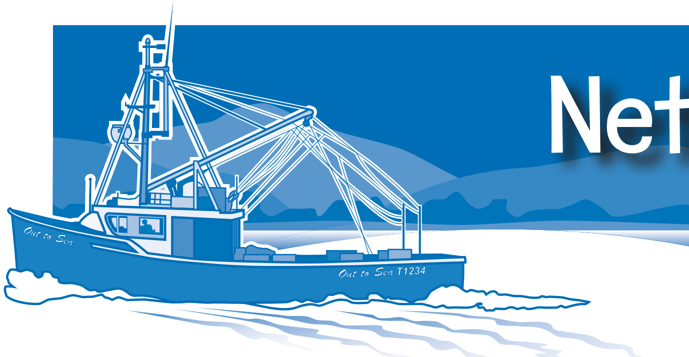


Net Gain, Net Effect

How do technological advances in commercial fishing affect fish populations?

Objectives

Students will (1) describe the evolution of fishing techniques, and (2) interpret the effect of changes in technology on fish populations.

Background

Throughout history, people have caught fish for food, to sell to others, for fun, and for sport. One type of fishing is subsistence fishing, in which the number of fish caught is no more than a family could consume. Commercial fishing differs from subsistence fishing because fish are caught and then sold to others. Sport fishing differs from commercial fishing because the catch is not sold for profit.

Humans have been engaged in fish gathering since prehistoric times. Research suggests that methods of catching fish began with humans wading into drying wetlands at the edges of large shallow lakes and using bare hands and clubs. As time passed, new techniques were invented. Native Americans built rock weirs or dams on streams and rivers to trap and spear the fish in holding ponds. Eventually, baskets were formed that allowed fish to swim downstream into intricately woven baffles that prevented their escape. (Source: American Sportfishing Association)

Fishing equipment has evolved over the years. Stone Age anglers used some sort of line, such as vines, and tied gorges to the end of the line. Gorges were a type of primitive hook made of bone, flint, and thorns or turtle shells. The earliest hook was made from copper about 7,000 years ago. Today, fishhooks are made from steel.

Roughly 4,000 years ago Chinese literature described wooden fishing poles with lines made from silk. Fishing lines were also made from plant fibers, human hair, cotton, and linen. Today, nylon is the most preferred material used for fishing line. Fishing rods have been made from many materials such as bamboo and steel, but today they are typically made from fiberglass.

Grade Level: Middle School

Content Areas: Mathematics, Social Studies, Environmental Education, Science

Method: Students conduct a simulation to explore the evolution of fishing and the effects of changing technology on fish populations.

Materials: Nets of differing mesh size (see page 137): onion bags, potato bags, fruit bags, netting from hardware store, or plain cloth fabric for nets; 1-lb each of lima beans, pinto beans, black beans, lentils, and rice; writing materials; four containers that are large and deep enough to hold one-fourth of the beans and grains; *Netting Data Sheet*

Activity Time: one 30- to 60-minute session

People Power: any size group

Setting: indoors or outdoors

Conceptual Framework Topic Reference: ECIB, ECIIA

Terms to Know: bycatch, depletion, commercial fishing

Appendices: Let's Go Fishing!, Using Local Resources, Sustainable Seafood, Agencies and Organizations

A tuna is ensnared in a trap.

Over 20 million tons of fish and other marine animals...are killed and discarded by commercial fishers each year. These discarded fishes are known as "bycatch."

The use of boats and rafts for fishing purposes evolved during the Stone Age. The first evolution in boat design came about when fishing boats shifted from a dugout—a narrow boat, made from hollowed trees and propelled by paddles—to sailing vessels. The development of sails allowed fishing vessels to extend their range and catch. The creation of steam and diesel-driven fishing fleets provided a method for rapid maneuver to any spot in the ocean.

The invention of the net enabled fishing to move from sustaining a family or tribe to an economic venture. Over time, the net evolved in size, design, and effectiveness. Many nets are now available for catching different fish species in a variety of situations. Gill nets, purse seines, trammel nets, and drift nets have all improved fishers' catch rates. Yet these advancements have also introduced new problems, such as the impact on other marine life, size discrimination, over-fishing, and loss of marine habitats.

Nets, combined with the range and maneuverability of steam and diesel boats, made it possible to catch larger amounts of smaller fish. Most commercial fishing companies have a specific fish species to catch, and other species that are caught inadvertently must be discarded. Over 20 million tons of fish and other marine animals, about one-fourth of the global catch, are killed and discarded by commercial fishers each year (Source: National Coalition for Marine Conservation). These discarded fishes are known as "bycatch."

