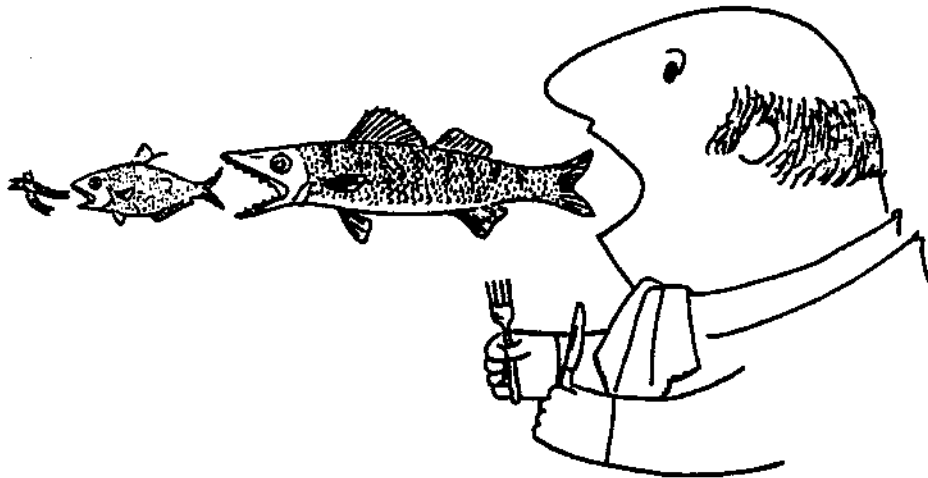




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# To Harvest A Walleye

by  
Susan Leach, Upper Arlington Schools, Ohio  
Gabriele Reil and Rosanne W. Fortner  
The Ohio State University



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Teacher Guide

OEAGLS-Oceanic  
Education  
Activities  
for  
Great  
Lakes  
Schools

**OEAGLS Investigation #11**

Completed June 1979  
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**TEACHER GUIDE**

# TEACHER GUIDE TO HARVEST A WALLEYE



by Susan Leach, Gabriele Reil and Rosanne W. Fortner  
Ohio Sea Grant Education Program

## OVERVIEW

This investigation is designed to introduce basic ecological relationships in a lake community, using the Lake Erie food chain involving algae, gizzard shad, walleye and man as an example. The first activity is a board game in the form of a biomass pyramid, with each of these organisms on a successively higher pyramid level. Beginning with 1,000 kg of algae, students move playing pieces through the pyramid levels, encountering environmental factors which increase or decrease the amount of biomass they have. The object of the game is to reach the "Harvest" with at least one kilogram of walleye.

In follow-up activities, the ecological pyramid concept is extended to land and ocean communities and the implications of energy loss between levels are discussed. The investigation concludes with the construction of a complete food web.

## PREREQUISITE STUDENT BACKGROUND

Basic mathematical skills: addition, subtraction, multiplication and division by 10 and 2

3 Describe how different conditions in the environment affect the pyramid

## MATERIALS

"To Harvest A Walleye" Game Board, spinner, and Productivity Cards, all constructed from patterns in this guide; place marker tokens (buttons — one per student), record sheets (in Student Guide), paper clip, paper fastener, Activity B Worksheets

4 Compare the biomass pyramids of lake, land and ocean environments

5 Describe how organisms are related to each other in a food web

## OBJECTIVES

1 Discuss the meaning of the following terms as they relate to a biomass pyramid: producer, herbivore, 1st order carnivore, 2nd order carnivore

2 Calculate the relative number of kilograms at each level of the biomass pyramid in a given environment

## SUGGESTED APPROACH

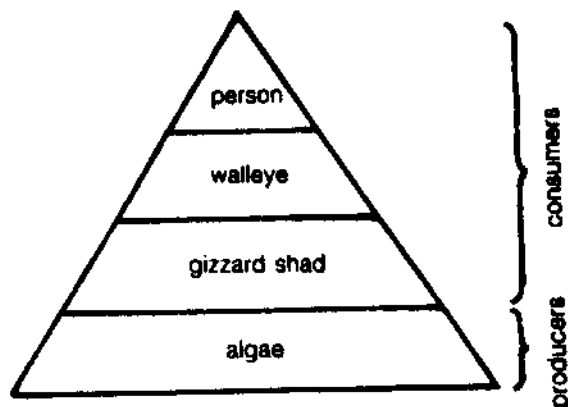
Activity A is designed for groups of 2-4 players, each group with a set of game materials. For Activities B and C students can work by themselves or in small groups. Some teacher guidance may be necessary here. You may want to discuss answers to certain questions.

## ACTIVITY A: WHO CAN HARVEST A WALLEYE?

**Keywords:** producer, herbivore, 1st order carnivore, 2nd order carnivore, lost energy, biomass pyramid (also called a food pyramid or energy pyramid)

Lake Erie is an example of a natural community. In this community the small organisms (living things) outnumber the large organisms. The smaller organisms are eaten by the larger ones. If we count all the organisms of one kind, then count all the things they eat and all the things that eat them, we can draw a pyramid of numbers that will also show who eats what.

In the "Walleye Game" there are four levels to the pyramid. The largest level is that of algae, the tiny water plants that produce food by photosynthesis. The other levels are all consumers which cannot make their own food. Gizzard shad are small fish that eat algae. Because they are plant eaters, scientists call them herbivores. The walleye is a larger fish. There are fewer walleyes than gizzard shad, so the walleye level is smaller. Walleyes eat herbivores, so scientists say that walleyes are first-order carnivores. The organism that eats the first-order carnivore (a person, in this game) is called a second-order carnivore.



**MATERIALS:** Walleye Game Board, Productivity Cards, Biomass Record (SG p. 8), markers (buttons), spinner, pencil or pen.

### PROCEDURE

This game shows how factors affecting lower parts of the food chain can affect higher levels as well. The pyramid in this game is a biomass type because it is based on the weight of the organisms in kilograms.

The object of this game is to end at the block labeled "Harvest" with at least one kilogram of fish. You will keep track of kilograms of organisms on the "Biomass Record." The game is best played by 2-4 individuals.

1. Before playing the game, read through the game board and Productivity Cards to pick out any words that are new to you. Look up the words in the Glossary on page 12.
2. Begin at block one with 1,000 kg of algae. Record this amount in the "Producers" column of the Biomass record. Spin the spinner to see who moves first. The player with the highest number will move first. Play then goes around the board to the left.
3. Move through each level of the pyramid by moving your marker the number of spaces shown on the spinner. Change your number of kilograms as the board directs. Record the new number of kg on your Biomass Record each time the mass changes.
4. Some sections of the board require you to divide the mass of the organisms by some number. Drop any fractions that you get in your answers.
5. At the end of each level, it is assumed that all organisms are captured by organisms of the next level. You must change columns on the Biomass Record and divide by 10 whenever you pass the algae or fish pictures, even if you don't land on them.
6. If at any time you have less than 1 kg left, you must return to block 1 and begin again.
7. The winner of the game is the first player to land at the triangle labeled "Harvest" with 1 kg of walleye. You must spin the exact number to land on "Harvest."

8. At the end of the game compare results on your Biomass Record with those of the other players. Compare the kg of biomass that you had at the beginning of each level of the pyramid.

9. List on your worksheet some of the things that happened to your organisms and how they affected your populations as you progressed through the game.

## ACTIVITY B: WHAT DOES A BIOMASS PYRAMID TELL US?

Although the results of the game depended on the luck of the spinner and the "Productivity Cards," many of the minor and major disasters described on the cards and on the game board actually are happening or have happened in Lake Erie. For example, on November 3, 1977, a power plant on Lake Erie killed over 600,000 fish by impingement. Most of these were gizzard shad.

At each level of a biomass pyramid energy is lost or "wasted." This is energy that cannot be passed on as food from level to level. Lost energy is one reason why it takes so much algae for so few gizzard shad and even fewer walleyes.

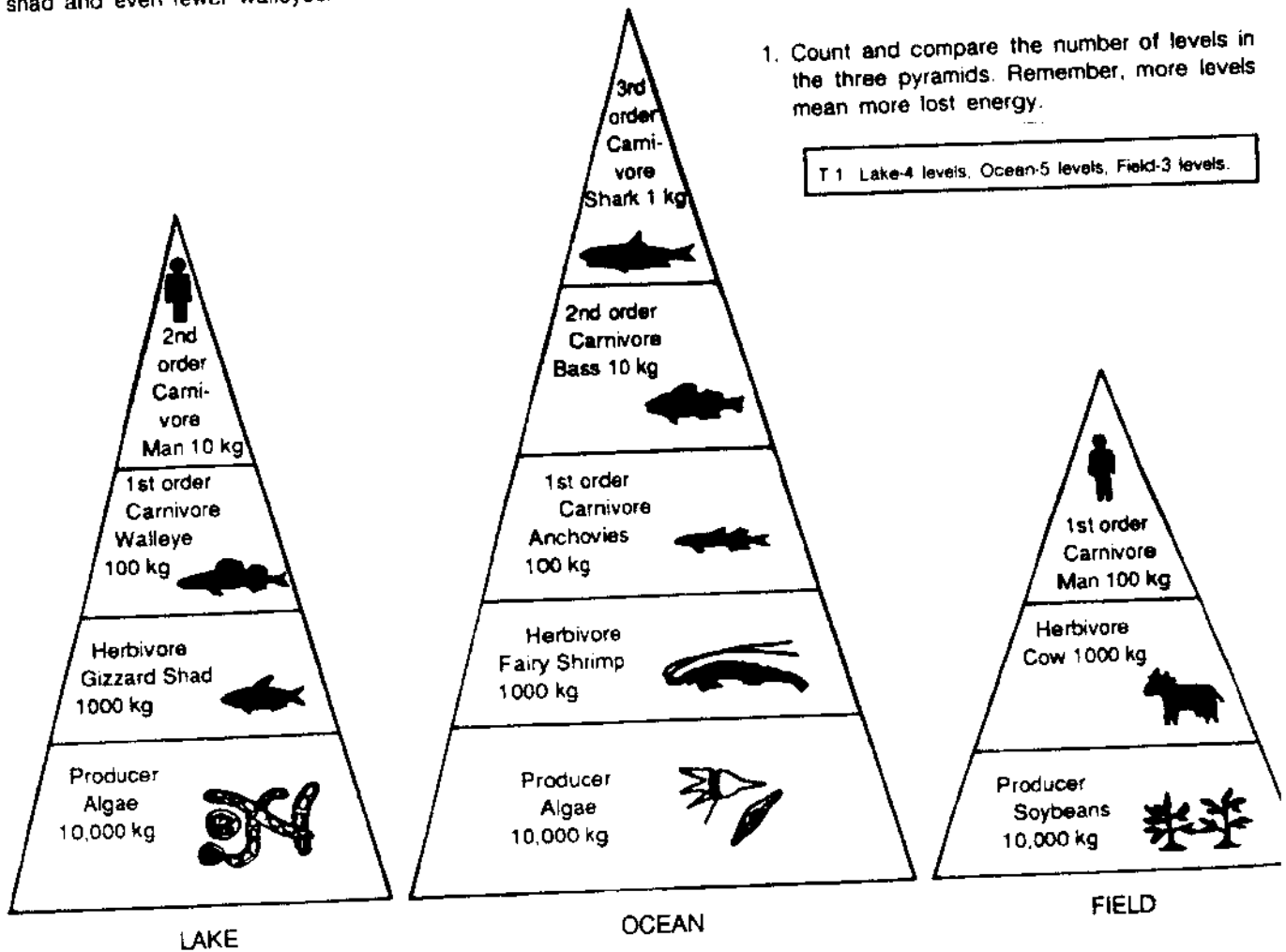
About 40% of the energy of algae is lost through respiring, growing, reproducing and waste removal. Seventy-five percent of the energy of herbivores is lost through eating, respiring, waste removal, molting, growing and reproducing. First order carnivores "waste" 55% of their energy in their normal body activities. Because of this, much less energy is available for producing biomass. Therefore, much less biomass ends up at the top of a pyramid.

