Banishing Bycatch

GRADE LEVEL	3rd—8th; CA science content standards for 3rd, 4th, and 7th
SUBJECTS	Life Sciences
DURATION	Preparation: 10-15 minutes Activity: 20-45 minutes
SETTING	Classroom

Objective

Students will learn why sea turtles and whales often end up as bycatch and sustainable fishing practices to prevent this from happening.

Materials

One bag of popped, plain popcorn (amount depends on class size)
One or two bags of oyster crackers (amount depends on class size)
One or two bags of Goldfish crackers (amount depends on class size)
Small cups, 1 per student
Serving bowls, medium size (or dinner plates), 1 per group
Spoons, 1 per student
Spatulas, 1 per group
Tongs, 1 per group
Watch, for timing the activity
Handout *Fishing Log*, 1 per student

Vocabulary

Sustainability: One of the most oft-cited definitions of sustainability is the one created by the Brundtland Commission. The Commission defined sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."

Extinction: When the last individual of a particular species dies

Tragedy of the Commons: a metaphor dealing with overexploitation of resources in an area where there is not clear ownership. The metaphor illustrates how free access and unrestricted demand for a finite resource ultimately dooms the resource through over-exploitation.

Bycatch: any fish or other organism that is unintentionally caught. These items are often wasted.

See *Vocabulary of Modern Fishing Methods* to enrich student vocabulary specifically about avoiding bycatch.

Teacher Background

Visualize, for a moment, that a group of eager hunters has stretched an indestructible net across the African savannah. Now imagine that the hunters begin to drag this net along the ground, tearing out trees, scouring the landscape, and gathering and crushing all kinds of unique animals. Imagine they do this for a series of hours, stopping periodically to sift through the mangled pile of broken creatures. In the end, they take only a couple of desirable items, and leave the rest, mostly corpses, to be devoured by scavengers.
- Adapted from End of the Line by Charles Clover

Dredging, one of many modern fishing practices, is used all over the world to extract fish from the ocean. It is analogous to the previous scenario, except that that the scoured landscape and pile of mangled creatures are conveniently shrouded from view by millions of gallons of water. Until recently, fishing practices like dredging were considered **sustainable** and economical, because people believed that the sea was inexhaustible. Although effective fisheries regulations currently exist in some locations, past fishing behavior was essentially a free-for-all in many parts of the world. This has led to huge declines in current global fish stocks. Since the 1950's, when fisheries became industrialized, global stocks of large fish such as tuna and swordfish have fallen by approximately 90%. This means that only 10% of these animals are still left to reproduce, making future years of fishing very bleak, and **extinction** likely.

Other marine life is also affected by these fishing practices. Sea turtles and whales are some of the victims of unsustainable fishing practices, and before the introduction of bycatch reduction devices, 44,000 sea turtles were killed in the Gulf of Mexico each year.

Juvenile loggerhead turtles hatched in Japan migrate all the way to the Pacific coast of Baja California Sur, México (BCS). Replete with langostilla (pelagic red crabs) and other organisms favored by turtles, the legendarily rich waters of México make the trans-pacific trip worthwhile. Juvenile loggerheads forage their way to maturity at this critical nursery habitat, a process that can take 30-50 years, before returning to Japan as adults to reproduce. The same richness attracts considerable fishing pressure, generating among the highest turtle **bycatch** rates documented worldwide where turtles and fishermen overlap. For instance, a pair of small-scale fleets totaling about 60 skiffs accidentally killed from 1,500-3,000 juvenile loggerheads per year prior to 2007, representing among the gravest threats to the endangered North Pacific population. On the positive side, bycatch hotspots like those in BCS offer conservationists great leverage. Partnering with a few dozen fishermen to mitigate their turtle bycatch can lead to disproportionately large conservation gains. From 2006-2010 the Mexican non-profit conservation organization *Grupo Tortuguero* partnered with both fleets to develop bycatch solutions resulting in hundreds to thousands of loggerheads spared each year since.

Turtle excluder devices (TEDs) are one of the devices designed to prevent sea turtles from being caught.

Tragedy of the Commons is a metaphor that describes a situation, such as ocean fishing, where each fisherman tries to catch as many fish as possible without thought to the ultimate unsustainability of such practices. Because no one owns the oceans, everyone has to take some responsibility for its preservation and continued prosperity.

