Unit IV: Problems and Solutions

Lesson IV: Fisheries

Lesson Objectives

- Students will be able to understand the concept of a fishery.
- Students will be able to explain how scientists identify fisheries whose fish populations are rapidly declining.
- Students will be able to explain way in which fisheries are being protected.

keywords: fishery, demersal, continental shelf, upwelling

Background Fisheries Information

Many people around the world depend on fisheries for their income, food, and recreation. But what exactly is a fishery? A fishery is two things. First, a **fishery** is the area of the ocean or the coastline where fish and shellfish are harvested. Secondly, the word fishery relates to the economic involvement, research and production of fish.

Fisheries are mostly marine, but some exist on large lakes (i.e., the Great Lakes) and rivers. The most productive fisheries are found as far out in the ocean as the edge of the **continental shelf**, about 80-km from shore. Rich fisheries are found in areas of **upwelling**, where cold, deep, nutrient-rich waters are carried to the surface.

Invertebrates and finned fish are taken from fisheries. Some of the fish are migratory, and the fisheries are active only part of the year. They include salmon, anchovy, tuna and others. Some of the fish that are harvested live on the ocean's bottom. These fish include cod, haddock, flounder and other bottom dwelling, or **demersal,** fish.

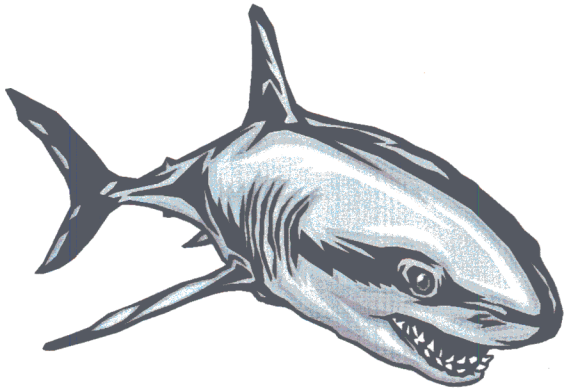
Commercial fish are harvested in many ways. Fishermen use nets that are either pulled close to the surface or trawled along the bottom. The three that are commonly used are called purse seines, gill nets, and otter trawls.

Fish that are thought to be in Trouble

Although there are many fish that are endangered or suffering from shrinking populations we are going to focus on three fish: The Great White Shark, the Orange Roughy, and the Snook.

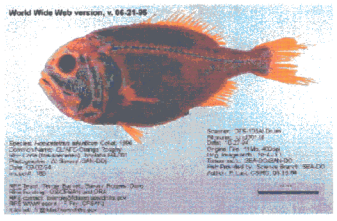
The Great White Shark

The Great White Shark, also known as the white pointer, has a conical, flattened snout, black eyes, and large, serrated, arrowhead-shaped teeth. The upper and lower lobes of the tail are almost equal in size, and the body is blue- or brown-gray, not white, except on the underside. One of the largest specimens ever caught was caught in 1964. It was 5.34 m long and weighed an estimated 2034 kg! White Sharks are animals that return to their home areas. Off the Australian Coast, one female, recognized by its scars, returned for 13 years.



Although it is considered the most dangerous of the sharks, little documented information exists about its behavior. Most authorities agree that its villainous reputation is undeserved. Some specialists believe it is endangered due to its shrinking food sources and overfishing by trophy hunters.

The Orange Roughy



The Orange Roughy has many names. It is also known at the Golden Pacific Roughy, Deep Sea Perch, or plainly Roughy and scientifically *Hoplostethus atlanticus*. It has a reddish body with a bluish tinge in the belly regions, spiky fins and a bony head with large eyes. The skin turns to orange after it is caught. Its average size is 30-40cm but can reach 45cm, it averages 2 kg in weight. This species is caught all year round and takes 40-60 years to mature! Although Roughy can be caught year round, catches are declining.

Orange Roughy are a trawl caught fish.

Orange Roughy is a very widespread fish found in the North Atlantic, off the coast of South Africa, Australia, and New Zealand. New Zealand has one of the largest Orange Roughy resources. It is found at depths of 750 to 1200m.

The Orange Roughy is a meat counter fish. That is, it is a widely eaten fish, and can be found in many markets all over the world. Unfortunately, the loss of the populations of Roughy is a good example of fisheries overfished, scientific mistake in age maturity estimate, and the human demand depleting the available resource.

The Snook

Snook growth rates are highly variable, (they range from 1 to 8 inches per year) but typically slow down after snook reach sexual maturity. East-coast males reach 24 inches total length (the minimum legal size) at four years of age and females reach 24 inches at three years. West-coast males reach 24 inches at six years of age and females reach 24 inches at four years. Most females reach the legal maximum size of 34 inches total length at seven years, but males seldom reach 34 inches. Even though large females are partially protected from fishing pressures, the population still contains more males than females.