### PROCEDURE

Use the following biomass pyramids to answer questions 1-3 below.

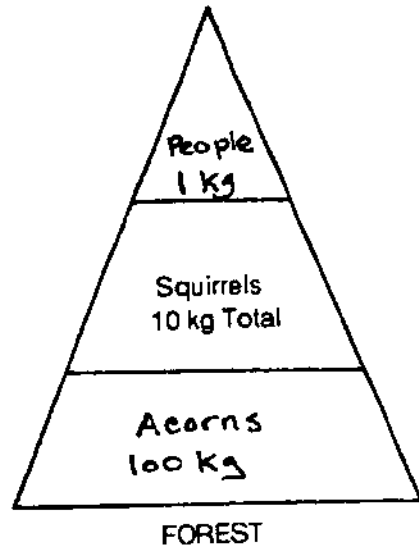
1. Count and compare the number of levels in the three pyramids. Remember, more levels mean more lost energy.

T 1 Lake-4 levels, Ocean-5 levels, Field-3 levels.



2. Which pyramid provides people with the most food?

T 2 The field pyramid provided the most food for people since food from lower levels of the pyramid is being utilized.  
 "Ocean" is not acceptable as an answer here. Since this is the tallest pyramid students tend to think that this provides the most food. They forget that more levels means more lost food energy. This pyramid does not include people. It is an example of the many food pyramids that do not involve people.



3. What might be a way of increasing the number of kilograms that people could harvest from lakes and oceans?

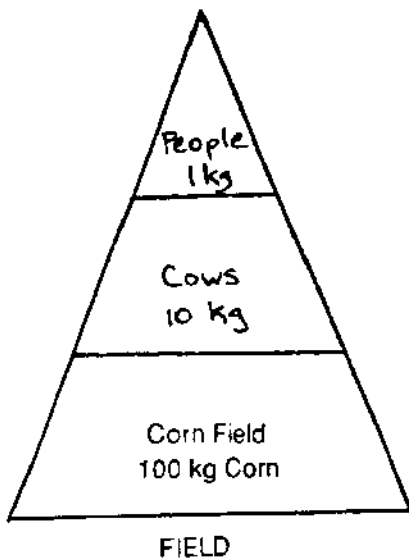
T 3. Increasing the number of producers and/or harvesting lower on the pyramid would increase available kg of food. Students may have other ideas that are correct.

Put in the amounts of each species in kilograms that would be needed to keep each level going. Assume only 1/10 of the biomass can be transferred from one level to another.

A biomass pyramid is not just a way of showing who eats what and how much they eat. It is also a simple way of showing how different parts of an ecosystem are related.

T 4. The field pyramid might be completed with pigs or cows, 10 kg, and people, 1 kg, or with squirrels, 10 kg, and bobcat, 1 kg. The forest pyramid might be completed with nuts or acorns, 100 kg, and people, 1 kg. This question is an open one, and any organisms within reason should be accepted.

4. Try and fill in on your worksheet some species of plants and animals that would fit the food pyramids below.



5. In Space 5 on your worksheet make up two food pyramids that you are in, based on a lettuce salad (one pyramid) and hamburgers from cattle (the second pyramid). Let each pyramid begin with 10 kg of producer.

T 5. The two pyramids ought to read from the bottom up: lettuce (10 kg), people (1 kg); and grass (10 kg), cattle (hamburger) 1 kg; people (1/10 kg).  
 NOTE: Students often insert hamburgers as a separate level, not realizing that they come from cattle. Also, the math seems to confuse some students, who multiply instead of divide by 10.

6. If you start with equal amounts of producers in these pyramids (10 kg) and you keep only 1/10 of the energy going from each level to the next one above it, how much biomass is available to you from the hamburger?

T 6. 1/10 kg. Again, watch the math. The question asks how much biomass is available to the student, not how much is in the hamburger.



7. To have a meal that provided 1 kg of lettuce biomass, you would have to eat 1 kg of producer (the lettuce). If you ate 1 kg of hamburger, how many kg of producer would you be eating indirectly?

T 7. 10 kg.

11. You are stuck on a desert island with nothing on it except for three chickens and a big sack of corn. What would you do in order to get the most food energy? Give reasons. (Remember, chickens are higher on the pyramid than corn.)

T 11. The students ought to answer that they would eat the chickens and then the corn, since feeding corn to the chickens would waste energy. Some answers to this question can become quite elaborate. Be flexible in accepting student ideas.

8. Which foods are usually more expensive, meat or plant products?

T 8. Meats are usually higher priced.

9. A biomass pyramid is also an energy pyramid. Based on your answers to questions 4 and 5, does it make more sense to get your energy from eating organisms on low levels of a pyramid or from eating those on higher levels?

T 9. Low levels, because very little energy has been "wasted" on life processes. (Lower levels are generally less expensive, too.)

Gizzard shad are low on the Great Lakes food pyramid. Today shad are used for oil and animal protein meal which is often fed to livestock. This wastes energy from two pyramids — the shad and the cow! If we used them directly, much less energy would be wasted in reaching the top of the pyramid. Some ways that shad could be prepared for use as human food might be as fish sticks, fish cakes, or a smoked product like herring or sardines.

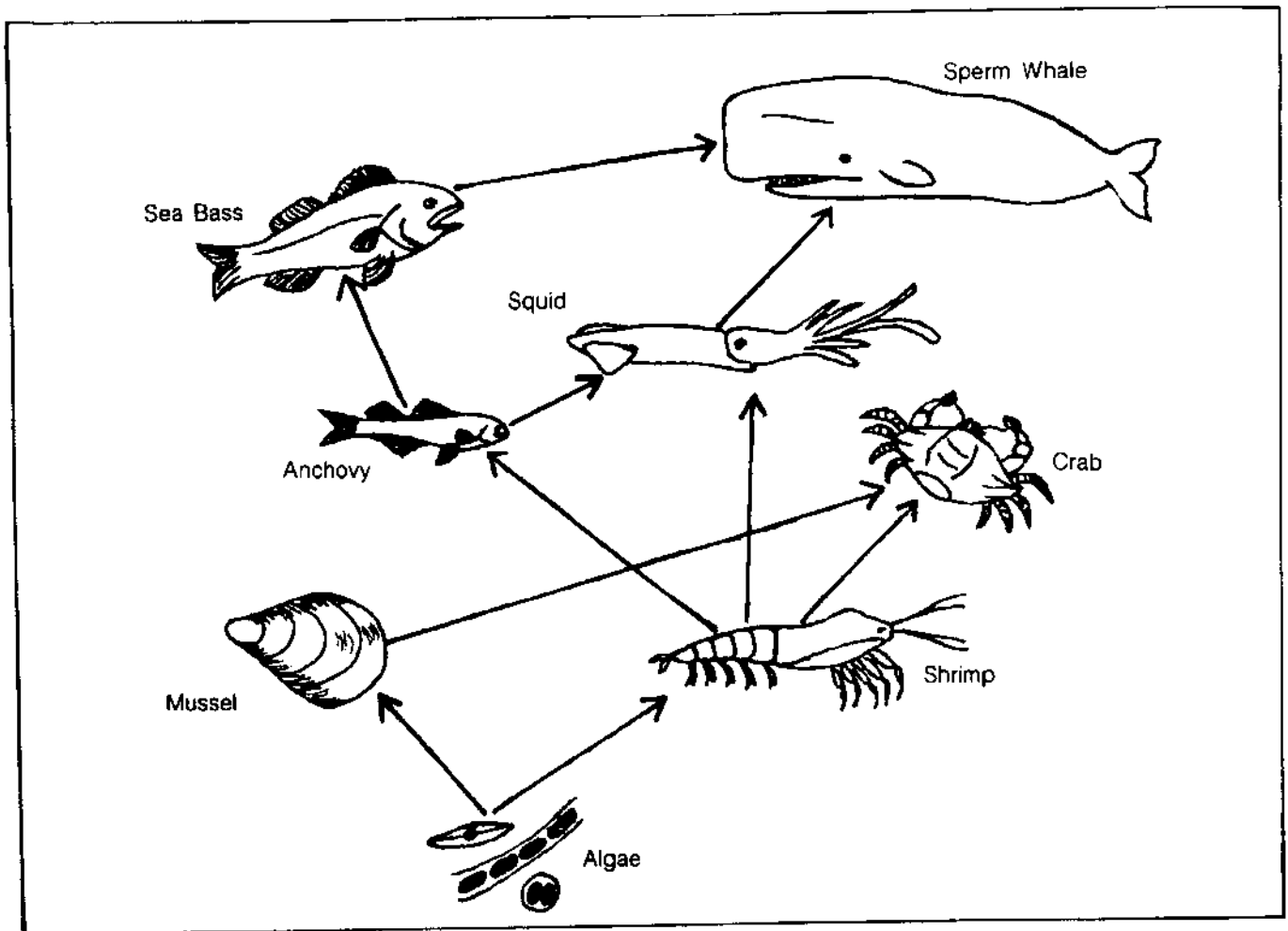
Lake Erie isn't the only place where food is wasted because we eat "high" on the pyramid. The oceans produce much food that people never use. We boil kelp to get gelatin for things like ice cream but there are many more low level pyramid foods that we can eat.

10. Look back at the Walleye Game. If you had to recommend a kind of fish for someone to eat that caused the least amount of energy to be wasted, which would it be?

T 10. Gizzard shad, as it is the lowest fish on the pyramid.

12. Look at the food web shown and see if you can find anything that people could eat. List what you find.

T 12. All the plants and animals can be eaten.



How do people decide what they are going to eat? Ask your students. Some possible ways include the availability of the food — strawberries in season, for example. Other people will choose foods because they look good, smell good, or they cost a lot and therefore must be good! On the other hand, foods may be avoided simply because the individual parts are not recognizable (as in a quiche or casserole), or because people have heard something about the food that indicated it was not good. Maybe the animal it came from is ugly or is one that people ordinarily don't eat.

One organism in this last category is the sheepshead, or freshwater drum. The name sheepshead, as much as any other factor, has probably prevented some people from using this fish as food. As the Walleye Game has indicated, the relative abundance of the organisms on lower pyramid levels makes them attractive as a source of human food. Commercial shore seiners in Sandusky Bay can collect 40 tons of drum in one haul, according to the Ohio Division of Wildlife. Most of the drum found in commercial nets are discarded as trash fish. Few people realize that proper preparation can produce a tasty fillet. Ohio Sea Grant has explored ways to develop markets and marketing methods for the drum and other underutilized species (including gizzard shad) as human food. Those who look to the oceans as the source of food for the future would do well to look to the lakes also!



