Fishing for the Future

OVERVIEW
Through a fishing simulation, students model several consecutive seasons of a commercial fishery and explore how technology, population growth, and sustainable practices impact fish catch and fisheries management.

OBJECTIVES
Students will:
Experience the “tragedy of the commons”\(^1\) as it relates to fishing resources.
Consider social, environmental, and economic impacts of overfishing.
Identify sustainable fishing practices.

GRADE LEVELS
6-10

SUBJECTS
Social studies
Biology
Environmental studies
Geography
Economics
Mathematics

VOCABULARY
sustainability, tragedy of the commons

TIME
1 hour

MATERIALS
Plain M&Ms, one 14-ounce bag for up to 30 students
Peanut M&Ms, one 14-ounce bag for up to 30 students
Small cups, 1 per student
Serving bowls, medium size, 1 per group
Spoons, 1 per group
Straws, 1 per student
Watch, for timing activity
Handout Fishing Log, 1 per student
Handout Fishery Facts, 1 per student

NATIONAL SCIENCE EDUCATION STANDARDS

\(^1\) The “tragedy of the commons” occurs when resources—such as the water we drink, and the fish we eat—shared by everyone (or held in common) are used at a rate that exceeds the resources’ sustainable limit. Ultimately, as population grows and consumption increases, the “commons” collapse. The phrase was first coined by Garrett Hardin in 1968, [www.garretthardinsociety.org/index.html](http://www.garretthardinsociety.org/index.html).
This activity supports the following National Academy of Sciences science education standards.

**Grades 5-8:**
- Unifying Concepts and Processes—Systems, order, and organization
- Standard C: Life Science—Populations and ecosystems
- Standard F: Science in Personal and Social Perspectives—Populations, resources, and environments
- Standard F: Science in Personal and Social Perspectives—Science and technology in society

**Grades 9-12:**
- Unifying Concepts and Processes—Systems, order, and organization
- Standard C: Life Science—The Interdependence of Organisms
- Standard E: Science and Technology—Understandings about science and technology
- Standard F: Science in Personal and Social Perspectives—Natural resources
- Standard F: Science in Personal and Social Perspectives—Environmental quality

**NATIONAL SOCIAL STUDIES STANDARDS**
This activity supports the following National Council for the Social Studies standards.

**Middle Grades:**
- Standard III: People, Places, & Environments—k
- Standard V: Individuals, Groups, & Institutions—g
- Standard VII: Production, Distribution, & Consumption—c
- Standard VIII: Science, Technology, & Society—b, d, e
- Standard IX: Global Connections—d

**High School:**
- Standard III: People, Places, & Environments—k
- Standard V: Individuals, Groups, & Institutions—g
- Standard VIII: Science, Technology, & Society—d, f
- Standard IX: Global Connections—d

**BACKGROUND**
Garrett Hardin coined the phrase “tragedy of the commons” in 1968. Hardin describes cows grazing on a common land. Since there is no direct cost to using the land, individual ranchers are motivated to add to their herds in order to increase their personal wealth. But each added animal damages the pasture a small, perhaps imperceptible, amount. Ultimately, this gradual degradation destroys the commons. Each rancher acting alone is behaving in an appropriate, rational manner, yet the sum total of all the ranchers’ actions destroys the resource for them all.

From 1950 to 1990, there was a fivefold increase in the world annual fish catch. An increasing demand for fish coupled with environmentally damaging fishing practices are leading to another tragedy of the commons. Roughly 70 percent of the planet’s marine stocks are fully or over exploited, according to the Monterey Bay Aquarium’s Seafood Watch program.
In this activity, students will simulate fishery activity in different oceans. As students progress through the fishing seasons, they will likely overfish their oceans and will have to migrate to other oceans to meet their basic needs. Most groups will eventually create a total crash of fish stocks in all the oceans. This demonstration will clearly indicate the benefits of sustainable fishing practices.

**BEFORE YOU BEGIN**
1. Check for peanut allergies in your class. You can do the activity using only plain M&Ms, if necessary.
2. For a class of 20, you will have five or six groups of three to four students each. Each group will start with 20 plain and 10 peanut M&Ms. Count out the first round of M&Ms and place them in cups or bags.
3. Copy the *Fishery Facts* and *Fishing Log* handouts.
4. As a pre- or post-activity reference, have students read the handout *Fishery Facts*. For additional references, read Chapter 5 “Global Trends – Food, Water, and Income” and Chapter 6 “Environmental Sustainability” from Facing the Future’s publication *Global Issues & Sustainable Solutions* (*www.facingthefuture.org*).

**WHAT TO DO**

**Before the Activity**
1. As a pre- or post-activity reference, have students read the handout *Fishery Facts*. For additional references, read Chapter 5 “Global Trends – Food, Water, and Income” and Chapter 6 “Environmental Sustainability” from Facing the Future’s publication *Global Issues & Sustainable Solutions* (*www.facingthefuture.org*).

