ACTIVITY 16

THE GREAT ANADROMOUS FISH GAME

WHAT ARE SOME OF THE FACTORS THAT DETERMINE THE REPRODUCTIVE SUCCESS OF FISH DURING THE SEASONAL MIGRATIONS OF RIVER-SPAWNING, OCEAN-LIVING SPECIES?

SCIENCE SKILLS:
- measuring
- organizing
- inferring
- experimenting
- communicating

CONCEPTS:
- Many fish species migrate seasonally for reproduction
- While each fish is capable of producing large numbers of offspring, many factors reduce the chance that a fish will reproduce and that its offspring will survive.
- If the number of fish that die exceeds the number that are born, the total fish population will decline

MATH AND MECHANICAL SKILLS PRACTICED:
- multiplication by fractions or decimals
- subtraction
- rounding off
- use of a calculator
- graphing

SAMPLE OBJECTIVES:
- Students will be able to describe the seasonal migration of anadromous fish.
- Students will be able to identify a variety of natural and human factors that affect the reproductive success of anadromous fish.
- Students will be able to apply mathematical skill to a biological problem

INTRODUCTION:

MIGRATION is the movement of animals from one area to another. Many species do migrations during specific SEASONS of the year. In this game, blueback herring seasonally migrate from the open ocean through estuaries and into freshwater rivers and streams where they SPAWN (lay their eggs). The newly hatched young must then migrate back down the rivers to the sea. Fish that follow this pattern are said to be ANADROMOUS from the Greek for "running upward." Both the adults and the young face a number of hazards, some natural and some of human making. As the students play this game, they will learn about these hazards. Bluebacks were once incredibly numerous along the Atlantic Coast of the United States and southern Canada, but are severely reduced in numbers due to many changes caused by humans which are explained in this game.

The math involved in calculating the reduction in numbers caused by these hazards requires advance practice for some age levels. One teacher with fourth graders "borrowed" some fifth graders to help her teach her class how to use calculators to do the math. After playing the game, students may wish to experiment with "what if" questions by removing some of the hazard cards,

such as suspending all fishing, to see what effects these changes have.

MATERIALS:
For each group of 2-8 players:
- game board
- worksheets to keep score
- sets of cards
- a die
- 2-8 colored herring or other markers for players to move
- storage box such as a shirt box
- vocabulary sheets
- calculator if not doing math by hand

LESSON PLAN:

BEFORE CLASS: This game requires time in its initial construction. Once made, it can be taken off the shelf and used. As with anything you plan to use repeatedly, lamination will make it last longer. Xerox the cards onto different colors of paper so they can be sorted easily. You might have your students add color to the illustrations. Xerox the worksheets. You will need to review fractions and rounding off with your students before playing the game. For example, you have 75,000 fish and one quarter of them are eaten by a school of striped bass. If one quarter are eaten, three quarters or .75 survive. Multiply 75,000 by .75 to get 56,250 fish still alive. If math is being done by hand, the numbers may be rounded off to the nearest thousand if this helps speed the calculations.

DURING CLASS:
METHODS: Start by asking the class if they think animals always stay in the same place or do they move. If so, why? MIGRATION should come up in the discussion. Have the students list some animals that migrate and suggest reasons why they might do seasonal migrations which are tied to climatic changes that affect food supply and reproductive potential. For example, humpback whales migrate to cold northern waters to feed in summer and move south to warmer water to calve during the winter. Canada geese migrate north each spring to breed in the northern U.S. and Canada and south each fall to winter feeding grounds in the southern regions of the United States.

What about fish? There is a game in which the students get to be herring which migrate to the ocean to feed as adults and into rivers and creeks to SPAWN, releasing eggs which are fertilized outside the female's body. These fish live along the eastern coast of the United States. Review the term ESTUARY as these fish will pass through an estuary both coming and going. Have the students predict some of the hazards they are likely to encounter during their migration: fishing, predators, bad weather, lack of food, manmade barriers like dams, pollution.

You may also show the videotape The River Herring - Bluebacks and Alewives which may be ordered from Photography by Michelson, PO Box 850093, Braintree, MA 02185. This excellent short tape was made by the Massachusetts Fish and Game Division. It sets up the game nicely by showing herring, their migration, reproduction and development in about 7 minutes.

RESULTS:

The students will keep track of their populations' sizes on worksheets. Make the game more real by averaging all of the students' results and having a discussion about the role of chance in producing higher populations for some students than for others. Graph the decline in the fish school as the fish swim up river and the decrease in offspring as they swim down to feeding grounds in the sea.

CONCLUSIONS:

These are among the things which may reduce the size of anadromous fish populations:
predation by a wide variety of predators
food supplies
changes in salinity and water level from unusual rainfall
abnormal temperatures
unusually severe storms
parasites and diseases
waste products from humans that are directly toxic or kill by lowering oxygen level
accidental entry of toxic compounds with runoff such as
pesticides
sediment from runoff
obstructions to migration such as dams
fishing by a wide variety of methods

With your students sort out which of these are the result of natural events over which humans have no control and which are things humans could alter to increase herring populations. Make sure they understand, however, that even if humans were totally out of the picture, far more herring are spawned than will ever survive to reproduce. Each species of animal or plant is capable of producing more offspring than are needed to just replace the individuals already alive. This allows species to survive predation and recover from natural changes or disasters. It also means that when natural controls such as predators are removed, populations may explode in size.

EXTENSIONS:

1. What would happen if human-caused fish deaths were reduced? Let the students choose one set of conditions to change such as no longer allowing any fishing. Replace these cards with blank cards and see what happens to the numbers. Would they continue to increase forever? No, because eventually the predator populations would increase and/or competition for food supplies would occur. These would set new limits for the numbers of herring. We do know from historical records that when European people first arrived in North America, there were far more herring than there are today. Many of the problems we have created are not new. Dams for power and the location of industries along rivers began more than two hundred years ago.
2. Have students choose an aquatic or marine species that migrates and make their own game that is based on that migration. When the games are done, trade them around and let other students play them.

ACTIVITY 16 Name Possible answers

THE GREAT ANADROMOUS FISH GAME

You have a school of herring trying to reach the spawning grounds. There are 100,000 fish in your school. There are many dangers waiting for your school. Each time you meet a hazard, deduct the number of fish that died from your school. Use this chart to keep track of how many fish you have.
Round your numbers to the nearest thousand if it helps.

GOING TO THE SPAWNING GROUNDS No. of fish at start _____

Ocean	Estuary and River	Streams
100,000	18,750	7,000
75,000	14,000	
37,500		

The number of adult fish that reached the spawning ground is 7,000 .
Now how many baby (larval) fish did these adults produce? Here is how to find out:

1. Roll the die. Your number was 2 .
2. Multiple this times 10 to get 20 .
3. Multiple this number by the total number of adult fish to get the number of baby herring that start down stream 140,000.

Now the baby herring will head for the ocean. Keep track of the changes in the number of fish as they swim.

RETURNING TO THE OCEAN No. of baby herring headed for the ocean _____

Streams	Estuary and River	Ocean
140,000	26,000	
70,000	13,000	
35,000		

The number of young herring that reached the ocean is 13,000 .

The average number of young herring that reached the ocean for the group I played the game with was 41,000 . (Add all your total young together and then divide by the number of you that played.)

Are the total number of herring increasing each year or decreasing?
Decreasing, because there are fewer offspring than adults

If you were a fisheries biologist, what actions would you take which could increase the number of herring in future years?
I would remove stream obstructions, stop water pollution and reduce the amount humans catch.