## ACTIVITY C: WHAT IS A FOOD WEB?

**Keywords:** food pyramid, food web

A food pyramid is a very simple way of looking at a bigger picture called a food web. A food web is made up of all the different plants and animals that have an effect on one another by their feeding habits. A group of food pyramids meshed together make a food web.

### PROCEDURE

On your worksheet is a model of a food web that you might find in the ocean. On it, draw arrows from the organisms that are being eaten to the ones that are eating. Remember that organisms on higher levels eat those on the lower levels. For instance, squid eat shrimp and anchovies, so you would draw arrows from the shrimp and the anchovies pointing to the squid. Since shrimp eat algae you would draw an arrow from the algae to the shrimp. You may use your own judgment about who eats what. Sizes of the organisms and their positions in the food chain should provide clues. The food chain position given for each carnivore is the most common one for that organism. It doesn't mean that the animal can only eat organisms immediately below it. Some animals which are scavengers can eat organisms from all levels of the chain.

There are many correct answers to this activity.

This last activity builds on Activity B by having the students draw lines between organisms that are in the same food pyramid. Since most animals eat more than one thing, a network of lines like a spider's web will result. A sample of possible connections is shown on page 8. Since there are several species of most of the organisms shown, many different webs are possible. As the Student Guide states, there are no absolutely correct answers.

Emphasize to the students that such a web is like a complex food pyramid. If one part is removed the whole system will be out of balance.

### REVIEW QUESTIONS

1. List the two kinds of organisms represented in a pyramid.

R 1. Producers and consumers, or plants and animals.

2. Which levels of a pyramid have the least energy available?

R 2. The higher levels have energy that has passed through several levels, decreasing at each level. Hence, they have lost the most energy and have the least available.

3. If the herbivores were taken out of a food pyramid by a disaster, what would happen to the producers? The carnivores? Use your own food web as an example if you want.

R 3. The producers would have a population explosion, use up all available nutrients, and die. The carnivores would starve since they cannot eat the producers. Many students answer: "They die." Have the students elaborate on and give reasons for their answers.

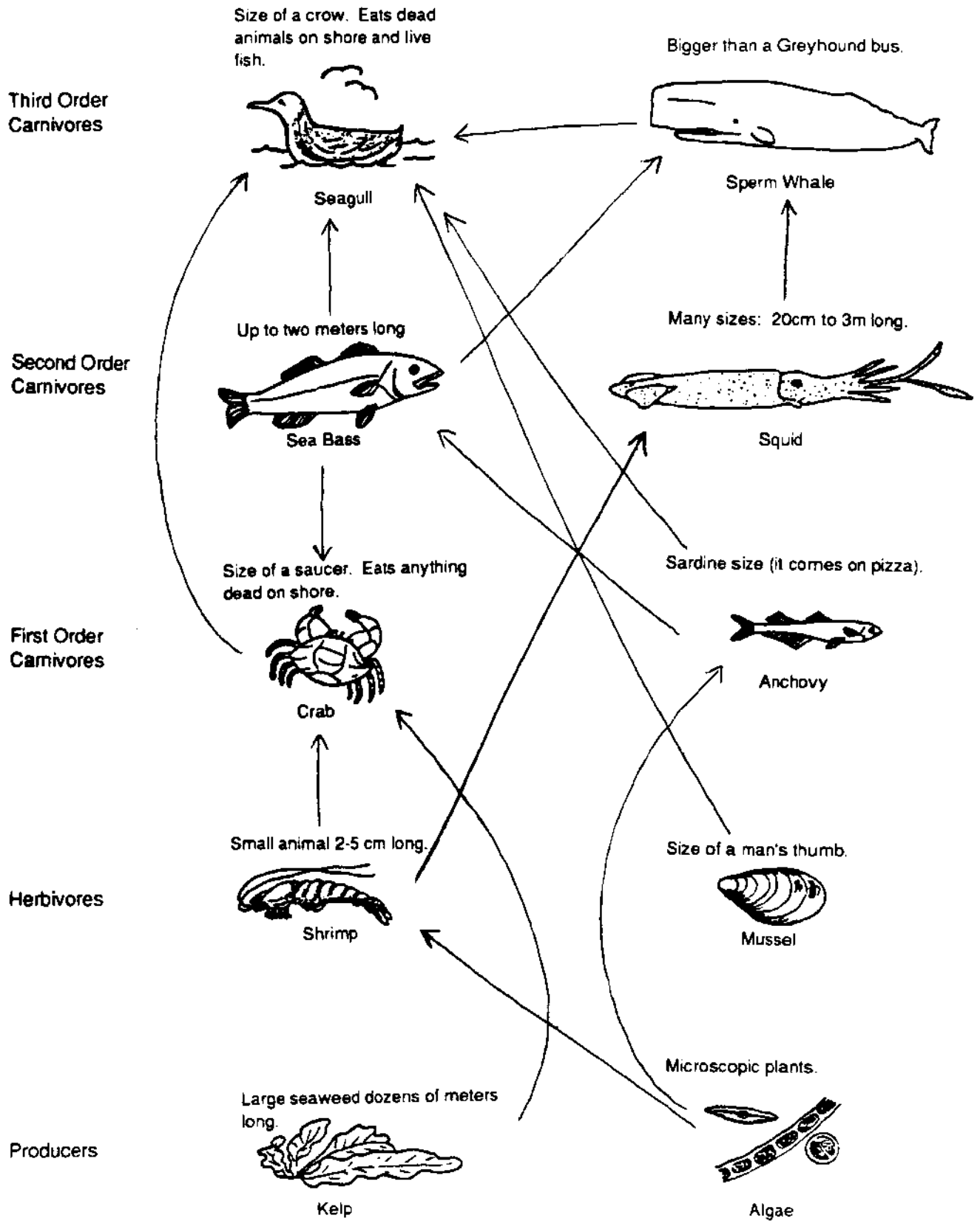
### THINK IT OVER

If people harvested all the carnivores in a food chain, what would happen?

Is it a good idea to harvest all the carnivores?

Carnivores hold down populations of herbivores. Without this population check, herbivores would have a population explosion and eat themselves out of food. Then they would starve.

NOTE: For answers to questions 3 and "Think It Over," try to have the students make up several scenarios as examples. Accept all of them and then have the students decide which are most true to life.



## EXTENSIONS

The Pete Seeger song entitled "The People Are Scratching" deals with the problem of removing organisms from the food web. Words and music are reprinted here. The song is on an album called God Bless The Grass (Columbus #CL 2432).

You may wish to play or have students sing the song and answer the questions. This would help to reinforce the importance of each link in a food chain.

### THE PEOPLE ARE SCRATCHING

by Ernie Marris, Harold Martin and Pete Seeger

Come fill up your glasses — set yourself down  
I'll tell you a story of somebody's town  
It isn't too near and it's not far away,  
It's not a place where I'd want to stay.

The people are scratching all over the street  
Because the rabbits had nothing to eat.

The winter came in with a cold icy blast  
It killed off the flowers and killed off the grass.  
The rabbits were starving because of the freeze;  
They started eating all the bark on the trees.

(Chorus)

The farmers said, "This sorta thing won't do;  
Our trees will be dead when the rabbits get through.  
We'll have to poison the rabbits — it's clear  
-Or we'll have no crops to harvest next year.

(Chorus)

So they bought the poison — and spread it around  
And soon dead rabbits began to be found.  
The dogs ate the rabbits and the farmers just said  
"We'll poison those rabbits till the last dog is dead."

The musical notation consists of three staves of music in 4/4 time. The first staff has a treble clef and a key signature of one flat (B-flat). The notes are: G4, A4, Bb4, C5, Bb4, A4, G4, F4, E4, D4, C4. Chords above the staff are Am, Dm, E7, Am. The second staff has a treble clef and a key signature of one flat. The notes are: G4, A4, Bb4, C5, Bb4, A4, G4, F4, E4, D4, C4. Chords above the staff are C, G7, C, Am. The third staff has a treble clef and a key signature of one flat. The notes are: G4, A4, Bb4, C5, Bb4, A4, G4, F4, E4, D4, C4. Chords above the staff are Am7, Dm, E7, Am.

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(Chorus)

Now up in the sky there were meat-eating fowl,  
The dead rabbits poisoned the hawks and the owls  
Thousands of field mice the hawks used to chase  
Started multiplying all over the place.

(Chorus)

The fields and meadows were barren and brown;  
The mice got hungry and moved into town.  
The city folks took the farmer's advice,  
And all of them started to poison the mice.

(Chorus)

There were dead mice in all the apartments and flats  
The cats ate the mice and the mice killed the cats  
The smell was awful — and I'm glad to say  
I wasn't the man hired to haul 'em away.

(Chorus)

Well all through the country and all through the town  
There wasn't a dog or a cat to be found.  
The fleas asked each other, "Now where can we stay?"  
They've been on the people from then till this day.

(Chorus)

So all you small creatures that live in this land  
Stay clear of the man with the poisonous hand.  
A few bales of hay might keep you alive;  
But he'll pay more to kill ya than to let you survive

(Chorus)

Interpreting the song:

1. What is making the people scratch?
2. What natural factor was responsible for starting all the problems described in this song?
3. In the space below, diagram the food web that the song describes.

- A. Put an X on the names of animals that the people poisoned on purpose.
  - B. Circle all the other animals that died from eating the X animals.
4. What is meant by the last line of the song?

## REFERENCES

Almost all biology and ecology texts will have some reference to food chains, pyramids and webs. The texts below may be useful.

Barufaldi, J. P., Geroge T. Ladd and Alice J. Moses, Health Science. D. C. Heath and Co., Lexington, MA, 1984.

Miller, G. Tyler, Jr., Living in the Environment, 4th Ed. Wadsworth, Belmont, CA, 1985.

Pimm, Stewart L., Food Webs. Chapman and Hall, New York, 1982.

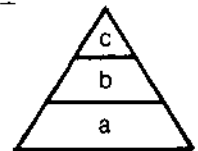
Ohio Department of Natural Resources, Publication 185, "Gizzard Shad in Ohio," Life History Notes.

Ohio Department of Natural Resources, Publication 141, "Yellow and Blue Walleye in Ohio," Life History Notes.

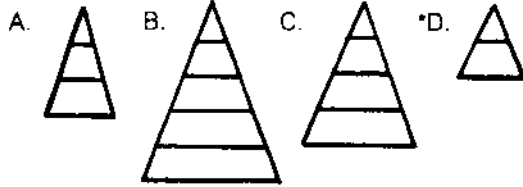
Ohio Department of Natural Resources, Division of Wildlife, Publication 7, "Water Pollution, Fish Kills and Stream Litter Investigations, 1984."

## EVALUATION ITEMS

1. A plant is eaten by a herbivore, and the herbivore is eaten by carnivore. This set of relationships is called:
  - A. A menu.
  - B. An eating cycle.
  - \*C. A food chain.
  - D. A food web.
2. How is energy "wasted" by the different levels of a biomass pyramid?
  - A. Breathing and respiration.
  - B. Eating and excreting wastes.
  - C. Growing and reproducing.
  - \*D. All of the above.
3. If this structure represents a biomass pyramid, how much of the biomass of a is available to be used by the organisms of b?
  - A. 1/5
  - \*B. 1/10
  - C. 1/4
  - D. 1/2



4. Which biomass pyramid would be more efficient at providing people with food? (NOTE: People are at the top of each pyramid.)



