Name____

MARINE ECOLOGY

Ecology hmmm, a popular word. What is ecology? Is ecology collecting paper and aluminum cans? Is it the balance of nature? Is it something to be "for" or "against"? Maybe we can tell by looking at the word itself. "Ecology" comes from two Greek words "oikos" which means "house" and "logic" which means the "science or study of". Isn't that a big help? Ecology means the"study of house". Well, not quite but, maybe so.... Ecology is the study of the relationships that occur in our house, the earth. Ecology is the study of three general types of relationships that we see in nature: (1) relationships among organisms of the same kind; (2) relationships among organisms of different kinds; and (3) relationships between organisms and the nonliving environment..

RELATIONSHIPS

Same kinds different kinds

non-living

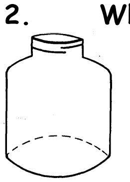
Ecologists then study these three types of relationships as they occur in a particular volume of space called an ecosystem. An ecosystem is all of the living and nonliving factors in a given space. We could look at the oceans as an ecosystem.

Since we define the boundaries of the ecosystem, we would also call a particular bay or inlet an "ecosystem. The ecosystem concept lets us look at a particular area in detail. It is important to remember, however, that ecosystem boundaries are

man-made. The real world is one single ecosystem in which all the nonliving and living factors affect each other to one degree or another.

1. What is "ecology"?

2. What is an ecosystem?



How could we study an ecosystem? Let's make one in a 10 gallon jar and see.

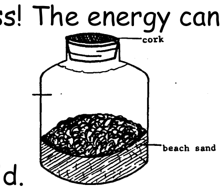
The Boundaries of Our Ecosystem

What kinds of things would we need to make a sealed ecosystem that could exist for an extended period of time? Lets look at the components of the ecosystem. Think of the ecosystem as composed of two major parts: The nonliving environment or surroundings and the living environment or the biological community. The nonliving environment provides the energy, nutrients, and living space that the members of the biological community require for their existence.

3. **What are the two major parts of an ecosystem?**

4. How could we call the 10 gallon jar part of the nonliving environment of our ecosystem? What does it provide?

Let's add 10 gallons of seawater and a couple of inches of beach sand to our jar to provide nutrients for the living organisms we'll need. But what about the energy? Lucky for us the jar is made of clear glass! The energy can shine



right in ...sunlight! Sunlight is the initial energy source for all of the ecosystems of the world.

Our ecosystem is now ready for us to add the biological community. What shall we add? One way of looking at the components of the biological community is to divide them into two major groups of organisms: The autotrophs and the heterotrophs.

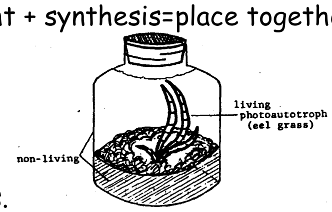
Autotrophs (auto-self + troph=food) are organisms capable of manufacturing their own "food" from simple inorganic molecules like carbon dioxide (CO_2) and water (HO_2). Most autotrophs are green plants. Heterotrophs (hetero=other + troph=food)
are organisms that cannot manufacture their own food. Heterotrophs obtain their food by feeding on other organisms or on particulate (small separate particles) organic matter such as a piece of seaweed that has washed up on the shore.

5. (a) What is a major difference between autotrophs and heterotrophs?

(b) Circle the autotrophs.

sea lettuce shark kelp periwinkle snail seaweed oysters floating microscopic green plants

Okay... let's add our autotrophs. This might present a bit of a challenge since there are two large groups of autotrophs: photoautotrophs and chemoautotrophs. Wow! That's a mouthful. Photoautotrophs use the energy from the sun to manufacture food from simple inorganic molecules. (Photo=light + auto=self + troph=food). Incidentally, the process of using light energy to manufacture food from the simple inorganic molecules, carbon dioxide and water, is called photosynthesis (photo=light + synthesis=place together). What can we add for our



photoautotroph? Let's add a couple of eel grass plants.