In this exercise, students will learn how the Tragedy of the Commons occurs, how fishing often leads to bycatch, and brainstorm ideas about how to prevent it from occurring in the future.

Activity

Introduction
Tell students that today they're going to go fishing and explore the sustainability of ocean fishing practices. Ask them what sustainability means. "*To do something sustainably means meeting the needs of people who live now without limiting the ability of people in the future to meet their own needs.*" How might this apply to fishing?

1. Explain the game rules:
   a. Each student will be a "fisher" whose livelihood depends on catching fish.
   b. Oyster crackers, popcorn, and Goldfish will represent different ocean animals.
   c. Each fisher must catch at least five of the target fishery in each round to survive to the next fishing season. There will be at least four fishing seasons total.
   d. When the fishing begins, students will use a spoon to represent a seine net to collect (crackers, popcorn, goldfish) from the "ocean" (bowl) and deposit them into their "boat" (cup).
   e. The ocean animals remaining in the ocean after each fishing season represent the reproductive population, and thus one new cracker/popcorn/goldfish will be added for every ocean animal left in the ocean (bowl).

2. Divide the class into groups of five to seven students and have each group choose an ocean in which to fish such as Atlantic, Arctic, Southern, Pacific or Indian Ocean.

3. Give each group one bowl and each student one cup, one spoon, and one copy of the handout *Fishing Log*.

4. Put 60 goldfish pieces, 40 oyster crackers, and 40 popcorns in each group's bowl. These represent the ocean life.

5. Remind students only to use spoons and not to collect with their fingers.

6. Students have to wait until the teacher says "start fishing!" Give the students 20 seconds for the first "season" of fishing. **Note:** *If students are not depleting their oceans, you may increase the "season" to 30 seconds.*

7. Have each fisher count his or her **target fish catch** (goldfish in their cup), **other fish catch** (popcorn), and **bycatch** (such as sea turtles, represented by oyster crackers) and record the data in their *Fishing Log*.

8. In order to survive to the next fishing season, fishers must catch at least five of the target fishery (goldfish). Fishers who did not catch the minimum must sit out for the following round or "fishing season".

9. Add one of each for every food item left in the bowl (ocean), explaining that the organisms reproduced themselves in between the seasons.

10. Allow one fisher per group to use the spatula during the second season to represent "trawling." Record catches on the *Fishing Log*.

a. Repeat for season three, but have someone else use the spatula in the group.
b. In the fourth season, students use the spoons again plus one student per group uses a set of tongs (represents a hook and line).

11. What happened when an ocean 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 separately to other oceans.

12. Repeat fishing, recording, and replenishing fish stocks until all (or most) groups fish out their ocean. Fishing log allows for up to six seasons, but focus on at least four.

13. Conduct a discussion about the concept of bycatch. Ask students to look at the composition of their catch. Explain to students that the oyster crackers represent bycatch such as sea turtles, and the popcorn represents other fish catch, such as sharks. Have each group of students brainstorm ways that they might have made the fisheries more successful while avoiding bycatch.

14. If desired, you could conduct another six rounds of fishing, using the suggestions that the students brainstormed for making their fisheries sustainable. Because students know how to play, this will go faster. Have students write their new fishing plan and compare to the trend seen in the previous seasons. Were their ideas successful in avoiding bycatch?

Discuss ways in which everyone can help make fishing more sustainable since in real life we're not all fishers!

- Pay attention to the fish you buy at the store
- Know where fish comes from
- Know how it was caught
- Use the Monterey Bay Seafood Watch Guide to help you choose fish that are Best

Choices
- If you can't find the answers, ask! You can help create a market for sustainable fishing by increasing demand for these options.

References and Resources

Monterey Bay Aquarium Seafood Watch Program
http://www.mbayaq.org/cr/seafoodwatch.asp
Tragedy of the Commons, Garrett Hardin, *Science* **162**, 1243-1248 (1968)
Global Sea Turtle Network www.SEATURTLE.org
S. Hoyt Peckham, Ph.D. et al. 2007. www.grupotortuguero.org

California State Learning Standards

Grade Three
Life Sciences

3c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

3d. Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

Grade Four
Life Sciences

2b. Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.

Grade Six
Life Sciences

5c. Students know populations of organisms can be categorized by the functions they serve in an ecosystem.