5. In harvesting a walleye from Lake Erie, which of the following is a correct food chain?

- \*A. Algae → gizzard shad → walleye → person
- B. Seaweed → minnows → carp → walleye → person
- C. Carp → algae → walleye → person
- D. Water plants → walleye → person

6. In order to feed more people, we should try harvesting:

- \*A. Plants and animals that are lower in food chains.
- B. More meat and fewer vegetables to eat.
- C. More sheep and fewer cows.
- D. As many walleyes as possible.

7. Why is there less energy available to top carnivores than to lower order consumers?

- \*A. Energy is "wasted" by body processes of the lower organisms.
- B. Top carnivores can't eat as much as herbivores.
- C. Top carnivores do not need as much energy to live.
- D. There are too many top carnivores.

8. In the biomass pyramid shown, how many kg of producers are needed to support 1 kg of man?

- A. 10
- \*B. 100
- C. 1,000
- D. 10,000

9. Where do humans usually fit into a biomass pyramid?

- \*A. At the top.
- B. In the middle.
- C. At the bottom.

10. What is a group of food chains stuck together called?

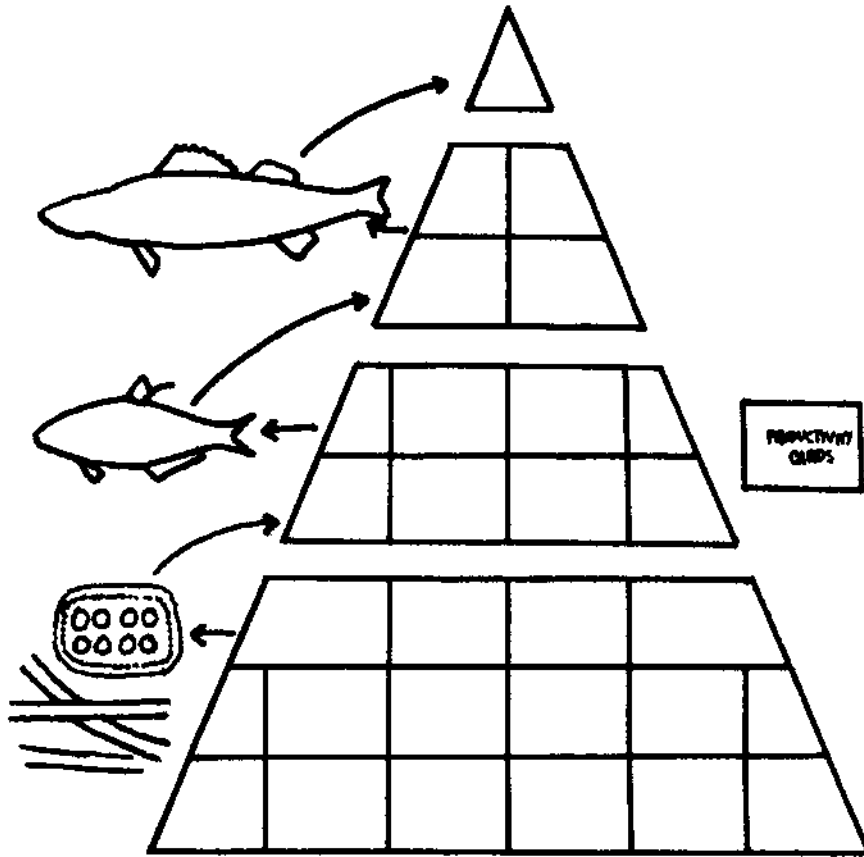
- A. Eutrophication.
- \*B. A food web.
- C. Productivity.
- D. An environment.

## GLOSSARY

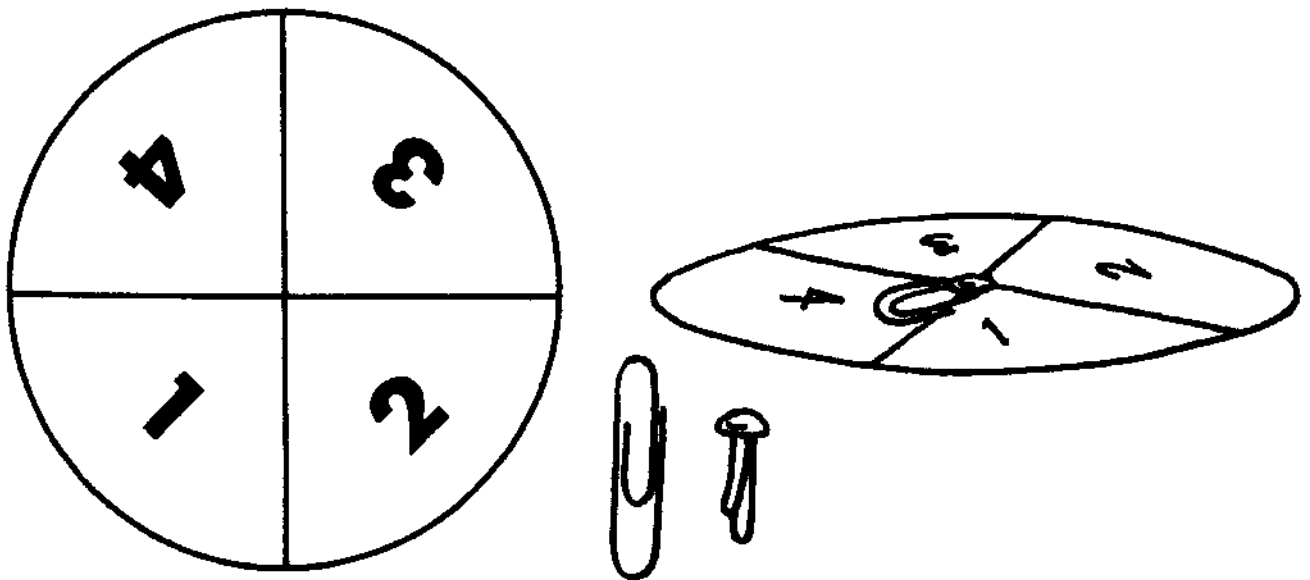
1. algae bloom: situation in which algae have multiplied very rapidly.
2. breeding ground: place where organisms reproduce.
3. carnivore: animal which eats animals.
4. entrain: to suck fish up into water intake valves from industry. (Such fish are killed by temperature and pressure changes and physical abrasion.)
5. eutrophication: the natural aging process of a lake during which the lake becomes shallower and shallower and warmer and warmer, finally becoming a marshland, and then dry land.
6. food chain: sequence in which organisms eat and are eaten by other organisms.
7. herbicide: a chemical that kills plants.
8. herbivore: animal which eats plants.
9. impinge: to suck fish up against industrial intake sieves and hold them there, causing suffocation.
10. landfill: portion of lake which is diked and filled with gravel, soil, garbage, etc., to make more land area.
11. nutrients: chemicals needed by plants and animals — fertilizers (potassium, phosphorus, nitrogen).
12. organism: any living thing.
13. producer: plant which performs photosynthesis and forms the base of the food chain.
14. productivity: a measure of the rate of production.
15. thermal pollution: hot water.

# Walleye Game Construction

The game board should look like this when finished.



Cut out the spinner and paste it on a piece of cardboard. You will need a paper clip and a paper fastener to assemble as shown.



Eutrophication speeds up in the Western Basin of lake. Lack of oxygen kills all but 100 kg.

Pollution from the Cuyahoga River enters the lake. Lose 100 kg organisms.

ORGANISMS DOUBLE !!

Tanker grounds on shoal dumping sulfuric acid. Lose 100 kg.

Oil spill. Lose all organisms. Go back to block 1; begin with 1,000 kg algae.

Sewage treatment plant opened with better cleaning equipment. Lower nutrient levels result because there is less sewage pollution. Lose 50 kg.



Land fill. Breeding grounds are destroyed. Lose all organisms. Go back to block 1 and begin with 1,000 kg algae.

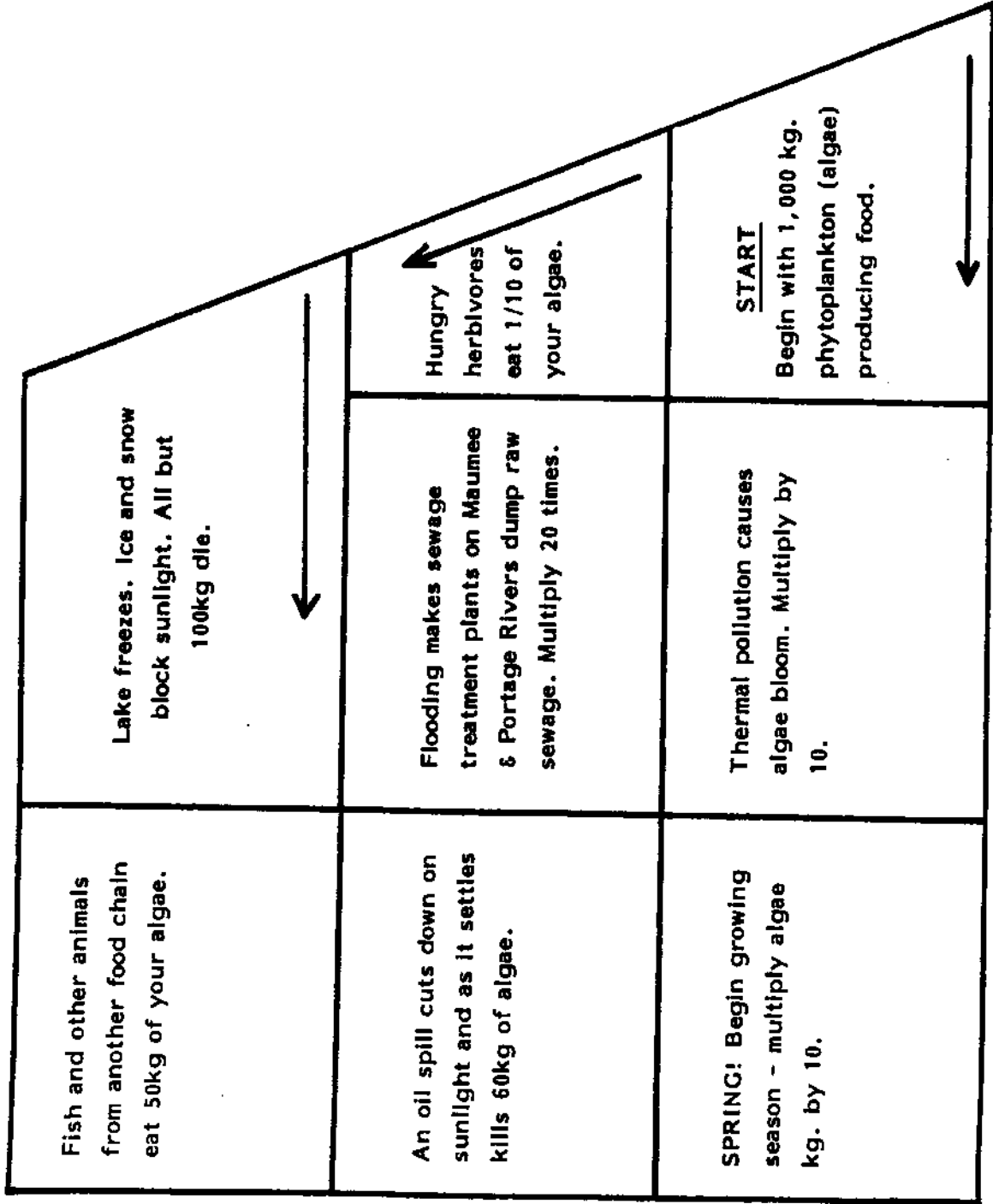
Grass carp (herbivorous fish from another food chain) are introduced into Lake Erie. They eat  $\frac{1}{2}$  your algae.