6. Use your knowledge of word parts to define "chemoautotrophic".

Biologists often ignore chemoautotrophs. Chemoautotrophs manufacture the food they need with energy derived from special kinds of chemical reactions (chem.=with chemicals + auto=self + troph=food.) Chemoautotrophs are generally microscopic bacteria that use sulfur and nitrogen to make protein molecules. These protein molecules can find their way back into the living system as the bacteria are eaten by larger organisms. Since these bacteria can live in areas with little or no oxygen, they are sometimes very important in ocean areas with sandy or muddy bottoms. How can we add chemoautorophs to our ecosystem? The bacteria are too small to see with our beach sand (hitchhikers) and will establish themselves just fine.

7. What do chemoautotrophs use as raw materials from which they manufacture food?

So, now we have an ecosystem with a non-living environment and a living environment. Are we finished? Well, we could be. Our system would maintain itself for a while. The autotrophs could continue to grow until they ran out of raw materials. Can we add anything else that might make our mini-sea more interesting? Sure, we've neglected a whole group of organisms, the heterotrophs.

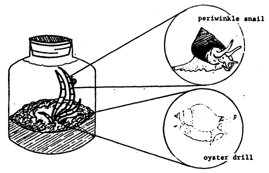
8. What are heterotrophs?

"Hetero" is the Greek prefix meaning "other or different".

Heterotrophs are organisms that obtain their food from other sources; they cannot make their own food. Since there are so many different organisms that fit into the heterotroph category, ecologists have divided heterotrophs into three groups: herbivores, carnivores, and decomposers. Each group has its own special way to obtain the energy-and nutrients needed for maintenance, growth and reproduction. Herbivores are plant eaters. Carnivores eat meat in the form of plant eaters or other carnivores. Decomposers are organisms that use dead plant and animal materials as food. Decomposers play an important role in recycling nutrients. They break down organic substances, and use the energy and some of the nutrients stored in the "food". They return the remaining nutrients to the environment where they are available for use by other organism.

9. "Omni" is from a Latin word meaning "all". What do you suppose omnivores, eat?

Can we add some heterotrophs to our ecosystem? Sure. Let's add some periwinkle snails which feed on the eel grass surface. To make things more interesting let's add an oyster drill that feeds on periwinkle snails. Now we have a complete system except for the decomposers. Many decomposers are bacteria. Ahal We've already added our decomposers with the sand. If we've picked the proper number of organisms, we could have a self sustaining ecosystem that would maintain itself for long periods.

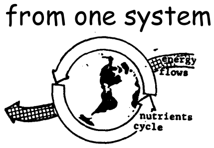


10. In our mini-ecosystem, what is the role of the periwinkle? Of the oyster drill?
11. The members of the biological community are listed below. Connect the members by drawing arrows that show who eats whom. Be sure your arrows point from the eaten to the eater.
eel grass periwinkle snail oyster drill decomposers
(b) Why might you want to draw an arrow from the decomposers to the eel grass?
(c) Your diagram above shows something called a "food chain". Use your knowledge of other marine plants and animals to create another food chain.

Now that you've built your ecosystem, let's take a look at the way in which it functions. It is important to realize that the ecosystem operates as a whole unit. What does this mean? Damage to one ecosystem component will inevitably cause other changes in the ecosystem. Since man is in the business of changing ecosystems, it is critical that we have as such knowledge about the anticipated change as possible. We can then be sure that the other ecosystem changes that follow the original change are minor and do not threaten the continued existence of the ecosystem as a stable unit. Nowhere is it more critical to understand the changes than in the marine ecosystem. Unfortunately, there is much we don't know. There is, however, much we can learn that is known.
12. Eel grass blight has been introduced into our system with the sand. What will happen to each of the other members of the living community if the blight kills all of the eel grass?
a. chemoautotrophs b. periwinkle snails c. oyster drill d. decomposers
13. Which organism or group will feel the effect more rapidly?

Before we leave' our ecosystem we need to look at two ecological processes which lie at the heart of ecosystem structure and dynamics: 1) energy flow and 2) nutrient movement. Both energy and nutrients move from one member of the biological community to another as food. What is the difference between the two?

Energy flows while nutrients or matter cycles. What does this imply? Energy enters a system and passes through that system. Once energy passes through an ecosystem, it is lost forever; not-so with nutrients. They are recycled from one system to another. Nutrients are almost never lost to the biological community as a whole.



