CODE BLUE: ENDANGERED OCEANS

introduction

As human population has increased and land uses have changed, our oceans have been negatively altered. For centuries, people have regarded the ocean as an inexhaustible source of resources and a convenient dumping ground that could absorb the residues of human activity with little negative impact. Mounting evidence now shows that human activities – **overfishing**, pollution, and carbon dioxide emissions – are stressing the ocean's health, leading to the progressive deterioration of marine habitats and species.

Vocabulary: overfishing

materials

- Clear plastic container or bowl of water
- Opaque film canisters or other small lidded containers
- Canister Labels (provided)
- Extraction Cards (provided)
- Extraction Items (provided)
- Plastic drinking cup
- Masking tape
- Canister ingredients (see chart)
- Water
- Salt
- 16 clothespins or binder clips
- Story: "Code Blue" (provided)

procedure

1. Before class:

   a. Fill a large, clear container with water until it is approximately half full.
   b. Print the Canister Labels and tape one to each canister. Fill each canister with the appropriate material from the chart. The canisters represent things that are added to the ocean.
   c. Print the six Extraction Items, laminate them if desired, and tape them to the side of the bowl. The Extraction Items represent something currently found in the ocean.

d. Print the six Extraction Cards and laminate them if desired. These will be passed out to students.
e. Tape the "Sea Level Rise" Canister Label onto the plastic drinking cup and fill with water.

Note: There are 17 different characters between the Canister Labels and Extraction Cards. For classes of more than 17 students, create two of some characters so all students can participate.

CANISTERS	
Character (Canister Label)	**Canister Ingredients**
Algal blooms	Green yarn
Abandoned nets	Fishing line, dental floss, or hair net
Antibiotics	Baking soda
Litter	Cut-up pieces of plastic
Natural disasters	Broken up toothpicks or craft sticks
Chemical fertilizers	Vinegar + green food coloring
Coal	Water + red food coloring
Off-shore Oil Wells	Cooking oil + red and green food coloring
Ocean acidification	Vinegar
Sewage	Water + instant coffee

2. Distribute the canisters and Extraction Cards so each student has one or the other.

3. Explain that you will be reading a story about the history and health of our oceans. Instruct the students to listen for the name of the character printed on their canister or Extraction Card. When they hear the name in the story, they should come to the front of the class and pour the contents of their canister into the bowl. If they have an Extraction Card, they should find the matching Extraction Item from the side of the bowl and remove it. After removing their item, they should hold it up for the class to see and say what they have removed.

4. Tell the students that the clothespins or binder clips represent the world population and that each clip represents 500 million people. You will begin the demonstration with one clip on the side of the bowl and end with 16 (representing 8 billion people). You may decide to have a few students be the "population monitors" and add clips throughout the story so that you do not have to pause.

5. Read the story, adding emphasis and pausing on the bolded words in all-caps so that students have a cue to either add their pollutant or make an extraction.

discussion questions

1. Who polluted the ocean?

   Everyone played a part. Students should mention that each person had an impact and everyone shares the oceans.

2. What effect did increasing population have on the health of the ocean? Can you think of any ways that population increase helped the ocean?

In this situation, population growth led to increases in pollution sources and decreases in open space and in available wetlands, which filter water. However, the increase in population also led to stronger environmental laws, more efficient uses of resources, and public services like sewage treatment plants.

3. Think about the pollution held in the canisters. What are some things individuals can do to prevent some of those materials from entering the water? What are some actions businesses (especially industry and farms), communities, and governments can take to reduce and prevent some of this pollution?

Answers may include: as individuals, we can use less chemical fertilizers on our property, be selective with what types of products we purchase and eat, recycle, participate in beach and park clean-up projects, use alternative transportation, etc. Farms (land-based and aquaculture) could reduce their use of chemical fertilizers and pesticides and better manage animal waste, as all can be foul watersheds. Industries can reduce their use of fossil fuels. Regulations on the fishing industry could prioritize sustainable fishing practices that do the least harm to marine ecosystems.

4. Think about the organisms that were removed or destroyed due to human activities. They aren't confined to just one area of the world, but swim freely. Who owns these animals? Who should manage how many of these creatures people are allowed to remove? How can these management systems be enforced internationally?