Save this card until you need it. Coast Guard saves the day and cleans up the oil spill. You lose only  $\frac{1}{2}$  your algae.

Algae that died in another bloom start to decay and release nutrients into the water. Add 50 kg.

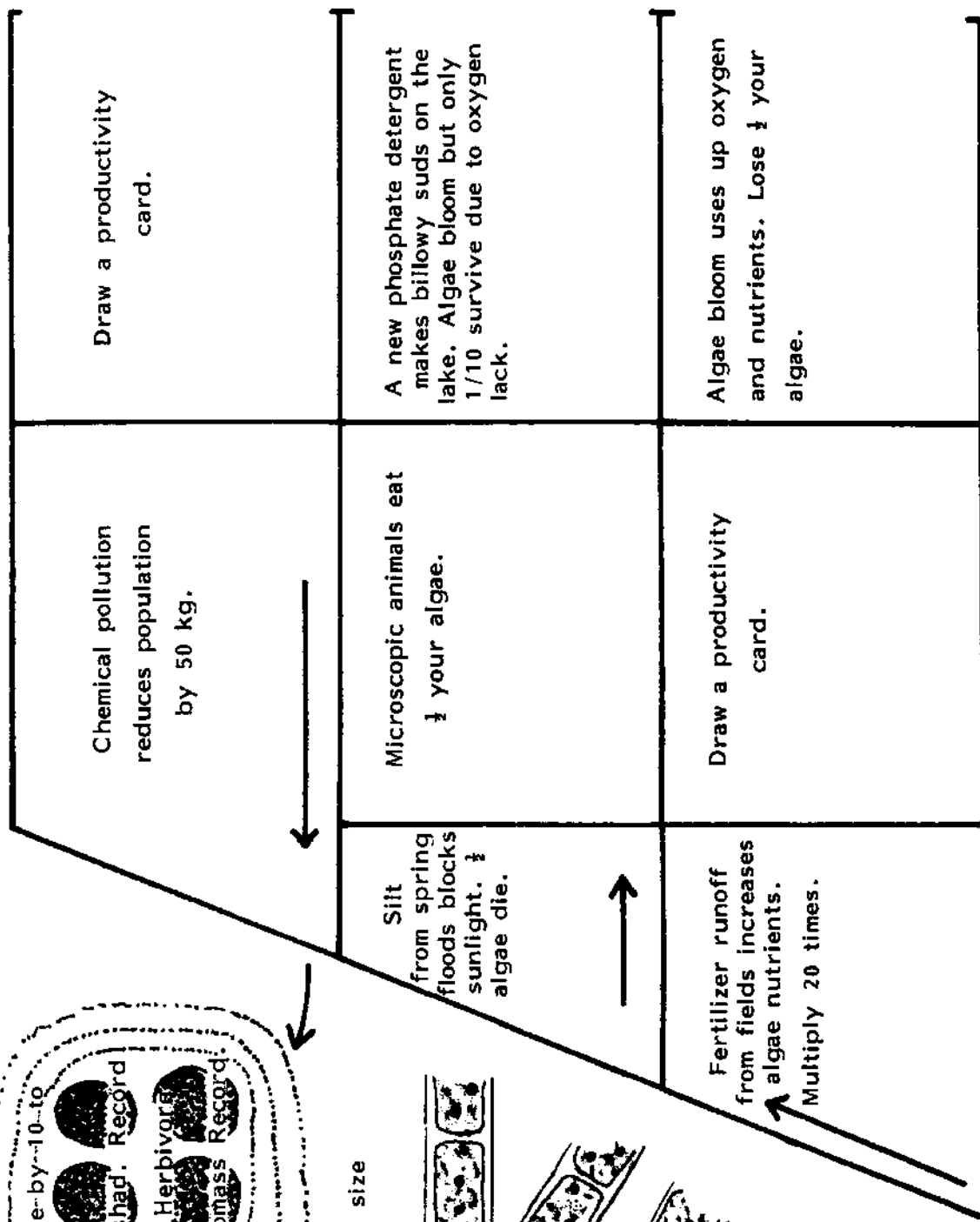
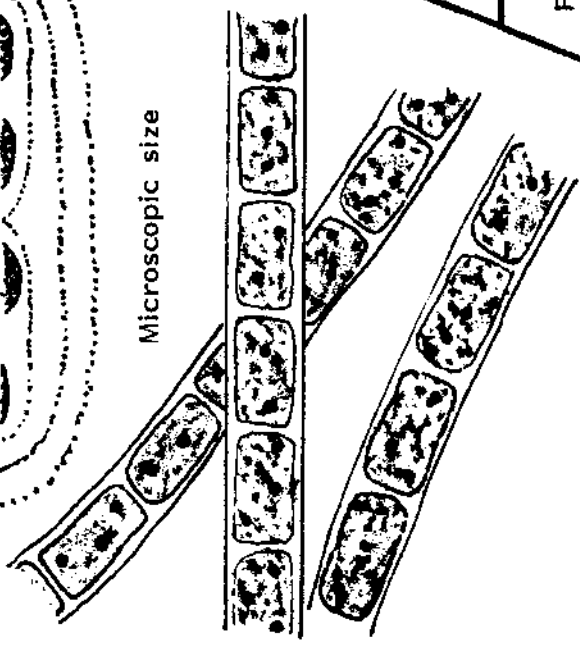
Army Corps of Engineers stops dumping dredging spoils into the lake. Add 50 kg.

A power plant dumps hot water killing all except blue-green algae. Lose 200 kg.

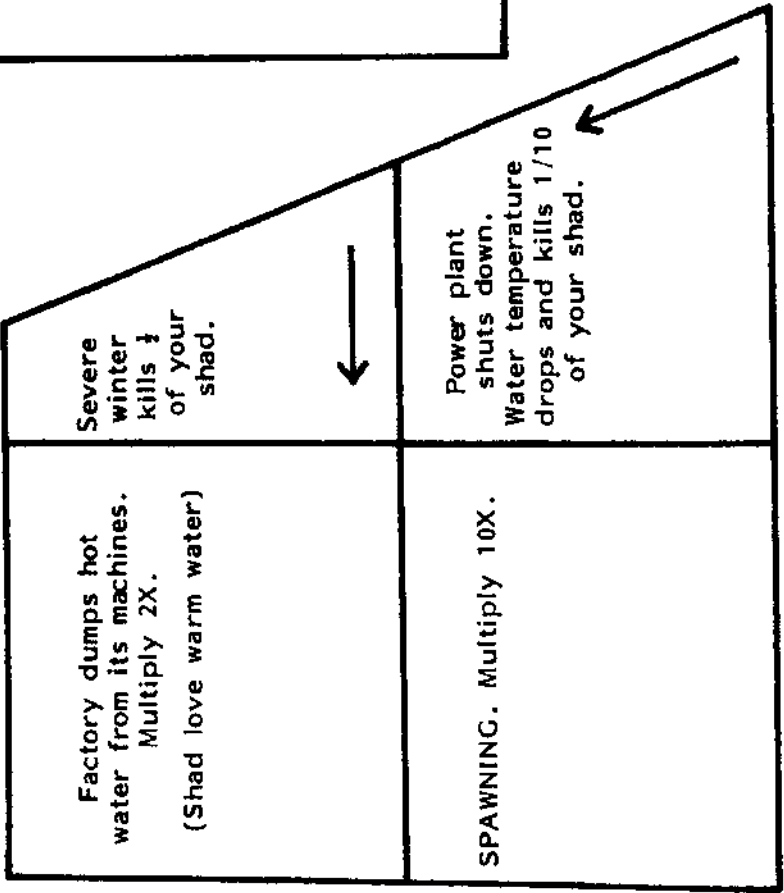


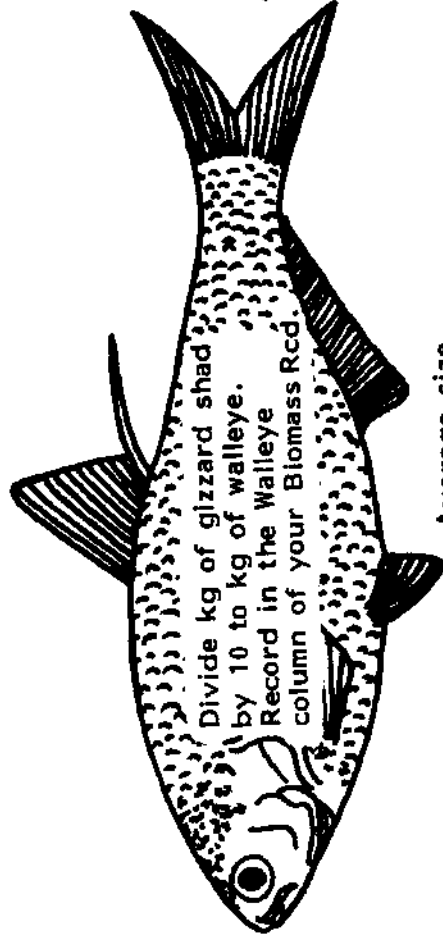
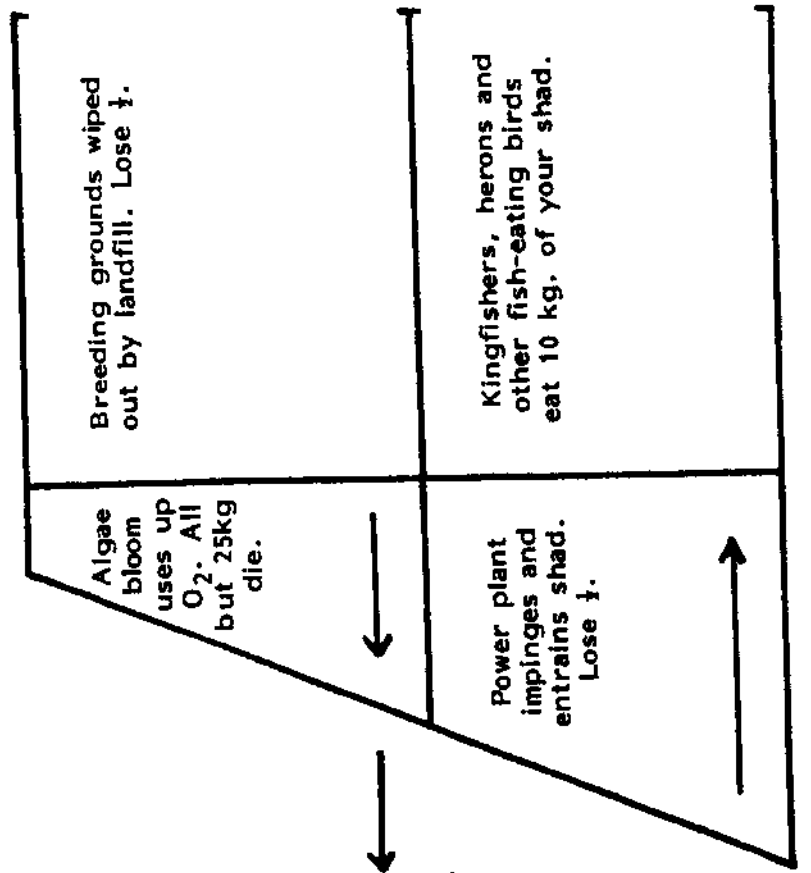
Divide kg. of algae by 10 to get kg. of gizzard shad. Record this number in the Herbivore column of your Biomass Record.