**The Activity**
1. Introduce and discuss the concept of sustainability using the following definition:

   “Sustainability is meeting the needs of the present without limiting the ability of people, other species, and future generations to survive.”

   Ask why sustainability might be an important goal for a society and what might be difficult about realizing this goal.

2. Tell students that today they’re going to go fishing and explore some of these sustainability issues.

3. Explain the game rules:
   a. Each student will be a “fisher” whose livelihood depends on catching fish.
   b. Peanut M&Ms represent the largest and most valuable fish (tuna, swordfish, et cetera).

4. Plain M&Ms represent the next most-valuable fish (cod, salmon, et cetera).
   a. Each fisher must catch at least two fish (large or small) in each round to survive (i.e., get enough fish to either eat or sell).
b. When the fishing begins, students must hold their hands behind their backs and use the “fishing rod” (straw) to suck “fish” (M&Ms) from the “ocean” (bowl) and deposit them into their “boat” (cup).

c. The fish remaining in the ocean after each fishing season represent the breeding population, and thus one new fish will be added for every fish left in the ocean (bowl).

5. Divide the class into groups of three or four students and have each group choose an ocean name such as North Atlantic, North Pacific, Arctic, Mediterranean, et cetera.

6. Give each group one serving bowl and each student one cup, one straw, and one copy of the handout Fishing Log.

7. Put 20 plain and 10 peanut M&Ms in each group’s bowl.

8. Say “start fishing” and give the students 20 seconds for the first “season” of fishing.

9. Have each fisher count his or her catch (M&Ms in their cup) and record the data in their Fishing Log.

10. Fishers who did not catch the two-fish minimum must sit out for the following round.

11. Add one new fish for every fish left in the ocean (bowl).

12. Allow fishers to use their hands on the straws during the second session to represent “new technology.”

13. After the second fishing season, give one fisher from each group a spoon representing more new fishing technology such as trawl nets, sonar equipment, et cetera. Continue the game for round three.

14. Ask, “What happened when ocean group [name] ran out of fish? How are the fishers going to survive now?” (One option is to move to another ocean.) Allow students to “invade” other ocean groups when their ocean is depleted, but don’t tell them that they can do this beforehand. Fishers may either go as a group to another ocean or they may disperse to other oceans.

15. Repeat fishing, recording, and replenishing fish stocks until either sustainable fishing is achieved or until all (or most) groups fish out their ocean.

**Reflection**

1. Have students do a free-write on the following quote by John C. Sawhill, relating it to the fishing activity: “*In the end, our society will be defined not only by what we create, but by what we refuse to destroy.*” (John Sawhill is the former President and Chief Executive Officer of The Nature Conservancy.)
2. Use the following sample questions to lead a discussion about the activity:
   • How did you feel when you realized that you had depleted your fish stock?
   • How did you feel when other fishers joined your ocean group?
   • How does this activity relate to real ocean and fishery issues?
   • What’s missing in this game? (Impacts to nonhuman animals that rely on fish for their survival, population growth, et cetera.)
   • What happens to a resource when you have infinite population growth, growing technology, and a finite resource?
   • Are there any commonly owned resources in our region or community? If so, what are some similar issues around them, and how can they best be managed? (Air is a commonly used resource—how do we deal with air pollution? Forestry or animal grazing rights also sometimes create similar discussions. You might also talk about city, national parks, and other public lands, and the competing uses and needs.)

3. Have students brainstorm ways to have a sustainable fishery. What rules could be developed? (For example, limits on type of equipment allowed, amount and type of fish, shorter seasons.)

ASSESSMENT
Ask students to write, draw, or chart an explanation of factors that affect management of fish populations and identifies the goal of sustainable fisheries. (Responses should reflect such factors as technology, environmental conditions, market prices, and consumer choices.)

EXTENSIONS
• Read Garrett Hardin’s essay “The Tragedy of the Commons” and discuss how it is reflected in this game. For a downloadable version, go to www.garretthardinsociety.org/articles/art_tragedy_of_the_commons.html.
• Repeat the activity after the class has experienced the “tragedy of the commons” and discussed sustainable practices to see if they can harvest in a sustainable manner.
• Students can research which fish are harvested in a sustainable manner and which are being depleted. Have them do an advertising campaign in their school promoting the consumption of sustainable fish and avoiding the consumption of threatened fish. (This might include researching the kind of fish served in your school cafeteria, developing a system that protects threatened fish, and presenting it to your cafeteria staff, principal, and school board.) For recommendations about which seafood to buy or avoid, check out the Monterey Bay Aquarium’s website “Seafood Watch” at www.montereybayaquarium.org or the Audubon website “What’s a Fish Lover to Eat?” at http://magazine.audubon.org/seafood/guide/.
• Have students research a local fishery and include interviews with local fishers, biologists, and other people involved with the fishery.
• Have students choose one of the major world fisheries, such as salmon, cod, or tuna, and develop a sustainable fishing plan, paying attention to international laws and treaties.
• Have students investigate fish farming and its environmental and economic impacts.
• Have students research federal and state laws relating to economic use of public lands by private companies and individuals. Determine whether these laws balance environmental protection and economic development. If not, outline new laws to create such a balance.
• Do a watershed planning/protection project to help protect fisheries from environmental damage.
• Participate in a beach or river cleanup project.
• Join an Ocean/Fisheries Action Network such as:
  Center for Marine Conservation Ocean Action Network: [www.cmc-ocean.org](http://www.cmc-ocean.org)
  Marine Fish Conservation Network: [www.conservefish.org](http://www.conservefish.org)
  SeaWeb: [www.seaweb.org](http://www.seaweb.org)