Along with developments in boats and nets, changes have taken place with fishing equipment. Commercial fishers now routinely use complex sonar fish finders, radio communications, spotter aircraft, computerized navigational equipment, at-sea catch processing, and other similar sophisticated tools.

With the remarkable advances in technology and the growth in investment of fishing trawlers and factory processing ships, fisheries have become overfished and exploited. The amount of fish caught in the world's oceans grew from 19 million tons in 1950 to 88.6 million tons in 2012. As oceanic fisheries were fished at or beyond capacity, scientists saw a substantial change in the oceanic fish catch in 1989. According to the U.S. National Marine Fisheries Service, 88 fish species found off the shores of the United States have been depleted.

In the United States, the fishing industry is a $4-billion business. The largest fishing nations of the world are Japan, Russia, and China. Fish supply the main source of protein for nearly half of the more than 7 billion people on the planet. Nearly 17 million tons of sardines, herring, and anchovies are netted commercially each year, while approximately 72 million tons of other kinds of fish are caught annually.

A fisherman removes bycatch.

The high demand for seafood and the modern, technologically advanced fishing fleets have led to a modification in the world's fish species. Widespread depletion of certain ocean predators such as sharks and tunas can upset the predator-prey relationship of the oceans. Overfishing not only disrupts food webs but also can threaten marine ecosystems.

One example of a fish species on its way to recovery is the swordfish. Swordfish roam most of the world's tropical and temperate oceans. They have a large dorsal fin and a rigid, swordlike beak. Swordfish can weigh up to 1,200 pounds but average 250 pounds.

Commercial fishers use long fishing lines stretching dozens of miles and baited with hundreds of hooks to catch and kill swordfish. Since the introduction of this fishing method, there has been a decline in the weight and age of the swordfish catch. In the 1990s, the average catch size of the swordfish was 90 pounds compared to a 250-pound average in the 1960s. At 90 pounds, females have not reached a reproductive age and weight, and thus the population size declines. In 1998, plans were made to reduce the international quota for North Atlantic swordfish. The "Give Swordfish a Break" campaign, supported by chefs, grocers, and consumers, was part of a national effort that successfully restored swordfish populations to near-healthy levels. In 2002, swordfish had reached 94 percent of full recovery. This campaign is proof that focused conservation efforts can help restore ocean wildlife. (Sources: SeaWeb and the Natural Resources Defense Council)

One species of fish that was once considered endangered and now has reached a balance between catch and reproduction rates is the Striped Bass. The Striped Bass, also called rockfish, lives in estuarine waters along the Atlantic coast as a juvenile, then moves to coastal waters to feed. In spring, the mature Striped Bass returns to brackish and fresh water to spawn. The Striped Bass is a major food and sport fish on the East Coast from Maine to North Carolina. In the late 1970s, the Striped Bass population began to decline. In 1984, the Atlantic Striped Bass Conservation Act was passed to help recover this species. Effective state and federal programs to protect the Striped Bass allowed the recovery of stocks, and the species was officially recovered in 1995. By 2012, the species was at record levels. (Sources: National Oceanic and Atmospheric Administration, the Monterrey Bay Aquarium, and Sea Grant: University of Delaware)

NOTE: This activity does not address ethical questions related to the appropriateness of catching fish for human uses. This dimension may be added at the professional discretion of the educator conducting the activity.

Widespread depletion of certain ocean predators such as sharks and tunas can upset the predator-prey relationship of the oceans. Overfishing not only disrupts food webs but also can threaten marine ecosystems.


Fishermen prepare nets.

WILD Work

What's the difference between a **Wildlife Communication Specialist** and a **Wildlife Education Officer**?

How does a **Game Warden** enforce fishing and hunting laws?

What does a **Fisheries Scientist** have to do with recreational and commercial fishing?

Start researching the answers to these questions with students by going to ***www.projectwild.org/aquatic***.

In Step with STEM

- Examine a fishing pole and reel. Diagram and describe each part of the pole and reel and explain the mechanics of how a fishing pole and reel work. Finally, practice and then demonstrate use of a fishing pole.
- Visit ***www.projectwild.org/aquatic*** for links on exploring "How to Fish." Learn about types of tackle, rods, and other fishing gear, as well as sport fishing techniques.
- Enter the data generated by the activity simulation into an online graphing program. See ***www.projectwild.org/aquatic*** for web links that will help you generate graphs.