14. What is the ultimate source of all the energy that ecosystems use?
15. Since nutrients-cycle from one ecosystem to another, is it possible that some of the nutrients that make up your body were in a cow in the state of Nebraska last month? Could some of the nutrients have been with Hannibal when he crossed the Alps with his elephants?
Real world ecosystems are much more complex than the one we just built. The principals are the same but as you add more and more components, the number of possible interactions increases dramatically. It is almost impossible to know all the things that will happen when one changes an ecosystem. The more we know the less the chance of making irreversible changes. In all of our decision making, we should strive to avoid making are irreversible decisions.
16. Why should we avoid making irreversible decisions?

ECOGRAM

Use the clues given below to find the words to fill the thirteen lines. The correct answer will have the same number of letters as there are blanks in the ecogram. When you have filled is all of the lines correctly, as important ecological term will appear as if by magic!

1. _

2. _

3. _

4. _

5. _

6. _

7. _

8. _

9 _

10. _

11. _

12. _

13. _

Clues:

1. These organisms can produce their own food.
2. This group of organisms-recycles nutrients by breaking down dead organic substances.
3. The study of the three general types of relationships we see is nature.
4. The living environment of an ecosystem is also call the community.
5. The raw materials of 'food'
6. An ecosystem is made up of the nonliving and the living __________or surroundings.
7. All of the living and nonliving factors in a given space
8. In living systems, its source is the sun.
9. Plant eaters
10. Organisms that obtain their food from other sources
11. We want to avoid making this type of decision when we deal with marine ecology.
12. This group of organisms uses sunlight to manufacture food from simple organic molecules.
13. Meat eaters

Questions

1.What is "ecology"?

2.What is an ecosystem?

3. What are the two major parts of an ecosystem?

4. How could we call the 10 gallon jar part of the nonliving environment of our ecosystem? What does it provide?

5. (a) What is a major difference between autotrophs and heterotrophs?

(b) Circle the autotrophs.

sea lettuce shark kelp periwinkle snail seaweed oysters floating microscopic green plants

6. Use your knowledge of word parts to define "chemoautotrophic".

7. What do chemoautotrophs use as raw materials from which they manufacture food?

8. What are heterotrophs?

9."Omni" is from a Latin word meaning "all". What do you suppose omnivores, eat?

10.In our mini-ecosystem, what is the role of the periwinkle? Of the oyster drill?

11. The members of the biological community are listed below. Connect the members by drawing arrows that show who eats whom. Be sure your arrows point from the eaten to the eater.

eel grass periwinkle snail oyster drill decomposers

(b) Why might you want to draw an arrow from the decomposers to the eel grass?

(c) Your diagram above shows something called a "food chain". Use your knowledge of other marine plants and animals to create another food chain.

12. Eel grass blight has been introduced into our system with the sand. What will happen to each of the other members of the living community if the blight kills all of the eel grass?

a. chemoautotrophs b. periwinkle snails c. oyster drill d. decomposers

13. Which organism or group will feel the effect more rapidly?

14. What is the ultimate source of all the energy that ecosystems use?

15. Since nutrients-cycle from one ecosystem to another, is it possible that some of the nutrients that make up your body were in a cow in the state of Nebraska last month? Could some of the nutrients have been with Hannibal when he crossed the Alps with his elephants?

16. Why should we avoid making irreversible decisions?

FOOD CHAINS AND FOOD WEBS

Food chains conduct the "transfer of energy" from the sun to *producers* (such as plants) and on to *consumers* (such as people) Each consumer in a food chain has a smaller iomass than the links below it. *Simple food chains* are those that have fewer links. Simple food chains usually exist where the environment i vulnerable to extreeme change or where plants have a short growth season. A *food web* describes interrelated food chains within an ecosystem. Protection of the natural food web to preserve the food supply for all mrine life is a top prioriy.

