

16 Ecosystems Out of Balance

ORGANISMS WITHIN an ecosystem interact at all levels, depending on each other for their survival, either directly for food or shelter, or indirectly through the carbon cycle. As you saw in the previous activity, both native and introduced species have a significant effect on the ecosystem around them. The entire ecosystem is a complex network that can be drastically altered if the population of one (or more) species goes into a decline or a surge. In this activity you will take on the role of a fisheries biologist and determine how to make several fisheries more sustainable.

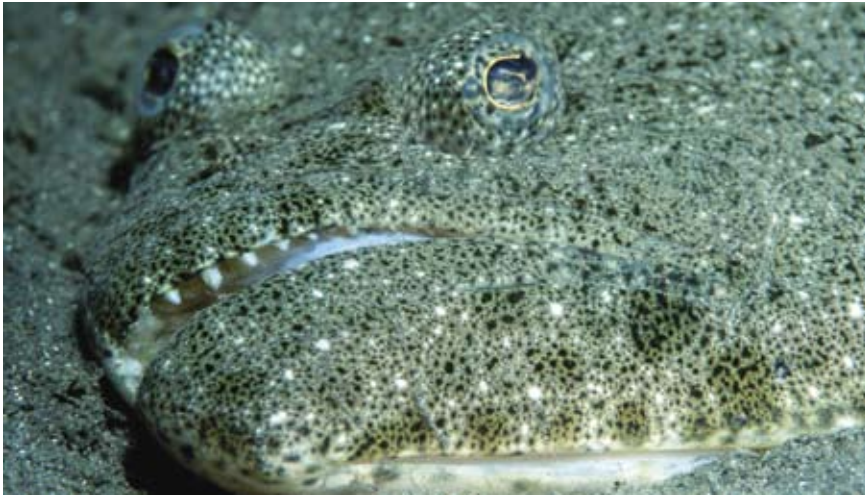
*You are a fisheries biologist who has, in the past, advised the Pacific halibut (*Hippoglossus stenolepis*) fishery, which is known for its successful sustainable practices. The Pacific halibut fishery is carefully monitored, and each year you and other fisheries biologists make a new set of recommendations on where and how many fish can be caught. The limits are adopted by the entire fishery. Several other fisheries have asked for your expert advice. These fisheries would like you to examine population data and other information for the species they fish and the species' ecosystems and, if they are not sustainable, to advise on how to make them more sustainable.*



A fisherman weighs the Pacific halibut he caught.

Challenge

- ▶ How does information about relationships among organisms help to determine the sustainability of a species and an ecosystem?



Pacific halibut are large flatfish that live on the ocean floor in coastal waters off the western United States and Canada.

MATERIALS

FOR EACH STUDENT

- Student Sheet 16.1, “Cod-dominated Ecosystem Graph”
- Student Sheet 16.2, “Tiger-shark-dominated Ecosystem Graph”
- Student Sheet 16.3, “Orca-dominated Ecosystem Graph”
- Student Sheet 16.4, “Caspian-seal-dominated Ecosystem Graph”

Procedure

Part A: Evaluating Fisheries’ Sustainability

1. With your group, examine the food chain for the cod-dominated ecosystem, and the corresponding graph on Student Sheet 16.1, “Cod-dominated Ecosystem.” This ecosystem is found in the North Atlantic Ocean.
2. Identify the role of each species in the food chain by determining what they eat and what they are eaten by.
3. With the key, label each line on the graph with the name of the organism.
4. Choose one time point on the graph, toward the beginning. Based on the information provided in the graph, explain in detail what is happening at this point with each species, relative to the other populations in the ecosystem. Write your description in your science notebook.
5. Choose a time point on the graph that is toward the end. Based on the information provided in the graph, explain in detail what is happening at this point with each species in the ecosystem. Include what this means about the food-chain relationships between the species. Write your description in your science notebook.

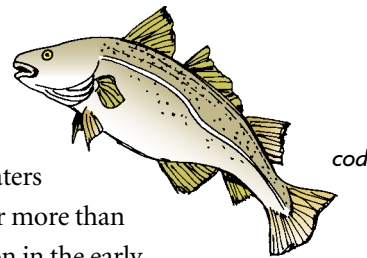
6. Summarize the population growth rates for each population for the full time period shown on the graph. Write your summary in your science notebook.
7. Discuss with your group what the graph shows overall. Note any patterns or anything that seems out of the ordinary, as compared to the Pacific-halibut-dominated ecosystem you reviewed with your teacher. Write your observations in your science notebook.
8. Repeat Steps 1–7 for the tiger-shark-dominated ecosystem. This ecosystem is found in the Atlantic Ocean off the southern coast of the United States.
9. Repeat Steps 1–7 for the orca-dominated ecosystem. This ecosystem is found off the northwestern Pacific coast of North America.
10. Repeat Steps 1–7 for the Caspian-seal-dominated ecosystem. This ecosystem is found in the Caspian Sea, the world’s largest enclosed body of water, located between the southern border of Russia and the northern border of Iran.