Procedure

1. Prepare the "ocean" by mixing all the beans and grains listed under "Materials," and dividing the mixture equally into four containers. These will be the four "fishing grounds."

2. For this activity, ask students to decide what species each bean will represent. Fish species can be hypothetical or can represent local fish species. On a wall chart as well as on the *Netting Data Sheet*, students can match the beans or grains with the fish they represent.

3. Divide students into four groups, and ask each group to go to the fishing grounds (the containers of beans and grains).

4. Discuss how fish are caught. Have students seen people catch fish? How were they catching fish? Could large numbers of fish be caught if all fish were caught with rods or poles? What are some ways to catch large groups of fish at one time? What are some ways people traditionally caught fish? After a general discussion on the methods people use to fish, inform students that they will now simulate the catching of fish using nets.

5. Next, distribute netting materials. The net materials must be cut into 4"x 6" squares. The number of nets needed will depend on how many students share a net. Provide one net for every three students.

6. With the coarsest netting in hand, ask students to "fish." Using only one hand, students are to hold the nets between their thumb and first finger (see Diagram A). This distance is known as the catching area. Ask students to make one pass with their nets through the fishing grounds.

For younger students, educators may want to demonstrate how to use each net. When it is the students' turn, allow them to make only one pass through the "ocean." Give each student a sheet of paper representing a boat. Instruct students to deposit their "fish" on the boat. Count the number of each species of fish caught, and record the numbers on a data sheet.

7. Next, allow students to use both hands (see Diagram B). Make one pass through the "ocean." Count the number of each species of fish caught, and record the numbers on a data sheet. Repeat this process several times.

8. Discuss the results between the one-hand and two-hand techniques. Relate those results as an improvement in technology. For example, using both hands may represent the shift from hand-powered boats with cast nets to trawlers.

9. Analyze the species the students have netted. The smaller lentils and rice will often slip through the netting and escape capture. The larger species—the limas and the pintos—are the most likely to have been caught. Ask students what they could do to catch more fish. Discuss possible options with them.

10. Ask students to return all fish to the ocean containers so that they can try fishing with a smaller-mesh net. Distribute a net with fine mesh (less than one-fourth inch). Again, the net needs to measure about 4" x 6". Repeat fishing attempts using one and then two hands for each type of net you are using.

11. Tabulate and discuss the results.

12. Return all the fish to the ocean.

For younger students, the activity may conclude with a discussion at this point. What happens when the different kinds of nets are used? Is it good to let the smaller fish through the net? Why or why not? What might happen if people fished from just one part of the ocean? **OPTIONAL:** Construct a bar graph to show the numbers of fish caught using the different nets and different techniques of netting.

13. Inform students that all the fish, beans through rice, are all the same species and that no fish smaller than the black bean species size can be caught. A penalty of one point will be added to the score for each of the smaller fish caught during this round. A regulatory agency responsible for monitoring fishing practices gives each team ten seconds to put the undersized fish back in the ocean after each netting. Appoint two members of each fishing team to play the regulatory agency role.

14. Instruct commercial fishers to use the fine mesh net (less than one-fourth inch mesh). Empty the net onto the table, and return the undersized fish to the ocean. At the end of ten seconds, the team must stop. The representatives of the regulatory agency will count the undersized fish that are still left on the table and fine them one point for each one.

15. Discuss the economics involved. Can the people fishing afford to return all undersized fish to the sea? What are their options? Should we release undersized fish? If yes, why? If no, why not?

16. Repeat this round with one of the larger-mesh nets. Is there an advantage to letting the smaller fish get through the net over returning them by hand? What aquatic animals might be caught in these larger nets?

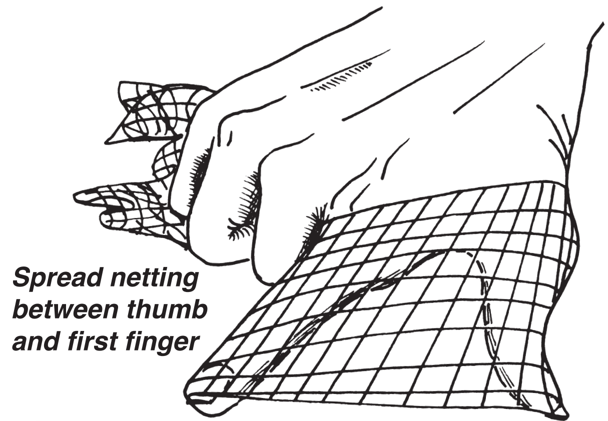


Diagram A

The invention of the net enabled fishing to move from sustaining a family or tribe to an economic venture. Over time, the net evolved in size, design, and effectiveness.