Answers will vary. Guide students to understand that there are international management groups that sign treaties to protect international interests (ICCAT, IPCC, IWC) but that these treaties are difficult to enforce.

5. Were all of the impacts on the ocean caused by humans? Which ones were? Which ones weren't?

Many were human caused, but natural disasters like tsunamis and mudslides can't be prevented. However, human activities can affect how devastating these natural disasters are by destroying natural buffers to storms, like mangrove forests, coral reefs, or cutting down trees that are meant to stop erosion and nutrient depletion. We also increase the intensity and frequency of these storms through global warming.

6. Think about the impacts of sea level rise in coastal communities. Where will these impacts be the worst?

Areas with high population density living in very low-lying areas. The poorer, tropical regions will be the most impacted.

7. Is it easier to prevent pollution by managing ocean resources beforehand, or to clean it up and restore it later?

To prevent it in the first place. Because preventing pollution typically requires cooperation among many stakeholders, people often rely on ocean restoration as the main way to maintain the health of the oceans. Most forms of pollution are nevertheless impossible to entirely remove from a body of water, making prevention always a better option when possible.

8. What could each of us do to help improve the health of the oceans?

Answers may include: using alternative transportation besides just cars, conserving water, eating organic foods or foods produced with natural fertilizers, only eating sustainably harvested seafood, etc.

assessment

Students complete an exit ticket identifying three ways humans impact oceans and two ways these impacts can be mitigated.

follow-up activities

1. Have students research a piece of the story that seemed the most interesting or relevant to them. For example, they could research overfishing, ocean acidification, whaling, the Plastic Gyres, or sea level rise and climate change. Then, have students write a short essay with more specific details and examples of how their research topic impacts the oceans. Students can also research impacts that were not included in this story.

2. Discuss international policymaking. What are the difficulties of getting countries to solve problems together? What is the best method of solving these problems? Have students research an international policy or regulatory body of their choice (Montreal Protocol, Kyoto Protocol, Paris Agreement, International Panel on Climate Change, International Whaling Commission, or the Convention in the Trade of Endangered Species). Ask them to write a short paper on the history of the policy, which countries were major players in the debate, and why it was important or controversial. Alternatively, they could work in groups and give a short presentation to the rest of the class on their treaty or commission.

3. Have students explore some of the following sources to learn more about ocean health:

   - FAO, The State of World Fisheries and Aquaculture 2020
   - Monterey Bay Aquarium, Seafood Watch Program
   - NOAA, Oceans & Coasts
   - Pew Charitable Trusts , Ocean Conservation
   - Ocean Conservancy
   - Joint Ocean Commission Initiative
   - UN Atlas of the Ocean

   Information on various international organizations that are working on these issues:

   - Intergovernmental Panel on Climate Change
   - International Whaling Commission
   - International Commission for the Conservation of Atlantic Tunas
   - International Coral Reef Initiative

Story: Code Blue

Throughout humans' existence on Earth, we have made our home on the coasts of the ocean, depending on its resources for food and transportation. The ocean makes up over 70 percent of the Earth's surface, making it the primary reservoir of water on Earth's surface. It is the largest of the three marine biomes, is teeming with wildlife, and is responsible for much of our climate patterns. Imagine that this container of water represents the ocean 500 years ago (*pour salt into the container*). Back then, our world population was 500 million, or about 1/16 of what it is now (*place one clothespin on the side of the bowl*). The oceans were filled with diverse ecosystems of corals, invertebrates, fish and mammals, all relying on each other in interconnected food webs.

However, the ocean has changed a lot since 1500 and this is a story of those changes.

One hundred years passed by and people turned to the ocean as a resource to improve their lives. During this "Age of Discovery," the popularity of ocean transit exploded. People and goods embarked on ambitious new oceanic trade routes that interconnected Europe, Africa, and Asia. Additionally, people began to recognize the ocean's wealth as harvestable. Though people had been hunting whales for thousands of years, new technologies like faster ships and large harpoons now entered the scene and made **COMMERCIAL WHALING** more lucrative in Europe and North America. Whale blubber was converted to lamp oil, and baleen ("whalebone") was used in ladies' corsets. By the mid-1700s, it became difficult to find whales near the Atlantic coast, leading fleets to expand their hunting to other parts of the globe, decimating whale populations worldwide. Currently, there is an international moratorium on commercial whaling; however, some countries such as Norway, Iceland, and Japan continue the practice.