Snook are **protandric hermaphrodites**, which means that they change sex from males to females. This transition usually occurs when the fish is between 2 and 7 years of age and has a fork length of 17-30 inches. Spawning begins in mid-April and lasts through mid-October, and a snook can spawn every four to six days. A 33-inch female snook is capable of shedding between 870,000 and 1,220,000 eggs during each spawning event! Spawning grounds include major passes and inlets of the Atlantic Ocean and the Gulf of Mexico.

The population of snook has been studied for many years. Tag-and-recapture experiments in which common snook are used have been conducted in three areas of Florida since 1976, although not concurrently. Tagging studies in the Naples area showed a 70% reduction of the population in this area from 1976 to 1982. The decline was attributed to overfishing and to rapid development, which altered freshwater flow, destroyed habitat, and polluted waterways.

On the East Coast, snook populations have been monitored in Lake Worth and Jupiter inlets since 1984. The estimated number of snook rose from less than 10,000 in 1984 to more than 20,000 by 1987 and has since remained at more than 20,000. The number of snook probably increased because of more restrictive management and favorable weather patterns. East-coast snook populations now appear to be stable.

On Florida's East Coast, 16 tagged snook have traveled more than 99 miles. The longest distance traveled was 193 miles, from Sebastian Inlet to Indian Key Bridge in the Florida Keys. Tag-return data suggest that snook move greater distances on the East Coast than on the West Coast. No movement of snook from the East Coast to the West Coast has been documented. Two snook were recaptured more than eight years after being tagged

How do We Know Fisheries are in Trouble?

Since fisheries are located in the ocean, and fish have the ability to swim all over the world, how do we know that fisheries and certain populations of fish are in trouble? There are three points that scientists assess before deciding if a fish population is in trouble. The first point is the number of complaints that are voiced by fishermen. These complaints are centered on fish size, and numbers of fish caught. Secondly, researchers will look at the data collected from tagged fish. A tagged fish is one that has a specific tag attached to it in an unharmful manner. It allows for researchers to document the migratory patterns of fish, fish counts, growth and age. Finally, researchers also look at the other populations of fish and organisms that surround the local feeding grounds of the fish in question. Often, when a fish population is in trouble or struggling, species of organisms not found in that area will arise. This does not mean a brand new species, or an exotic species, but simply an organism that has not been found in those waters before. The findings of new and different organisms suggest depletion of populations, greater competition for food, and exploitation of new areas. For example, the Giant Squid is now being found in nets off the Australian coast. Before the Orange Roughy population declined, the squid were not found there. Most likely, the Giant Squid are moving closer to the coasts to look for food because there is not as much in their feeding grounds. In a more local example, Florida is finding that the number of stingrays along the coast is increasing. This could be a direct result of overfishing of shark, which is the natural predator of the stingray.

What is being done to Protect Fisheries?

Protecting populations of fish, and fisheries is a tough job. Researchers have made many recommendations, but a few of these seem to be more beneficial than others. The first recommendation is to tag some fish in a local population. This allows the fish to be followed and data about their size, length, and sex to be collected. In documenting this data, the status of the fish population can be monitored through geographic and physical data.

Another recommendation that seems to be working is to designate areas of our oceans as National Marine Sanctuaries. A National Marine Sanctuary an area in which designated fish, mammals, and invertebrates are protected. The only problem with a sanctuary is that the organism is protected in that area only. Most organisms are mobile, and have the ability to leave the protected area.

Thirdly, regulations have been placed on human actions. Fish catch regulations have been enacted and enforced. For example, there were no limits on catch size and number in 1982 in the state of Florida. Now, there are limits and a fishing license must be purchased. In addition to fish catch regulations, to help deter people from purchasing the fish as a food item, the cost of fish in markets has risen. The cost of the fish has also risen because there are fewer fish to sell. In the market, the most sought after item will bring the highest price.

Other states have placed bans on certain methods of fishing. Florida has succeeded in banning fishing with some kinds of nets, and Mississippi has made fishing with gill nets illegal.

Finally, in an effort to help fish populations rebound, artificial reefs have been installed to provide fish with areas to live and feed. Another method to help the fish populations is **aquaculture,** a method of raising fish in a controlled environment. The intent of aquaculture is to help lower the demand for specific fish, and allow natural populations to rebound. Aquaculture can also be used to replenish natural stock populations. Game fish grown in aquaculture situations can not be sold for commercial benefit because that would create problems with sportfishermen and fishermen that rely on some gamefish for their livelihood. They must be released into the wild. These fish include the salmon, snook and red snapper.

Food fish, such as catfish, can be aquafarmed for sale as food.

Although restrictions will have benefits, some people argue that artificial reefs lack biological diversity, net bans discriminate amongst fishermen and sanctuaries only provide a safe realm if the organisms stays in it. The study of fisheries is to help preserve and maintain fish populations, and then to help to repair the damage that overfishing and pollution has inflicted.

Activity I and Ia. Design a Hospitable Environment

Primary curriculum topic: marine biology
Related curriculum topics: nature/wildlife, animal behavior, careers (science)
Grade Levels: 6-12

Background: Recall Keiko, the Killer Whale, both in his habitat in Mexico and his new facility in Oregon. Although his living conditions in Mexico were inadequate and harmful to his health, Keiko's plight made people aware of the importance of providing appropriate, safe habitats for marine life if they are to be studied in captivity.