Microscopic size



PRODUCTIVITY  
CARDS

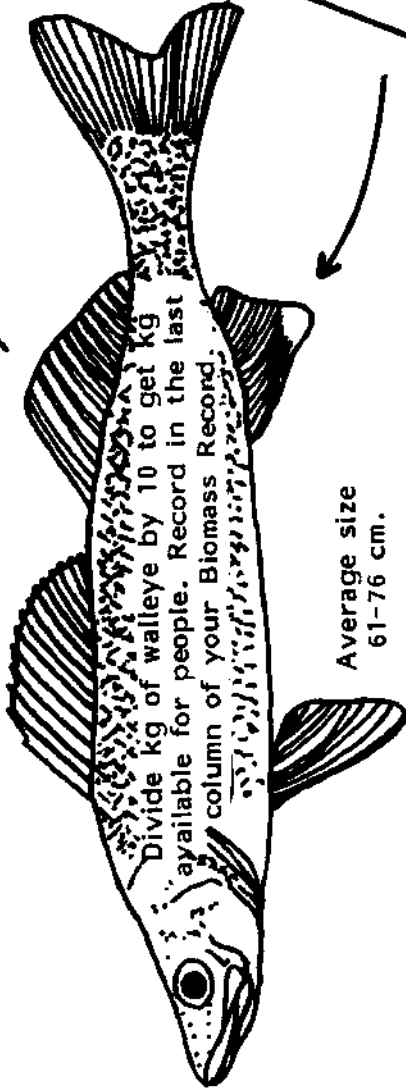




Divide kg of gizzard shad by 10 to kg of walleye. Record in the Walleye column of your Biomass Rcd.

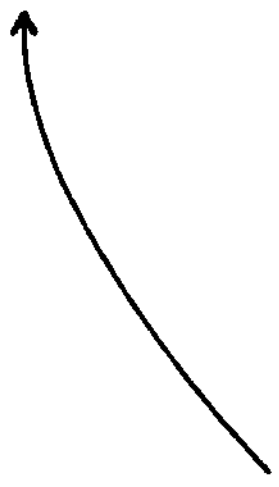
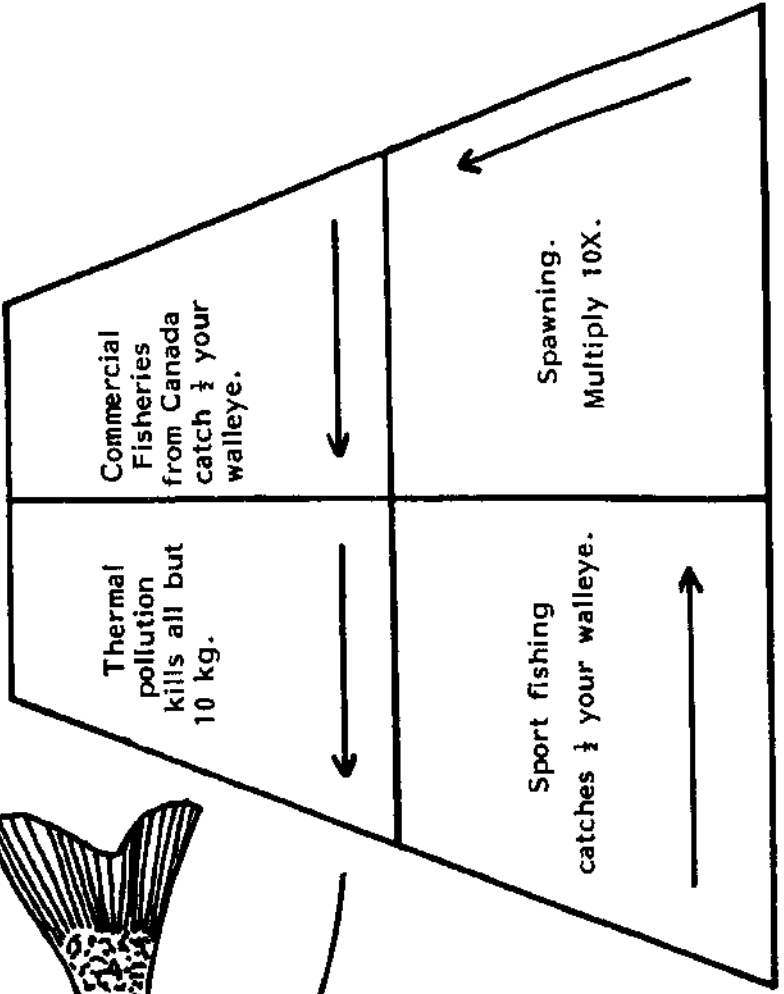
Average size 30-38 cm.

**HARVEST.**  
A person be-  
comes a second  
order carnivore.



Divide kg of walleye by 10 to get kg  
available for people. Record in the last  
column of your Biomass Record.

Average size  
61-76 cm.





**Ohio Sea Grant Program**

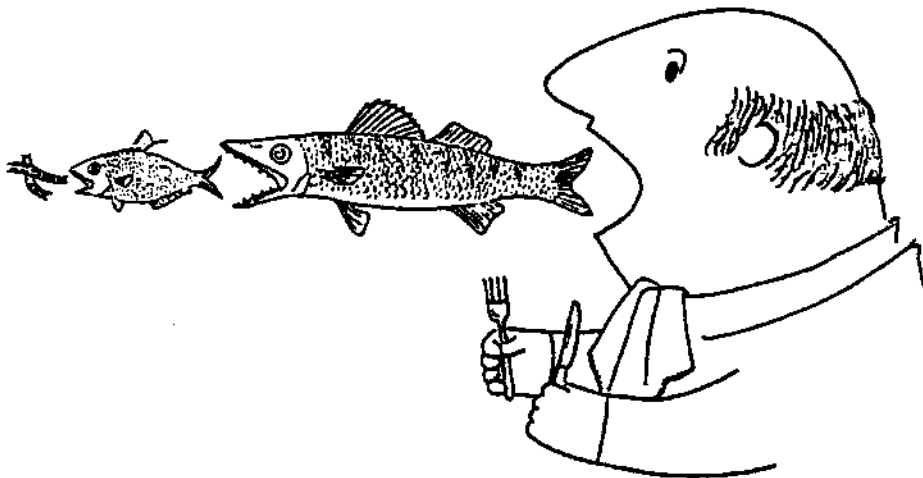
**Charles E. Herdendorf, Program Director**  
**Rosanne W. Fortner, Assistant Director for Education**  
**Victor J. Mayer, Project Director**

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# To Harvest A Walleye

by  
Susan Leach, Upper Arlington Schools, Ohio,  
Gabriele Reil and Rosanne W. Fortner,  
The Ohio State University



**OEAGLS—Oceanic  
Education  
Activities  
for  
Great  
Lakes  
Schools**



## **OEAGLS Investigation #11**

Completed June 1979

Revised November 1980 and January 1986

This instructional activity was prepared with the support of the National Oceanic and Atmospheric Administration, Office of Sea Grant, The Ohio State University School of Natural Resources and College of Education. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the views of NOAA or the University.

# To Harvest A Walleye



by

Susan Leach, Gabriele Reil and Rosanne W. Fortner

## INTRODUCTION

A walleye is a large, good-tasting fish that is also a good fighter when it is caught. Because of these characteristics, the walleye is a favorite of fishermen. In 1982, fishermen caught over 3,000,000 walleye in Lake Erie.

Lake Erie is considered by many to be the best walleye lake in North America. What does it take for a lake to produce a walleye? Why can't we catch as many walleyes in Lake Erie as we can some smaller fish?

**OBJECTIVES:** When you have completed these activities, you will be able to:

1. Discuss the meaning of the following terms as they relate to a biomass pyramid: producer, herbivore, 1st order carnivore, 2nd order carnivore.
2. Calculate the relative number of kilograms at each level of the biomass pyramid in a given environment.
3. Describe how different conditions in the environment affect the pyramid.
4. Compare the biomass pyramids of lake, land and ocean environments.
5. Describe how organisms are related to each other in a food web.

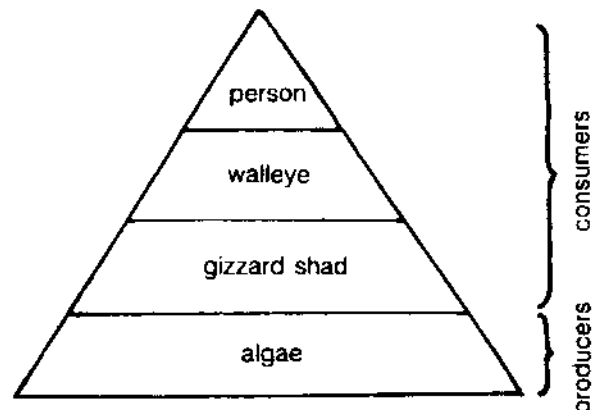
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## ACTIVITY A: WHO CAN HARVEST A WALLEYE?

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Lake Erie is an example of a natural community. In this community the small organisms (living things) outnumber the large organisms. The smaller organisms are eaten by the larger ones. If we count all the organisms of one kind, then count all the things they eat and all the things that eat them, we can draw a pyramid of numbers that will also show who eats what.

In the "Walleye Game" there are four levels to the pyramid. The largest level is that of algae, the tiny water plants that produce food by photosynthesis. The other levels are all consumers which cannot make their own food. Gizzard shad are small fish that eat algae. Because they are plant eaters, scientists call them herbivores. The walleye is a larger fish. There are fewer walleyes than gizzard shad, so the walleye level is smaller. Walleyes eat herbivores, so scientists say that walleyes are first-order carnivores. The organism that eats the first-order carnivore (a person, in this game) is called a second-order carnivore.



**MATERIALS:** Walleye Game Board, Productivity Cards, Biomass Record (page 8), markers (buttons), spinner, pencil or pen.