In the early 1800s, world population had reached 1 billion (*place another clothespin on the bowl*) and scientists and farmers were looking for ways to increase crop yields to feed the population. Scientists began creating **CHEMICAL FERTILIZERS** with high levels of nitrogen, phosphorous, and potassium. Nitrogen is highly soluble and when used in large amounts, can run off into large bodies of water. Increases in nutrient pollution in the ocean cause **ALGAL BLOOMS** that consume all of the oxygen in an area and create a dead zone where no other organism can live. Dead zones occur in many areas, including the East Coast of the U.S. and the Gulf of Mexico, which has the second largest dead zone in the world. Worldwide, there are now some 700 coastal dead zones. However, the small amounts of chemical fertilizers used in the early 1800s weren't enough to cause these troubles, and people probably never anticipated how widespread their use would become or that, in large quantities, their use could harm marine ecosystems.

The Industrial Revolution in the mid-19th century ushered in a new era of technologies and jump-started a fossil-fuel based economy. **COAL** was the new main energy supply, but it caused a large amount of air pollution. Burning coal was also a source of mercury poisoning in our ocean system. Trace amounts of mercury found in coal were released as coal was burned, and it moved into our atmosphere and our oceans. Fish ingest the mercury and humans are susceptible to illness if they eat fish with high mercury content.

- *What has changed about the oceans from 1500 to 1850?*
- *How have humans been helped/hurt by these changes? Possible answers: Helped – more access to food due to fertilizer use and whaling; better transportation systems. Hurt – less biodiversity because of the algal blooms and whaling; water has high levels of mercury.*

In the early 1900s, the first **OFF-SHORE OIL WELLS** were installed off the coast of California to try to keep up with growing demand for oil. These early wells, dug close to the shoreline, blackened beaches but produced only modest amounts of oil. The first major oil spill was in California in 1910 and dumped 378 million gallons of oil into the Pacific, devastating the ecosystem. By 1930, when world population reached 2 billion *(place two more clothespins on the bowl)*, oil companies began constructing platforms in the Gulf of Mexico. Today there are over 1,300 offshore oil rigs around the world. One of the largest spills occurred as a result of an oil rig explosion on April 20, 2010. It took nearly three months to stop the flow of oil into the Gulf of Mexico, which had devastating effects on the environment but also for the Gulf Coast community and economy.

In the 1950s, much of the maritime technology that was developed during World War II was converted into new **FISHING TECHNOLOGIES** to help feed the 3 billion people on the planet *(place two more clothespins on the bowl)*. However, these technologies caused severe overfishing, as fishermen could now catch thousands of pounds of fish in one outing. These new technologies, including trawling, a technique the scrapes the seafloor with large nets, would catch anything and everything. Additionally **BYCATCH**, or the accidental catch of marine life, was becoming a problem as turtles, dolphins, and other fish were often caught and killed in fishing gear that was meant for other animals. **ABANDONED NETS,** fishing lines, and traps can also continue to kill animals for weeks after they have been deployed if fishermen forget to retrieve them. As of 2017, two-thirds of the world's fisheries were being fished at maximally sustainable levels, while one-third were being overfished, depleting fish stocks. The cod fishery in the Northeastern United States and Canada had record high catches in the 1960s but later collapsed due to overfishing.

Even with the fishing boom, we weren't producing enough fish to provide for our growing population. In the 1970s when world population reached 4 billion, *(place two more clothespins on the bowl)* **AQUACULTURE**, or raising fish in pens as you would cows or chickens, became a growing industry, especially in Asian countries such as Indonesia and Thailand. In many rural areas, coastal ecosystems were decimated as fish farmers cleared mangrove forests to create room for more aquaculture. These mangroves were home to hundreds of species of birds and fish but were converted into large feeding pens of shrimp and salmon. Due to the density in which the fish are grown, they must put large quantities of **ANTIBIOTICS** in the water to stop the spread of disease. Unfortunately, these antibiotics seep into the oceans and pollute our water, endangering our public health as well as our food sources.