Food Webs

Procedure:

1. Study the food chains listed below (in #3) and then on a sheet of paper, draw and label a food web.
2. In the food web you've drawn, label each organism as *producer* or *consumer*. (HINT: an animal can have more than one arrow leading to it or from it. Arrows go from *eaten* to *eatee.* Avoid crossing arrows.)
3. Use the food chains below to make the food web.

zooplankton eat phytoplankton
oysters eat phytoplankton and zooplankton
snails eat seaweed
fish eat shrimp
blue crabs eat shrimp, snails, oysters, and whelks
shrimp eat zooplankton
whelks eat snails and oysters
gulls eat shrimp, fish, oysters, crabs, snails and whelks
lobsters eat crabs, whelks, and oysters

Questions

1. Which organisms make up the *producers*?
2. Which organisms are the top *consumers*?
3. Which animals are the *herbivores*?
4. Which animals are both *herbivores* and *carnivores*?
5. Which animals are just *carnivores*?
6. What would happen if all the *producers* were wiped out?

Multiple choice

1. Food producing organisms are called (A) primary consumers (B) producers (C) consumers (D) herbiores
2. An animal that will eat a primary consumer is a(n) (A) producer (B) tertiary consumer (C) secondary consumer (D) none of these
3. Animals that eat plants only are (A) herbivores (B) carnivores (C) omnivores (D) producers
4. Animals that eat secondary consumers but also eat primary consumers and producers are ....consumers. (A) producers (B) primary (C) secondary (D) tertiary
5. A crab that eats fish as well as plants is an exmple of a(n) (A) primary consumer (B) secondary consumer (C) omnivore (D) none of the above.
6. The following figure is an exmple of a (A) food link (B) food web (C) food chain (D) food bubble
   O------>O----->O----->O
7. The following figure is an exmple of a (A) food link (B) food web (C) food chain (D) food bubble

Energy Flow Through the Biosphere

Learning Outcomes:

After completing this lab activity you should be able to:

1. Describe a trophic pyramid and show how a food web on land differs from an aquatic food web.
2. Explain biomagnification and why it is important.

Vocabulary:

Biomagnification – the process by which contamination "magnifies" (intensifies) with each trophic level.

Food Glorious Food

Introduction:

As you might have noticed, life in the sea shares some characteristics with terrestrial life and differs greatly in other aspects. Organisms living in a liquid medium are presented with several unique challenges and these organisms have responded in a variety of methods. Individual organism differences and adaptations, however, are only part of the story. The big picture of life in the ocean shows that even the structure of organism interaction can be different. A standard trophic (food) pyramid might have anywhere from as few as two levels to as many as six or more. It isn't the general amount of levels that is of concern but rather the relative differences that matter.

Materials:

• No specialized materials are needed for the activity.
Procedure:
1. Research Question(s):
How do terrestrial food webs differ from aquatic food webs? Why is this important?
2. Literature Review:
Food webs and trophic pyramids might not seem to be related to your daily life. But, if you eat seafood you might be better off concerned. As you have learned from your reading, organisms at the top of a trophic pyramid require vast amounts of organisms beneath them. But what happens if those organisms have consumed dangerous or damaging chemicals? Lower level organisms such as zooplankton take in minute quantities of dangerous chemicals but when such large quantities of these animals are consumed as the energy moves up a trophic pyramid the levels can become very concerning. Heavy metals such as mercury and lead as well as synthetic organic compounds such as DDT (a pesticide) or PCBs (a chemical used in refrigerant cooling) have been or are of concern. DDT, for example, was implicated in the 1960s with the brown pelican. Beginning with zooplankton, DDT was concentrated as it moved up the pyramid, through small fish, into larger fish, and finally into the fish consuming pelican. The DDT caused pelicans to lay eggs with thin shells that were easily destroyed. The pelicans nearly went extinct before a DDT ban helped populations recover. But, in cases more relevant to everyday human consumption, heavy metals are bioaccumulating in some of the top predators with which you might be familiar. Take tuna for example. Tuna consume approximately 10,000 kilograms of primary producers per kilogram of weight. Mercury is a byproduct of some industrial production and is converted to methymercury. This is accumulated in lower organisms and eventually moves up the food chain where it accumulates in many of the top predators such as tuna. You might be familiar with some of the warnings that limit the safe consumption of certain fish due to the amount of mercury in the tissues.