Grade Seven
Life Sciences

3e. Students know that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient for its survival.

Fishing Log

Adapted from www.facingthefuture.org

Ocean:_____ Fisher:_____

Record your catch and fish left in the ocean after each season:

Season	Your Catch				Fish left in Ocean
	Target Fish Catch	Other Fish Catch	Total Catch	Bycatch	
1					
2					
3					
4					
5					
6					

How could your group have made fishing more sustainable?

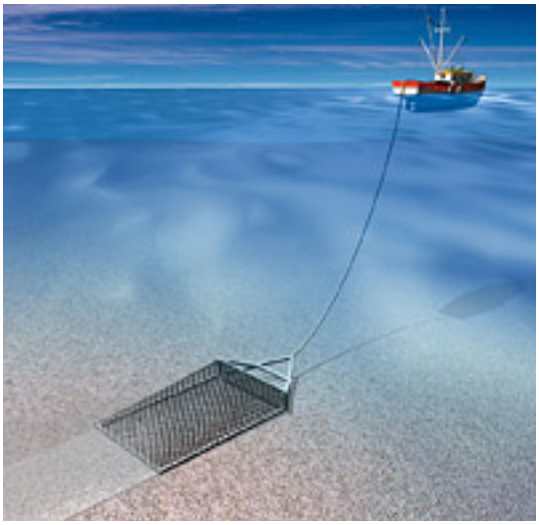
Record your catch and fish left in the ocean after each season:

Season	Your Catch				Fish left in Ocean
	Target Fish Catch	Other Fish Catch	Total Catch	Bycatch	
1					
2					
3					
4					
5					
6					

Was your group successful in making fishing sustainable in your ocean?

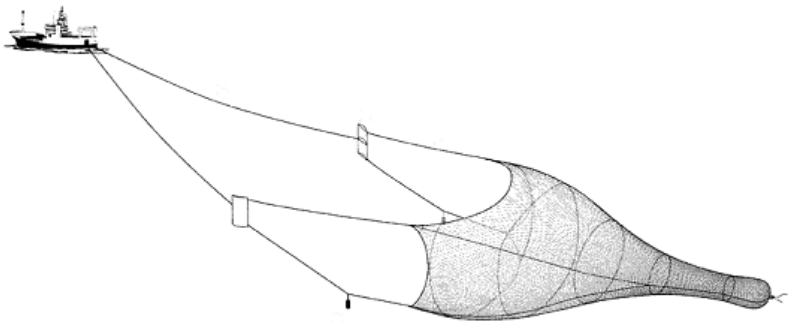
Vocabulary of Modern Fishing Methods

Adapted from the Monterey Bay Aquarium website.
Please see website for more information: www.mbayaq.org/cr/cr_seafoodwatch/sfw_gear.asp#dredging



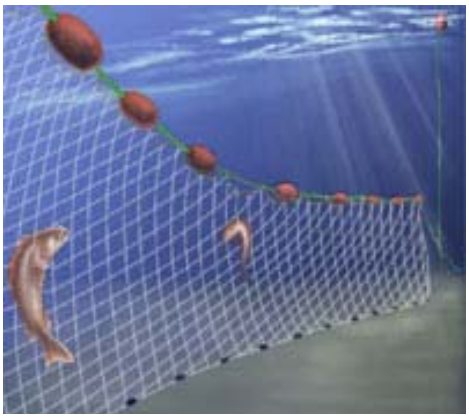
Dredging
Dragging a heavy frame with an attached net across the sea floor. This method is usually used to collect shellfish and is similar to trawling. It is very damaging to the seafloor and collects significant amounts of bycatch.

www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.asp



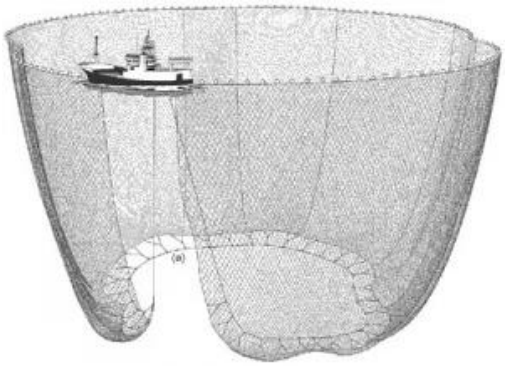
Trawling
Towing a net behind a boat at various depths. This method is very indiscriminant about the creatures that are captured. A bottom trawl is similar to dredging. There is a great deal of bycatch and it can be damaging to the seafloor.