Part B: Fishery Histories

11. Read the brief history of the cod fishery below.

ATLANTIC COD

The Atlantic cod (*Gadus morhua*) fishery is one of the oldest fisheries in the world. There are records of explorers from Europe hunting for new cod fishing grounds as far back as 1000 A.D. Atlantic cod are found throughout the North Atlantic in waters up to 400 meters deep. While the Atlantic cod has been fished for more than 1,000 years, the invention of steamships and on-ship refrigeration in the early 1900s brought huge changes to the fishery. Overfishing of the cod intensified to the point that, in 1992, Canada declared a two-year moratorium on cod fishing off its shores. Soon other nations began to apply strict rules limiting the size and number of cod that were fished in an attempt to bring the cod population back to sustainable levels that would maintain a healthy ecosystem and support the fishery.

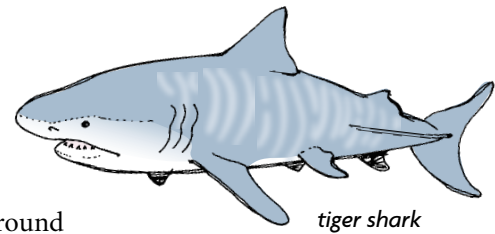


12. With your group, compare this information with your observations of the cod-dominated-ecosystem graph. How does this information support or inform your conclusions about what the graph shows? Write down any additional observations or thoughts about what might be happening in the cod-dominated ecosystem.

13. Repeat Steps 11 and 12 for the tiger shark fishery.

TIGER SHARK

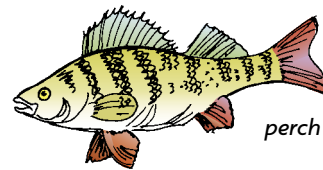
The tiger shark (*Galeocerdo cuvier*) is one of the largest predatory sharks found in the world's oceans. Like many other shark species, the tiger shark is fished for its fins to make shark fin soup, a dish in Chinese cuisine that has become more popular around the world over the past few decades. The tiger shark is also fished for its liver, which is high in vitamin A. The shark is highly valued by sport fishers, particularly because it is known as a dangerous predator. Tiger sharks' gestation period is very long: 14–16 months between fertilization and birth. They give birth only once every three years, producing, on average, 40 pups. As shown in the food chain, tiger sharks feed on bay scallops. The bay scallop population crashed in the early 1960s due to overfishing. Limits were set on scallop collection and the population started to recover in the 1970s.



14. Repeat Steps 11 and 12 for the perch fishery (part of the orca-dominated ecosystem).

PACIFIC OCEAN PERCH

Pacific ocean perch (*Sebastes alutus*) are caught primarily for human consumption. The population was heavily fished starting in the early 1960s. The fishery grew rapidly, but in 1990, the perch were declared overfished off the west coast of the United States. In 2003, a fishery management council put in place a plan that they hoped would allow the population to recover. Perch are slow growing, and only mature (are able to have offspring) after they are at least five years old. Some females do not mature until they are 15 years old.



15. Repeat Steps 11 and 12 for the anchovy kilka fishery (part of the Caspian-seal-dominated ecosystem).

ANCHOVY KILKA

The anchovy kilka (*Clupeonella engrauliformis*) is one of the main commercially fished species in the Caspian Sea. Major fishing of the kilka began in the 1950s, and by the 1990s there were record catches as large as 400,000 tons annually. In 1999, an invasive comb jelly (*Mnemiopsis leidyi*) was found in the Caspian. It reproduced quickly, feeding on the same plankton the kilka relied on for food. Meanwhile, as the area around the sea became more developed, pollution in the sea began to take a toll, and by 2001, the kilka population plunged dramatically, resulting in catches of less than 60,000 tons annually.



Analysis

1. How does the size of the apex (top) predator population affect the other populations in the cod-dominated ecosystem? Is the effect similar or different in the orca-dominated ecosystem? Explain.
2. Choose one of the four ecosystems you examined in this activity, and draw a graph showing what you think the populations would look like if there were no fisheries present.
3. How is what is happening in the Caspian-seal-dominated ecosystem different from what is happening in the other ecosystems?
4. What impact might sustainable fisheries have on these four ecosystems?
5. Choose one of the four ecosystems, and in your role as a fisheries scientist, explain to the people who run the fishery what you think is happening in the ecosystem. Citing evidence from the graph and from the history of the fishery, write a summary that explains what is happening in the ecosystem. Include in the summary:
 - a. your explanation of whether you think the fishery is sustainable
 - b. what changes in the ecosystem indicate that the fishery is or is not sustainable
 - c. how the overall biodiversity of the ecosystem has been affected
 - d. what advice you would provide about making the fishery sustainable, based on the other fisheries in this activity

KEY VOCABULARY

fishery	population growth rate
invasive species	sustainability
population	