Trophic Worksheet

Terrestrial/Aquatic Food Type Trophic Level
1. What is your favorite fish to eat? What is the trophic level of chosen fish? If you don't eat fish ask a neighbor.
____ ____
2. What is your favorite land animal to eat? What is the trophic level of chosen meat? If you don't eat meat ask a neighbor.
____ ____
3. What is your favorite plant to eat? What is the trophic level of chosen plant?
____ ____
3. Hypothesis:
Based on the research question(s) and the literature review write your hypothesis/prediction(s) below:
____
4. Activity:
In this activity you'll complete the Trophic Worksheet to help determine the differences between terrestrial food pyramids and aquatic food pyramids. Then, as a class, you'll explore the implications by looking at how this can affect your everyday life.
1. Using your textbook, the internet or any resources provided by your teacher, complete the Trophic Worksheet. You have 30 minutes to do so.
2. Then draw the trophic pyramid (or simple food web) for each of the above three favorite dishes using the Trophic Pyramid Worksheet.
3. Compare and contrast terrestrial food webs and aquatic trophic pyramids. What are several differences between the two?
Differences between terrestrial and aquatic trophic pyramids include:
____
4. Complete the Compare and Contrast of Terrestrial and Aquatic Trophic Pyramids Worksheet.
5. As a group, discuss the research questions.
Analysis of Results:
1. One of the problems facing the oceans is a rise in toxic chemicals. If these toxins are consumed by plants and animals at the bottom of a trophic pyramid, how does this affect animals at the top of the trophic pyramid.
____
____
2. Define biomagnification. How does this affect your choice of foods, including seafood?
____
____
____
3. Does biomagnification affect terrestrial animals?
____

Conclude and Communicate:

1. The research questions for this activity:
____
2. Your hypothesis/prediction(s) for this activity:
____
3. Is your original hypothesis/prediction(s) supported by your data? Why or why not?
____
____
4. Write two new research questions based on what you have learned from this activity:
____
5. The value and importance of this activity to the study of science:
____

Trophic Pyramid Worksheet

Favorite Fish Dish	Favorite Meat Dish	Favorite Plant Dish

Compare and Contrast Terrestrial and Aquatic Trophic Pyramids

Terrestrial Trophic Pyramids	Aquatic Trophic Pyramid
	Answers vary.

Ecology and Ecosystems Lab

Learning Outcomes:

After completing this lab activity you should be able to:

1. Describe the concept of an ecosystem.
2. Explain how energy flows through ecosystems.
3. Describe a four-member open-sea food chain.
4. Identify primary producers in ocean food webs.
5. Describe the energy flow pyramid.
6. Explain why energy is lost at each trophic level of the pyramid.
7. Summarize and describe the importance of the role you played in the ecosystem during the activity.

Marine Ecosystems – The Energy Flow Through the Ecosystems Pyramid

Introduction:

Many processes connect the Earth's nonliving and living components and are the focus for the study of ecology. Scientists often use models as simulations or as approximate depictions of real life systems. They do this to further explore ideas and hypotheses regarding these systems and as a result better our understanding of ecology. There are many types of models such as: mental models, conceptual models, graphic models, physical models and mathematical models. This lab activity is an exercise using a conceptual model that of the energy flow pyramid.

Materials:

• Grassy outdoor playing area (the ground will get wet)• One large bucket of water

• One clear container approximately the same size as the bucket • Name tags, mailing labels, or laminated name cards

Procedure:

1. Research Question(s):

Using water as a substitute for energy, can you demonstrate the energy flow pyramid and interconnections within a model ecosystem?

2. Literature Review:

The pyramid of energy flow is an illustration representing the stream of energy through each trophic level in a food chain or food web from a particular ecosystem. In a food chain energy stored in the bodies of the organisms is transferred from one trophic level to the next. Some energy is lost as heat. At each new level some of the organism is not eaten, digested or absorbed – it just passes through the digestive tract of the consumer and becomes waste. Only a small amount of what is eaten and digested becomes biomass and the amount of usable energy at each trophic level gets smaller and smaller. The amount of energy lost at each level depends on the ecosystem and the organisms involved. Generally, around 90% of the energy is lost at each level. Because so much energy is lost between levels, one can see why food chains and webs rarely have more than four or five trophic levels–too little energy is left after 4-5 levels to support the organisms at the top. This is why there are fewer numbers of top consumers such as sharks, hawks, lions etc. They are usually the first to be affected by disruptions in the food chain and are vulnerable to extinction. Therefore the amount of primary production shapes the ecosystem. For example, the more phytoplankton there are in an ecosystem, the greater the population of sharks. Energy flow pyramids also help explain why the Earth can support a greater human population if people eat at lower trophic levels.