njscuba.net/artifacts/ ship_fishing.html



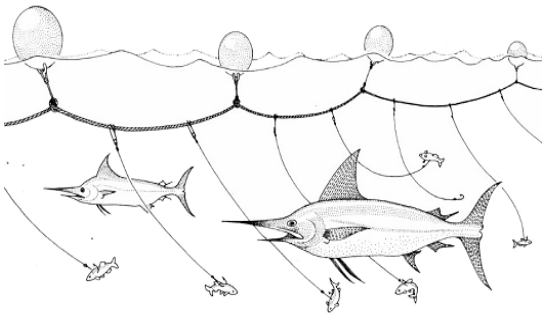
Gillnets
A large curtain of net is hung at various depths that catch fish as they attempt to swim through. Only the fishes' heads pass through, and their gills become entangled when they try to back out. This method can entangle many unintended creatures and can damage the seafloor if anchored to the bottom.

www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.asp



Purse Seine
A large wall of net is encircled around a school of fish and then closed from the bottom to trap the fish. This method is popular for tuna fishing but it catches all kinds of other organisms that might be traveling with the school of tuna.

www.ejfoundation.org/ printpage271.html



Long-lining
A central fishing line is stretched anywhere from 1 to 50 miles that has many smaller lines with hooks dangling at a certain depth. This method traditionally results in large amounts of bycatch, particularly seabirds that dive for bait as the lines are deployed. However, modern technologies like brightly colored floats that frighten birds away are helping make this fishing method more sustainable.

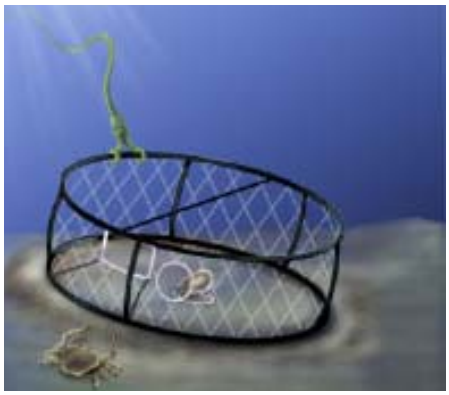
njscuba.net/artifacts/ ship_fishing.html

Hook and Line
Pole and rod fishing that specifically catches a variety of fish depending on depth and bait used. This method is environmentally responsible because one fish is caught at a time, and fish are reeled in soon after they bite the hook. They can also usually be released if not wanted.

www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.asp

Trolling
A hook and line method that tows lines from the back of a boat. This method is environmentally responsible because one fish is caught at a time, and fish are reeled in soon after they bite the hook. They can also usually be released if not wanted.

www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.asp



Traps and Pots
Submerged cages catch and hold fish until they are later reeled in. This method is usually used for bottom-dwelling animals like crabs and cod. It is generally environmentally responsible because unintended animals often have a way of escaping. However, the traps can be damaging to the sea floor and abandoned traps can entangle other animals.

www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_gear.asp

Turtle Excluder Device ("TED")
A "Turtle Excluder Device" is a grid of bars with an opening either at the top or the bottom of the trawl net. The grid is fitted into the neck of a shrimp trawl. Small animals such as shrimp pass through the bars and are caught in the bag end of the trawl. When larger animals, such as marine turtles and sharks are captured in the trawl they strike the grid bars and are ejected through the opening. Initial TED designs did not allow for the release of larger leatherback and hardshell turtles and TED openings were later redesigned to address this problem.

Turtle escaping from net equipped with a TED
Photo: NOAA

Circle Hooks and J Hooks
A circle hook is a type of fishing hook that looks more circular than a traditional J-hook. Circle hooks are thought to be less likely to incidentally capture marine turtles, although there is some debate about their effectiveness as a universal solution to incidental capture of sea turtles in commercial fisheries.

A j-hook is the traditional form of a fishing hook - it looks like the letter "J." This form of fishing hook is thought to be more likely to incidentally hook a sea turtle that tries to take the bait from the hook.

Photo: Tony Tucker, seaturtle.org Image Library
Definition: seaturtle.org Glossary