By 1987, world population was at 5 billion people (*place two more clothespins on the bowl*) who were together producing millions of pounds of trash. This **LITTER** from land sources, commercial ships, and cruise vessels entered the ocean system as pollution. By 1997, with population nearing 6 billion (*place two more clothespins on the bowl*), scientists discovered two "Plastic Gyres" in the Pacific and Atlantic Oceans. These massive swirling mounds of plastic, created by water currents, seep toxic substances into the water and kill **MARINE BIRDS** who choke on or consume the plastic.

Litter isn't the only pollution we have to worry about. In many countries, sewage treatment facilities are not available, and **SEWAGE** from cities and households runs directly into our rivers and oceans.

Recognizing the global nature of the problems our oceans were facing, international bodies have been created to monitor pollution, climate, and fishing industries. However, it was and still is difficult to get countries to agree on an action plan, and, without an enforcing body, many countries still do not comply with the agreements. As the world population reached 7 billion people in 2011 (*place two more clothespins on the bowl*) all of the detrimental human impacts on the ocean were accumulating. Increased concentrations of carbon dioxide, or CO_2, in the air from burning oil and coal led to Arctic ice melting and **SEA LEVEL RISE**. Low lying countries such as Bangladesh, Papua New Guinea, and islands in the Pacific Northwest have already had to evacuate some communities due to permanent sea level rise.

Similarly, as more CO_2 is absorbed by ocean waters, the pH level of the water decreases and causes **OCEAN ACIDIFICATION**. Many organisms can only handle a narrow range of pH in their environment and maintain homeostasis. This acidification makes it difficult for **CORAL REEFS** to form shells, leading to the death of the coral and the rich biodiversity that relies on it. Both coral reefs and the mangrove forests normally act as natural buffer zones against storms for coastal communities. With increases in global temperatures, storms, like hurricanes, are increasing in intensity, and without these natural protective structures, **NATURAL DISASTERS** wipe out entire towns and wash them into the water. Mangrove forests are also a "carbon sink," sequestering – or soaking up – carbon dioxide from our atmosphere. Without them, the cycle of global warming and ocean acidification continues.

Now, as our population approaches 8 billion (*place the last two clothespins on the bowl*), our accumulated activities are threatening ocean health and all it provides to us and the global ecosystem. Our oceans are essential for nutrition, transportation and recreation, but also for making the Earth habitable for humankind by regulating temperatures and atmospheric moisture, and storing carbon. The UN has recognized the need for protecting ocean health by including the goal "to conserve and sustainably use the world's ocean, seas and marine resources" (SDG#14) in the Sustainable Development Goals, hoping to ensure healthy oceans exist for generations to come. It is important for all countries to work together to achieve this goal.
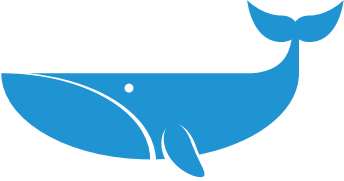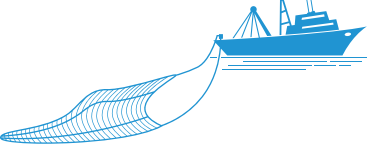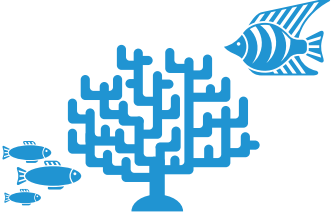
Print and tape each label to a canister.

CHEMICAL FERTILIZERS	**ALGAL BLOOMS**	**COAL**
OFF-SHORE OIL WELLS	**ABANDONED NETS**	**ANTIBIOTICS**
LITTER	**SEWAGE**	**OCEAN ACIDIFICATION**
NATURAL DISASTERS	**SEA LEVEL RISE**	

CODE BLUE: ENDANGERED OCEANS | extraction cards & items

Extraction Cards: Print and give one to six students in the class instead of a canister.

COMMERCIAL WHALING	**MARINE BIRDS**	**BYCATCH**
FISHING TECHNOLOGIES	**AQUACULTURE**	**CORAL REEFS**

Extraction Items: Print and tape to the side of the clear bowl of water.