Consider the following:

3. Hypothesis:

Based on the research question(s) and the literature review write your hypothesis/prediction(s) below:

____

Vocabulary:

Biomass – the mass of all living organisms in a given region.

Food chain – a portion of a food web showing only one organism per trophic level.

Food web – a complete set of food links between organisms in a community showing who eats whom.

Plankton – passively drifting or weakly swimming organisms suspended in the water column.

Pyramid of energy flow – conceptual model expressing the relationships between trophic levels in terms of energy flow.

Trophic level – the position of a species in the food chain.

<u>The Present and Future of the Marine Environment</u>

This activity is a very simplistic teacher led simulation that actively involves twenty students. The simulation requires active participation and makes concrete the abstract concept of energy flow through an ecosystem. The remainder of the students are to watch the simulation and record their observations. Twenty nametag cards need to be created for the simulation. Nametag cards should include: primary producer names (phytoplankton), specific names (diatom), and a sketch of the organism. Divide the class into groups to research and create the nametags for the simulation.

Marine Ecosystems – Activity:

1. Make 20 nametag cards and distribute as follows:

• 8 cards with diatom or dinoflagellate and phytoplankton written on them. Students are to learn the names of the primary producers. Use the nametag card as a reference.

--These students will be the primary producers in this activity and will stand side by side facing the teacher who will be the sun.

• Five cards with various zooplankton on them such as copepods and krill.

---These students will be the primary consumers and stand side by side behind the producers.

• Four should receive cards with shrimp on them (or other secondary consumers that eat zooplankton).

• Two should receive cards with small shrimp-eating fish on them such as ballyhoo, mackerel etc.

• One student will be at the top of the pyramid and receive the shark card. This student will have the clear container at his/her feet.

• One card should be made for the teacher as the sun.

• Arrange the students into a pyramid with the phytoplankton at the bottom and the shark at the top. Put the sun at the bottom of the pyramid.

• Then, have the sun continuously pour the bucket of water into the cupped hands of the first row.

• Students in the front row then pass sunlight energy (water) with their cupped hands to the row behind them. That row passes to the next row and so on. This is a continuous process.

• At the top of the pyramid the shark puts the energy (water) into the clear container, which represents the shark's stomach.

• The class should try to conserve as much water as they can so the shark will have as much water as possible.

• When the sun is out of water, compare the amount of water that was in the sun's bucket to the amount of water that the shark put in the clear container (ie, how much energy made it to the shark?).

1. Sketch the energy flow pyramid you modeled and label the trophic levels .

2. What did the water represent in the simulation?

____

3. Approximately how much water made it to the shark?

____

4. Why? What happened to it?

____

Observation statement: Make an observational statement based on the comparison of the amount of energy (water) the sun delivered and the amount of energy (water) the shark received.

____

<u>Analysis of Results:</u>

Interpret and analyze your results for each station by answering the following question(s).

1. How was energy lost as it moved up through the pyramid's trophic levels?

____

2. How is energy "lost" in real ecosystems as it moves up the pyramid?

____

3. How many trophic levels were there in this model ecosystem?

____

4. Why do most real food chains rarely have more than four or five trophic levels?

____

5. Why are there fewer sharks than shrimp in the open ocean ecosystem?

____

6. Why can more people be supported eating lower on the food chain?

____

<u>Conclude and Communicate:</u>

1. The research question(s) for this activity:

____

Using water as a substitute for energy, can you demonstrate the energy flow pyramid and interconnections within a model ecosystem?

2. Your hypothesis/prediction(s) for this activity:

____

3. Is your original hypothesis/prediction(s) supported by your data? Why or why not?

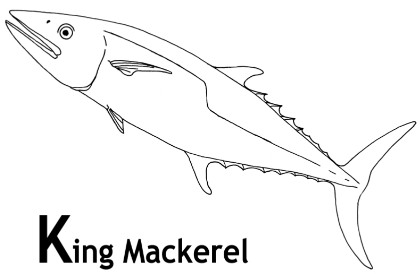
____

4. Write two new research questions based on what you have learned from this activity:

____

5. The value and importance of this activity to the study of science:

____


King Mackerel