## PROCEDURE

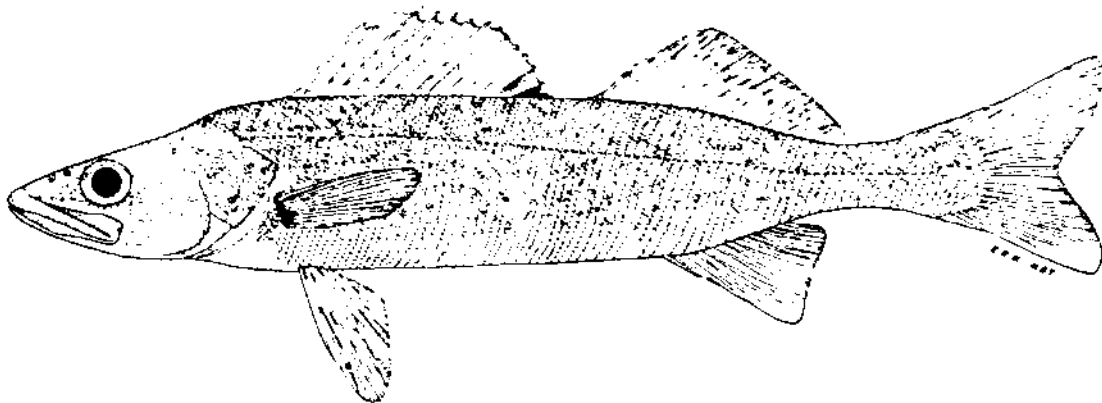
This game shows how factors affecting lower parts of the food chain can affect higher levels as well. The pyramid in this game is a biomass type because it is based on the weight of the organisms in kilograms.

The object of this game is to end at the block labeled "Harvest" with at least one kilogram of fish. You will keep track of kilograms of organisms on the "Biomass Record." The game is best played by 2-4 individuals.

1. Before playing the game, read through the game board and Productivity Cards to pick out any words that are new to you. Look up the words in the Glossary on page 7.
2. Begin at block one with 1,000 kg of algae. Record this amount in the "Producers" column of the Biomass record. Spin the spinner to see who moves first. The player with the highest number will move first. Play then goes around the board to the left.
3. Move through each level of the pyramid by moving your marker the number of spaces shown on the spinner. Change your number of kilograms as the board directs. Record the new number of kg on your Biomass Record each time the mass changes.
4. Some sections of the board require you to divide the mass of the organisms by some number. Drop any fractions that you get in your answers.
5. At the end of each level, it is assumed that all organisms are captured by organisms of the next level. You must change columns on the Biomass Record and divide by 10 whenever you pass the algae or fish pictures, even if you don't land on them.
6. If at any time you have less than 1 kg left, you must return to block 1 and begin again.
7. The winner of the game is the first player to land at the triangle labeled "Harvest" with 1 kg of walleye. You must spin the exact number to land on "Harvest."
8. At the end of the game compare results on your Biomass Record with those of the other players. Compare the kg of biomass that you had at the beginning of each level of the pyramid.
9. List on your worksheet some of the things that happened to your organisms and how they affected your populations as you progressed through the game.

## WALLEYE

*Stizostedion vitreum vitreum* (Mitchill)



## ACTIVITY B: WHAT DOES A BIOMASS PYRAMID TELL US?

Although the results of the game depended on the luck of the spinner and the "Productivity Cards," many of the minor and major disasters described on the cards and on the game board actually are happening or have happened in Lake Erie. For example, on November 3, 1977, a power plant on Lake Erie killed over 600,000 fish by impingement. Most of these were gizzard shad.

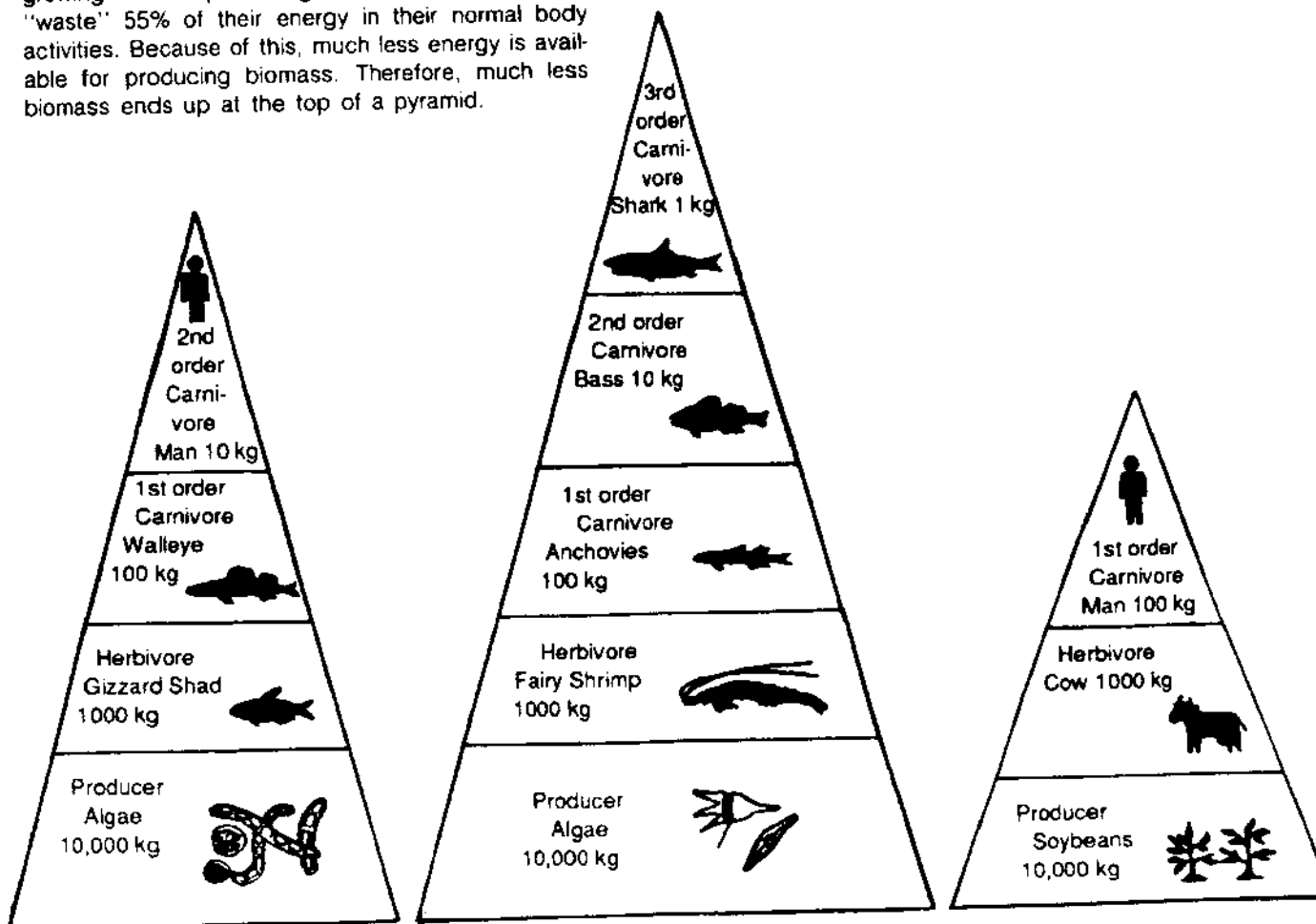
At each level of a biomass pyramid energy is lost or "wasted." This is energy that cannot be passed on as food from level to level. Lost energy is one reason why it takes so much algae for so few gizzard shad and even fewer walleyes.

About 40% of the energy of algae is lost through respiring, growing, reproducing and waste removal. Seventy-five percent of the energy of herbivores is lost through eating, respiring, waste removal, molting, growing and reproducing. First order carnivores "waste" 55% of their energy in their normal body activities. Because of this, much less energy is available for producing biomass. Therefore, much less biomass ends up at the top of a pyramid.

### PROCEDURE

Use the following biomass pyramids to answer questions 1-3 below.

1. Count and compare the number of levels in the three pyramids. Remember, more levels mean more lost energy.
2. Which pyramid provides people with the most food?
3. What might be a way of increasing the number of kilograms that people could harvest from lakes and oceans?



LAKE

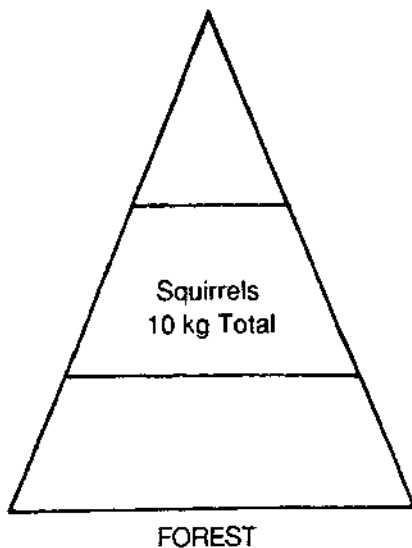
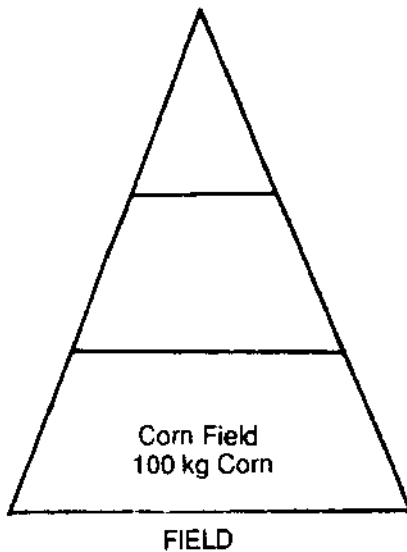
OCEAN

FIELD

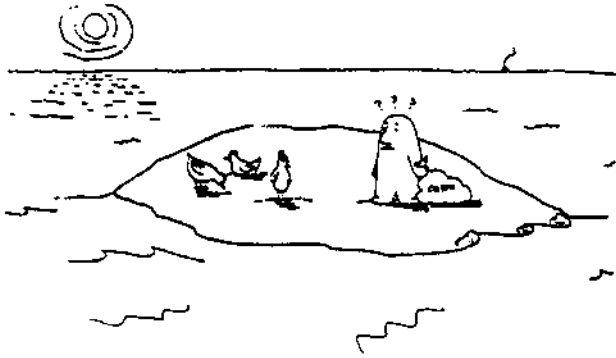
A biomass pyramid is not just a way of showing who eats what and how much they eat. It is also a simple way of showing how different parts of an ecosystem are related.

4. Try and fill in on your worksheet some species of plants and animals that would fit the food pyramids below.

Put in the amounts of each species in kilograms that would be needed to keep each level going. Assume only 1/10 of the biomass can be transferred from one level to another.



5. In Space 5 on your worksheet make up two food pyramids that you are in, based on a lettuce salad (one pyramid) and hamburgers from cattle (the second pyramid). Let each pyramid begin with 10 kg of producer.
6. If you start with equal amounts of producers in these pyramids (10 kg) and you keep only 1/10 of the energy going from each level to the next one above it, how much biomass is available to you from the hamburger?
7. To have a meal that provided 1 kg of lettuce biomass, you would have to eat 1 kg of producer (the lettuce). If you ate 1 kg of hamburger, how many kg of producer would you be eating indirectly?
8. Which foods are usually more expensive, meat or plant products?
9. A biomass pyramid is also an energy pyramid. Based on your answers to questions 4 and 5, does it make more sense to get your energy from eating organisms on low levels of a pyramid or from eating those on higher levels?
10. Look back at the Walleye Game. If you had to recommend a kind of fish for someone to eat that caused the least amount of energy to be wasted, which would it be?