**MORE INFORMATION**

For information and pictures about the state of the world’s fisheries, see the New International Magazine on-line issue on fishing at [www.newint.org/issue325/facts.htm](http://www.newint.org/issue325/facts.htm).

To explore sustainable seafood choices, visit the Seafood Watch web site at [www.mbayaq.org/cr/seafoodwatch.asp](http://www.mbayaq.org/cr/seafoodwatch.asp) or The Marine Stewardship Council (MSC), an independent non-profit organization that promotes responsible fishing practices. [www.msc.org](http://www.msc.org)

Seafood Information Center, a clearinghouse for sharing seafood knowledge [www.seafoodinfocenter.org](http://www.seafoodinfocenter.org)

**CREDIT**
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FISHING FOR THE FUTURE—FISHERY FACTS
The world’s fisheries are under more pressure than ever before. From 1950 to 1990, there was a fivefold increase in the world annual fish catch. The average yearly per-person fish consumption in the industrialized world (59 pounds) is three times that of people in the developing world (20 pounds). Fish demand remains high: An additional 15.5 million tons of fish will be required by 2010 just to maintain current rates of fish consumption. Today, 70 percent of the planet’s marine stocks are fully exploited or overexploited.

The number of people fishing and practicing aquaculture worldwide has doubled since 1970. More than 21 million people are full-time fishers, and 200 million depend on fishing for their livelihood. Asia contains the vast majority of the world’s fishers. In the early 1950s, developed countries took 80 percent of the world’s fish catch. Today, they take only 36 percent of the catch, while developing countries take 64 percent.

The technology used to catch fish and the number of fish caught per fisher varies enormously. Modern fleets are the most environmentally destructive, as they use enhancements such as airplanes, radios, seafloor maps, and video sonar to track down fish schools. Once they have found the fish, these fleets use large nets to drag up not only the targeted fish but also coral, the seafloor, and around 27 million tons annually of “by-catch”—nonmarketable fish that are killed and thrown overboard.

To compensate for reduced wild fish stocks, more and more fish are being farmed. Nearly a third of all fish for food is harvested from aquaculture. For every 11 pounds of beef grown globally, there are now 4.5 pounds of farm-raised fish produced. Fish farming causes environmental destruction comparable to the replacement of rain forest with cattle ranches. About 11 pounds of wild ocean fish need to be caught to feed each pound of farmed species. Thailand, which has one of the biggest aquaculture industries, has lost half its mangrove forests due to shrimp farming. Densely stocked salmon farms in British Colombia, Canada, produce waste (including fertilizer, effluent, and fishmeal) equivalent to that generated by half a million people.

Despite these numbers, there is still hope for the world’s fisheries. Fisheries can be restored through the adoption of sustainable fishing practices. With the proper incentives, fishers can be encouraged and rewarded in their effort to sustainably manage marine resources. For example, partnerships between local communities and scientists in the central islands of the Philippines resulted in the establishment of marine reserves to help manage overexploited fisheries. The establishment of no-fishing zones in the reserves has increased catches in adjacent fishing grounds. Another solution is to use the power of the market to encourage sustainable fishing practices. The Marine Stewardship Council together with the World Wildlife Federation and Unilever, one of the largest makers of fish products, has developed a certification process that includes a label telling consumers that fish products came from fisheries certified as sustainable.

## Fishing Log

Ocean Group: ___________________________  Fishers: ___________________________

Record your group’s catch and fish left in ocean after each season:

<table>
<thead>
<tr>
<th>Season</th>
<th>Catch</th>
<th>Fish Left in Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Value Fish</td>
<td>Medium Value Fish</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write a brief description of the status/health of your fishery: ___________________________

<table>
<thead>
<tr>
<th>Season</th>
<th>Catch</th>
<th>Fish Left in Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Value Fish</td>
<td>Medium Value Fish</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discuss changes in fishing practices or regulations. Are any fisheries in trouble? What did they do and how did that impact your fishery?

_____________________________________________________________________________

_____________________________________________________________________________

<table>
<thead>
<tr>
<th>Season</th>
<th>Catch</th>
<th>All Fish Left in Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Value Fish</td>
<td>Medium Value Fish</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
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</tr>
</tbody>
</table>

Write a brief description of the status or health of your fishery now: ___________________________

_____________________________________________________________________________

_____________________________________________________________________________

How could you have made your fishing sustainable? ___________________________

_____________________________________________________________________________