The complexity of marine organisms in the wild and the difficulties of studying them in a large geographic area where the animal has the ability to leave has just been briefly discussed. It is even more difficult to try to protect them, and maintain populations in the marine environment. A scientist is faced with these problems and questions every day.

The size and biological complexity of the natural environment cannot be duplicated, but many aquaria and marine zoological parks have designed spacious, naturalistic habitats with the health and welfare of the animals in mind. In addition, the Animal and Plant Health Inspection Service has established standards for the care of animals in captivity, and it does its best to enforce them. In a well-run facility, the animals receive good medical care and a balanced diet, and are not subject to the predation, commercialism, or water pollution of the wild.

Keiko's new habitat at the Oregon Coast Aquarium was designed to be as naturalistic as possible, to prepare him for a return to the wild. Consider what is involved in creating an artificial habitat that simulates any animal's natural environment. What factors are most important?

For this activity, select a marine mammal, marine bird, or fish, then design a perfect replica of that animal's natural habitat.

Step One: Choose a marine mammal or fish you would like to study.

Step Two: Your assignment. Pretend you are a marine biologist who has been hired by the local aquarium to redesign the artificial habitat for _____ (the marine animal you are studying).

For months, you have been observing and documenting the existing conditions at the facility. You find, among other problems, that the pools are not large enough for the animal to exercise, the water temperature is not correct, the water currents are not strong enough, and there is too much chlorine in the artificial salt water. Your observations lead to the conclusion that a new habitat is necessary.

You will now need to consider the physical features of the animal, its migratory patterns, where and how it hunts for food, and the ecological features of its natural habitat in order to design a new aquarium.

Step Three: Description of the animal.

Submit the following data describing unique features and behavior of the mammal, fish, or seabird:

- a detailed physical description.
- feeding strategies.
- special appendages.
- methods of defense.
- type of movement.
- interaction with other organisms.
- day/night activity period.

Step Four: Design a new habitat.

In designing the new habitat, the following factors must be considered:

1) What will be the size, depth, and shape of the tank?
2) What type of substrate (rocks, gravel, sand or mud) should be in the tank? Will you be able include natural materials? If not, what shall you use?
3) Does the organism require ledges, moving water, hiding places or shelter?
4) How salty must the water be?
5) What is the water temperature?
6) Is any wave action or water current necessary?
7) Is special lighting necessary to simulate a day/night cycle?
8) What vegetation and other life forms need to be in the tank?
9) What does your specimen eat?
10) How will the specimen be fed? Or, where will it find food?
11) How are each of these habitat features crucial to the survival of the organism?

Step Five: Draw a scale model of the new habitat.

Step Six: Compile the work you accomplished in Steps 1 through 5 into a report.

Activity 1a. Design a Habitat Part II
Teacher's Note: A Twist.

Give students the option of creating a habitat for a strange new creature discovered in the Galapagos Islands. Assume you are a marine biologist who has been observing and documenting this creature for months in its natural environment. Recognizing that you may have discovered a new organism, the local aquarium would like to exhibit the specimen. Now, your mission is to convince the curator that a new habitat must be created for this organism, which is unlike any other animal on display. You know that the specimen must have a new habitat, or it will die in captivity.

If you try this idea, use the same procedures listed above and add the following questions to Step Three: describe the specimen's coloration, unusual abilities (production of light, ability to secrete poison, etc.). Finally, explain why it is a new species.

Student Information Sheet IV
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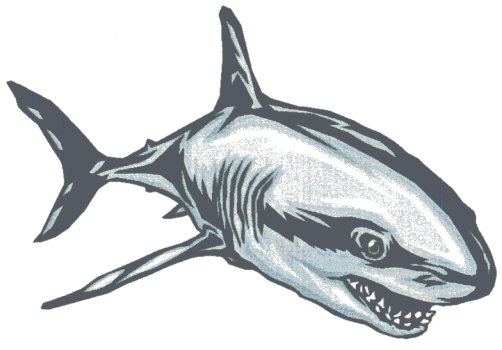

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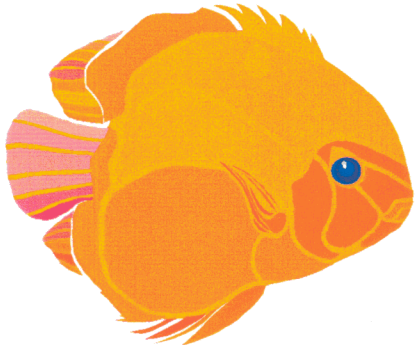
The Future of Fisheries

It is hard to determine an easy answer for the future of fisheries, and the fish that are declining in population numbers. It is hard to understand the problems because the fish populate such a large geographic location. Scientists do not completely understand what is happening. Further study and research will allow better ways to test and develop methods to replenish stocks, restore populations, and protect organisms.



Currently, stock enhancement with aquaculture techniques, enforcement of laws, and research into genetic engineering will continue.