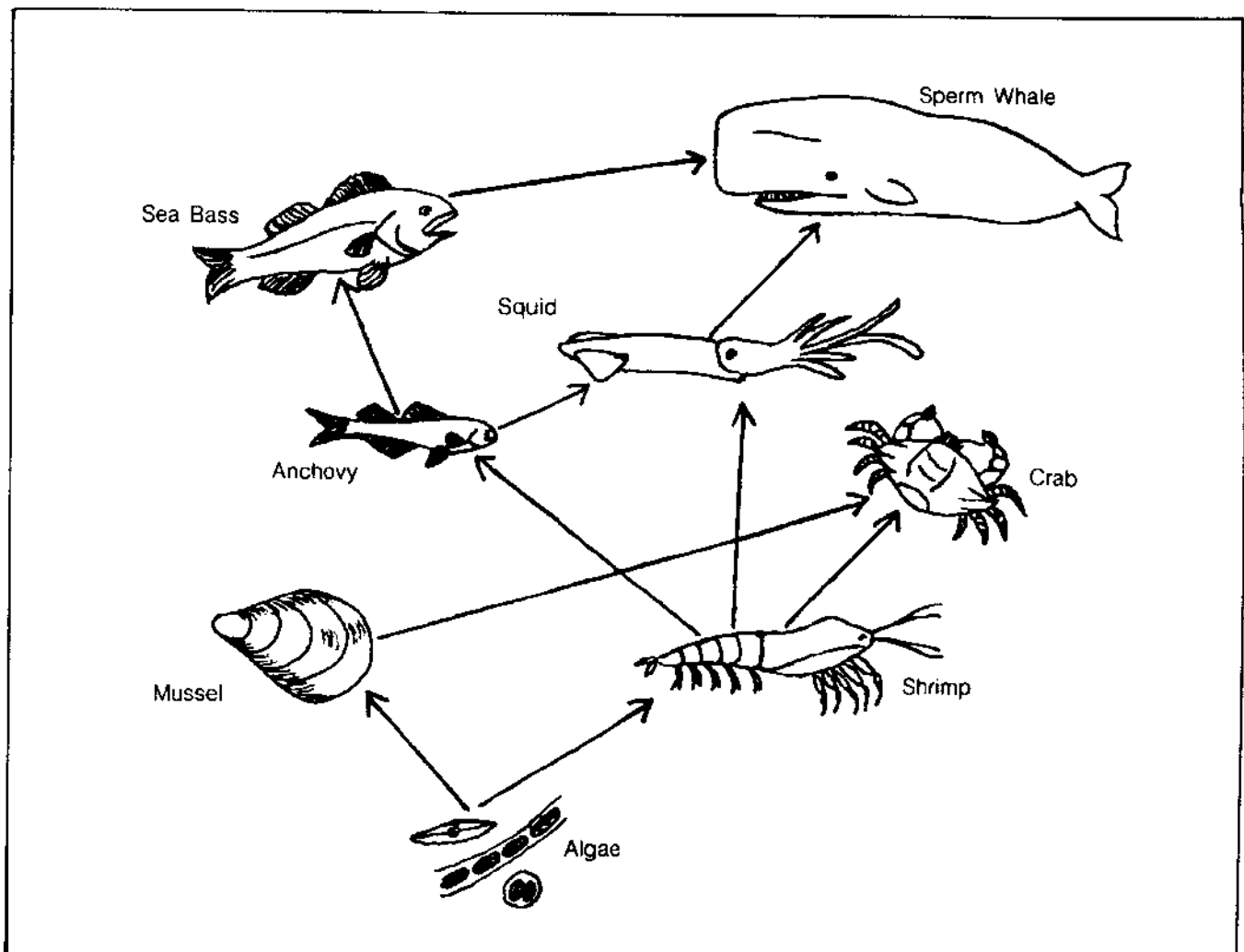


11. You are stuck on a desert island with nothing on it except for three chickens and a big sack of corn. What would you do in order to get the most food energy? Give reasons. (Remember, chickens are higher on the pyramid than corn.)

Gizzard shad are low on the Great Lakes food pyramid. Today shad are used for oil and animal protein meal which is often fed to livestock. This wastes energy from two pyramids — the shad and the cow! If we used them directly, much less energy would be wasted in reaching the top of the pyramid. Some ways that shad could be prepared for use as human food might be as fish sticks, fish cakes, or a smoked product like herring or sardines.

Lake Erie isn't the only place where food is wasted because we eat "high" on the pyramid. The oceans produce much food that people never use. We boil kelp to get gelatin for things like ice cream but there are many more low level pyramid foods that we can eat.

12. Look at the food web shown and see if you can find anything that people could eat. List what you find.



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## ACTIVITY C: WHAT IS A FOOD WEB?

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A food pyramid is a very simple way of looking at a bigger picture called a food web. A food web is made up of all the different plants and animals that have an effect on one another by their feeding habits. A group of food pyramids meshed together make a food web.

### PROCEDURE

On your worksheet is a model of a food web that you might find in the ocean. On it, draw arrows from the organisms that are being eaten to the ones that are eating. Remember that organisms on higher levels eat those on the lower levels. For instance, squid eat shrimp and anchovies, so you would draw arrows from the shrimp and the anchovies pointing to the squid. Since shrimp eat algae you would draw an arrow from the algae to the shrimp. You may use your own judgment about who eats what. Sizes of the organisms and their positions in the food chain should provide clues. The food chain position given for each carnivore is the most common one for that organism. It doesn't mean that the animal can only eat organisms immediately below it. Some animals which are scavengers can eat organisms from all levels of the chain.

There are many correct answers to this activity.

### REVIEW QUESTIONS

1. List the two kinds of organisms represented in a pyramid.
2. Which levels of a pyramid have the least energy available?
3. If the herbivores were taken out of a food pyramid by a disaster, what would happen to the producers? The carnivores? Use your own food web as an example if you want.

### THINK IT OVER

If people harvested all the carnivores in a food chain, what would happen?

Is it a good idea to harvest all the carnivores?

## GLOSSARY

1. algae bloom: situation in which algae have multiplied very rapidly.
2. breeding ground: place where organisms reproduce.
3. carnivore: animal which eats animals.
4. entrain: to suck fish up into water intake valves from industry. (Such fish are killed by temperature and pressure changes and physical abrasion.)
5. eutrophication: the natural aging process of a lake during which the lake becomes shallower and shallower and warmer and warmer, finally becoming a marshland, and then dry land.
6. food chain: sequence in which organisms eat and are eaten by other organisms.
7. herbicide: a chemical that kills plants.
8. herbivore: animal which eats plants.
9. impinge: to suck fish up against industrial intake sieves and hold them there, causing suffocation.
10. landfill: portion of lake which is diked and filled with gravel, soil, garbage, etc., to make more land area.
11. nutrients: chemicals needed by plants and animals — fertilizers (potassium, phosphorus, nitrogen).
12. organism: any living thing.
13. producer: plant which performs photosynthesis and forms the base of the food chain.
14. productivity: a measure of the rate of production.
15. thermal pollution: hot water.



NAME \_\_\_\_\_

### TO HARVEST A WALLEYE WORKSHEET

#### ACTIVITY A: WHO CAN HARVEST A WALLEYE?

Procedure: Follow steps 1 - 7 and fill in the biomass record below.

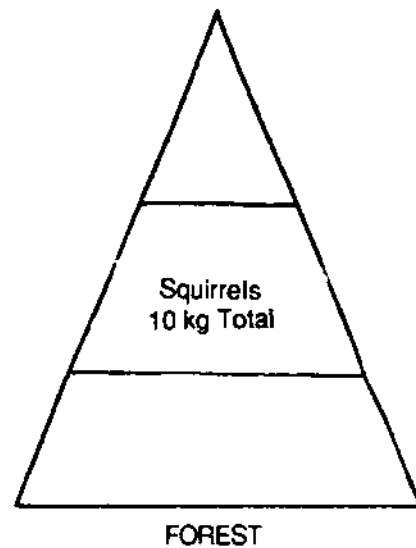
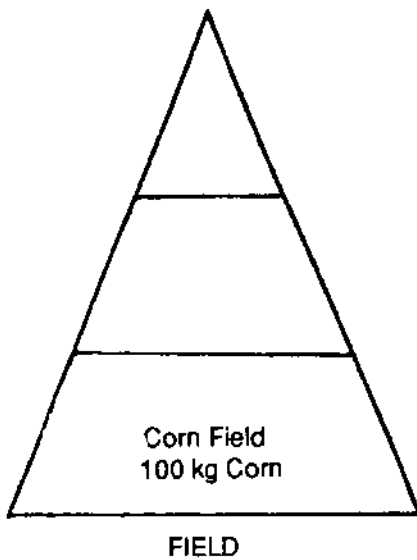
BIOMASS RECORD

	PRODUCERS (ALGAE)	HERBIVORES (GIZZARD SHAD)	FIRST ORDER CARNIVORES (WALLEYE)	SECOND ORDER CARNIVORE (PERSON)
PLAYER 1				
PLAYER 2				
PLAYER 3				
PLAYER 4				

## ACTIVITY B: WHAT DOES A BIOMASS PYRAMID TELL US?

Procedure: Follow directions to answer the questions below.

1. Count and compare the number of levels in the three pyramids. Lake \_\_\_\_\_ Ocean \_\_\_\_\_  
Field \_\_\_\_\_
2. Which pyramid provides people with the most food? \_\_\_\_\_
3. What might be a way of increasing the number of kilograms that people could harvest from lakes and oceans?  
\_\_\_\_\_
4. Fill in some species of plants and animals that would fit the food pyramids below. Assume only 1/10 of the biomass can be transferred from one level to another.



5. Draw the pyramids here.

6. How much biomass is available to you from the hamburger? \_\_\_\_\_
7. If you ate 1 kg. of hamburger, how many kg. of producer would you be eating indirectly? \_\_\_\_\_
8. Which foods are usually more expensive, meats or plant products? \_\_\_\_\_
9. Does it make more sense to get your energy from eating organisms on low levels of a pyramid or from eating those on higher levels? \_\_\_\_\_
10. If you had to recommend a kind of fish for someone to eat that caused the least amount of energy to be wasted, which would it be? \_\_\_\_\_
11. You are stuck on a desert island with nothing on it except for three chickens and a big sack of corn. What would you do in order to get the most food energy? Give reasons. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# ACTIVITY C: WHAT IS A FOOD WEB?

Third Order Carnivores

Size of a crow. Eats dead animals on shore and live fish.



Seagull

Bigger than a Grayhound bus.



Sperm Whale

Second Order Carnivores

Up to two meters long



Sea Bass

Many sizes: 20cm to 3m long.



Squid

First Order Carnivores

Size of a saucer. Eats anything dead on shore.



Crab

Sardine size (it comes on pizza).



Anchovy

Herbivores

Small animal 2-5 cm long.



Shrimp

Size of a man's thumb.



Mussel

Producers

Large seaweed dozens of meters long.



Kelp

Microscopic plants.



Algae

## Review Questions

1. List the two kinds of organisms represented in a pyramid.

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2. Which levels of a pyramid have the least energy available?

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3. If the herbivores were taken out of a food pyramid by a disaster, what would happen to the producers?

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What would happen to the carnivores?

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## Think It Over

If people harvested all the carnivores in a food chain, what would happen? \_\_\_\_\_

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Is it a good idea to harvest all the carnivores? \_\_\_\_\_

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