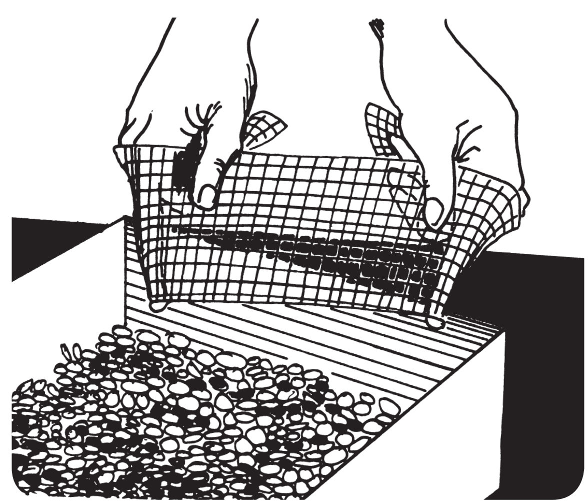


Diagram B


Tuna are harvested using nets or lines.

The amount of fish caught in the world's oceans grew from 19 million tons in 1950 to 88.6 million tons in 2012.


A net is prepared for release into the water.

17. Ask students to summarize what they have learned. Review the general history of fishing, including how each change may have affected fish populations. Consider possible impacts on fish habitats as well. Identify some of the potential positive and negative issues related to the advancement of commercial fishing. The *Netting Worksheet* provided may be helpful.

Extensions

1. Use nets of different sizes to try to catch aquatic organisms in a local pond or stream. Observe and record any differences in what the nets catch. Be extremely careful to return any animals to their habitats unharmed. **NOTE:** Check regulations with your state's wildlife agency regarding net use; in some areas it is against the law to use nets in local waters.

2. Who "owns" the fish in the sea? In streams? In lakes? In ponds? In other aquatic habitats? Who is responsible for conserving and protecting fish species?

3. Research regulations on personal, noncommercial fishing in freshwater and marine environments.

4. Research regulations on commercial fishing in freshwater and marine environments.

5. Discuss the role of aquaculture (freshwater) and mariculture (marine) aquatic farming. How will this emerging field affect commercial fishing? What possible positive effects, if any, on fish populations and habitat might there be from a change to aquaculture? Mariculture? What possible negative effects, if any?

6. Research the fishing industry in your state. What methods are most commonly used to catch fish? What regulations apply to commercial fishing in your state? Are they different from, or similar to, the regulations for personal and recreational fishing?

7. Research international treaties and organizations dedicated to conserving and protecting oceanic habitats.

8. Create an illustrated history of the fishing net.

Assessment

For Younger Students

1. Draw three pictures showing different ways that fish are caught. Indicate which picture shows the way most fish are caught.

For Older Students

2. Describe how fishing has changed from prehistoric times to the present. How have these changes affected fish populations?

Netting Data Sheet

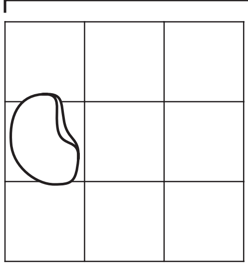
FOR STUDENTS

Directions: After each round of fishing, record the number of fish caught for each species.

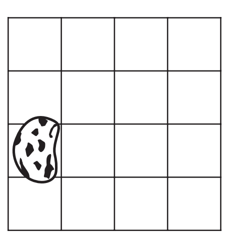
	Coarse Nets				Fine Nets				
	Net A (most coarse)		Net B		Net C		Net D (most fine)		
Number of Hands Used→	1	2	1	2	1	2	1	2	
Name of Fish ↓									**Comments**
Fish Species — **Species #1 Name:** (example: "Lima lunker")									
Species #2 Name:									
Species #3 Name:									
Species #4 Name:									
Species #5 Name:									

Examples of Netting

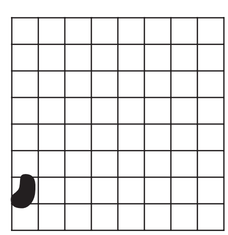
Coarse ———————————————— Fine



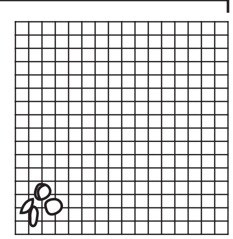
¾-inch netting
Lima Bean



½-inch netting
Pinto Bean



¼-inch netting
Black Bean



⅛-inch netting
Sunflower Seed
Rice
Lentil
Barley