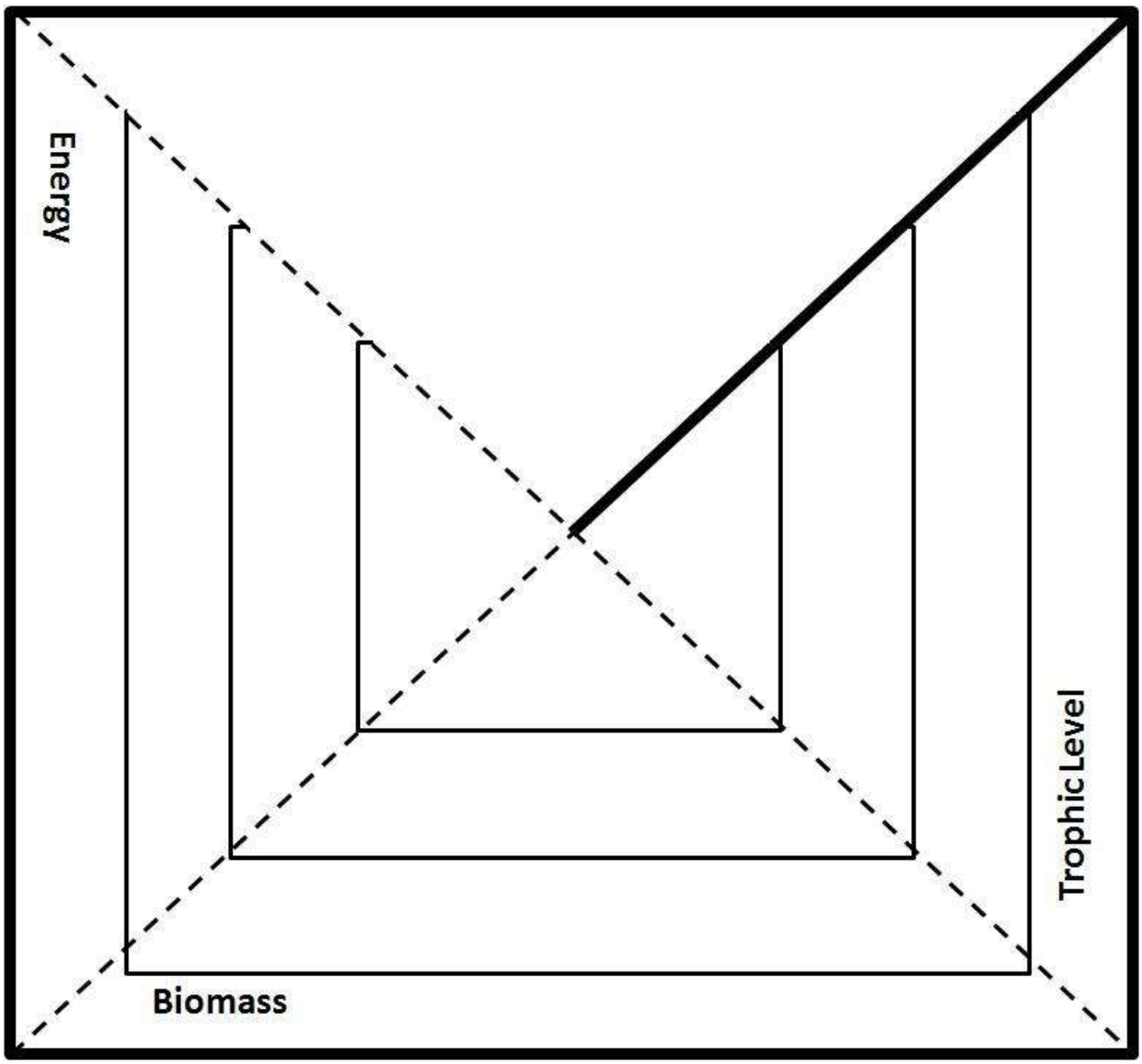
- Only 10 % of the energy from a level is passed up to the next level
- Only 10 % of the biomass from a level is passed up to the next level

There are always fewer individuals in the populations as you go up the pyramid. The higher you go on the pyramid, the less energy is available!

ECOLOGICAL PYRAMID PATTERN

PROCEDURES:

1. Cut along heavy black lines.
2. Using the information in the reading section “Pyramids As A Model For Material And Energy Movement Through Ecosystems” Label the spaces in the triangles with the appropriate information.
3. Fold along the dashed lines to make a pyramid! (fold the triangle with no lines on it under) Tape the pyramid together.

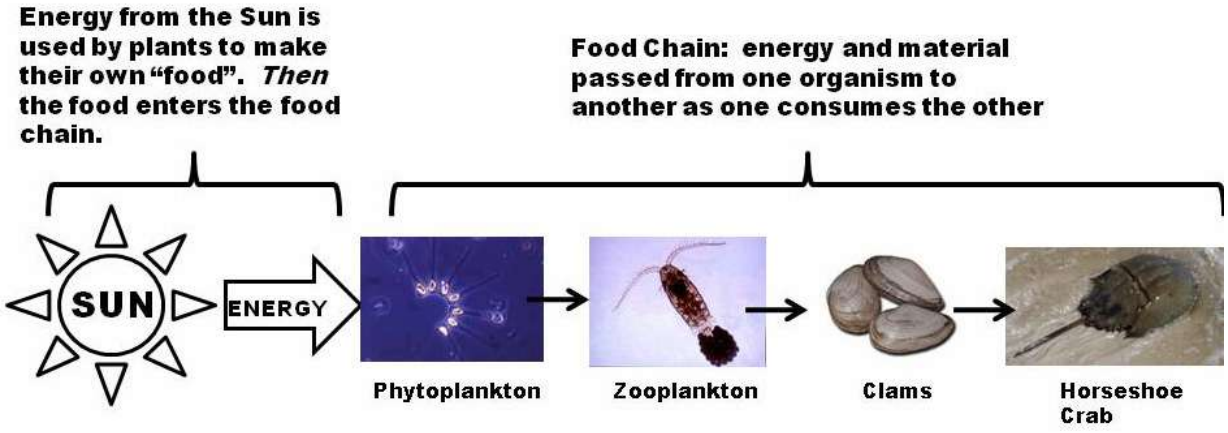


FOOD CHAINS AND FOOD WEBS AS MODELS FOR MATERIAL AND ENERGY MOVEMENT THROUGH ECOSYSTEMS:

Let's take a second to think about how the organisms in a bay ecosystem get the energy they need. Diatoms and many other phytoplankton are able to use energy from the sun to make "food" for themselves during photosynthesis. Copepods and other zooplankton consume phytoplankton to get the energy and materials they need to live and grow. Soft shelled clams, mussels and other filter feeders consume phytoplankton and zooplankton as well as organic debris they filter from the water. Horseshoe crabs (HSC) feed on different things during different stages of their lives. In early juvenile stages they consume organic debris from phytoplankton, microalgae and decaying marsh grasses while in later stages juveniles consume crustaceans, polycheates and mollusks. Adult HSCs consume various types of soft shelled clams, mussels, snails as well as other organisms. Horseshoe crabs themselves are consumed by different organisms at different stages of development. Eggs and larvae are consumed in large numbers by migratory shorebirds as well as various fish such as killifish, flounder and juvenile sea bass. Adult horseshoe crabs are preyed upon by loggerhead turtles. Sharks, other sea turtle species and even alligators have been observed eating adult horseshoe crabs. There are even species of marine bacteria and fungi that are decomposers that break down wastes and dead organisms.

Food Chains:

The concept of a food chain is a very simple look at how energy and materials move through an ecosystem. Let's look at a food chain made from some of the organisms in the description above.



As you can see, light energy from the sun is used by the phytoplankton. The zooplankton eats the phytoplankton, the clam eats the zooplankton and the horseshoe crab eats the clam. Energy passes from the sun and is transformed by the phytoplankton into chemical energy in the food. The plant uses most of the energy it gets from the sun to live. Some of the energy is stored in the plants tissues so when the zooplankton eats the phytoplankton the zooplankton gets energy from the food it eats. The energy stored in the zooplankton tissues is passed to the clam and finally the energy stored in the clam's tissues is passed to the horseshoe crab. This is a very simple view of how energy and materials move through an ecosystem. At each step of the chain most of the energy at that level is used by that organism, much of the energy

that the zooplankton gets from the phytoplankton is given off to the environment as heat and is not available to be passed on to the clam.

Food Webs:
Do horseshoe crabs eat only clams? Of course not! Do *you* eat only one type of thing? Hopefully not! Food chains are helpful in beginning to understand how energy and materials move through ecosystems but they are not very realistic. Food webs are a much more realistic model of what really happens because almost every organism gets materials and energy from many different sources. Think about a spider's web. It is made of many individual strands all interconnected. A food web is the same type of concept. It is a series of interconnected food chains. For example energy and materials could move in some of the following pathways:

Sun → phytoplankton → zooplankton → clam → HSC

Or

Sun → phytoplankton → zooplankton → Mussel → HSC

Or

Sun → phytoplankton → juvenile HSC → killifish

What if these different chains were interconnected? It would look like a web! At all levels in a food web, waste materials and dead organisms are broken down by decomposers and the materials are returned to the environment for use again.

CREATE A FOOD CHAIN:

In the space below, create a food chain using the sun and the following organisms found in a typical bay ecosystem. You may use words instead of pictures if you like! Use arrows to indicate the direction energy and/or materials move through the system.

NOTE: BE CAREFUL! An arrow pointing *to* the zooplankton *from* the clam would mean the zooplankton ATE the clam!

Sun, clam, zooplankton, HSC, phytoplankton

CREATE A FOOD WEB POSTER:

Create a food web poster by cutting out the cards with the sun and different organisms. Arrange the cards on a large sheet of paper or poster board. Use the reading from this activity and from "Movement of Energy and Materials through an Ecosystem" to help you. Have your teacher check your web before you glue the cards down.

Use arrows to indicate the direction energy and/or materials move through the system. Use different color arrows to represent different energy levels (light, producer, primary consumer etc.) and create a key.

NOTE: Remember! Some organisms can eat at different trophic levels dependent upon what they eat. For example when you eat a salad you are feeding as a primary consumer, but when you eat a hamburger you are feeding as a secondary consumer. (You ate an animal that ate a plant.)

Food Web Cards

Sun	Soft shelled clam	Copepods-zooplankton
Adult HSC	mussels	polycheates
Juvenile HSC	HSC eggs	Diatoms-phytoplankton
Migratory shorebirds	Marine fungi	crustaceans
Sea bass	Marine bacteria	Logger head turtle
Eel	Whelk (conch)	

ENERGY IN THE ECOSYSTEM VOCABULARY

Define the terms below as you read the assigned work.

Reading: A Brief Description of a Bay as an Ecosystem

ecosystem

bay

biotic factors

abiotic factors.

habitat

species

population

community

limiting factors

carrying capacity

Reading: Movement of Energy and Materials through an Ecosystem

photosynthesis

trophic level

autotrophs

producers

heterotrophs

consumers

primary consumers

herbivores

secondary consumers

tertiary consumers

carnivores

omnivores

scavengers

decomposers

Reading: Pyramids as a Model

ecological pyramids

biomass

the 10% rule

Reading: Food Chains and Food Webs

food chain

food webs