Marine Environmental Challenges – Tutorial Script

Marine pollution is defined as any substance that humans add to the ocean and that results in harm to living organisms that live in the ocean or that use the ocean's resources. It's an important definition, because some toxins and destructive substances in the ocean are naturally produced and released, such as natural oil seeps, neurotoxins emitted by harmful algal blooms, and, well, if you're a salmon, you might consider a shark harmful to your well being. None of these are considered pollution. So what ARE some examples of harmful substances that we humans put into the ocean? For starters, anything that is left on the sidewalk near a storm drain will enter the ocean through rain runoff. That can include oil drippings from your engine, antifreeze, detergent, fertilizers from your garden, pesticides, plastics, and styrofoam. Sometimes we are more deliberate in our dumping. Some countries dump their garbage directly into the ocean. New York City did so until very recently. This map shows 4 different dumping sites along the East Coast near New Jersey. The first site chosen, on the continental shelf, caused a lot of problems when longshore currents produced by waves arriving from storms to the North caused the garbage to get spread southward along the New Jersey beaches. It was a common sight at that time to find garbage, including hypodermic syringes, along these beaches. The uproar over these sights caused the dumping to be pushed further offshore, eventually onto the bottom of the continental slope. Garbage has been dumped directly into the ocean by human civilizations for millennia. Unfortunately with human population now at 7 billion and rising, it is becoming increasingly difficult to pretend this dumping isn't a problem. Finding areas of the ocean without pollution is harder and harder. The worst problems are with materials that are difficult to break down. One of the worst is plastic, which takes hundreds to thousands of years to break down. It breaks into smaller and smaller pieces as it's exposed to sunlight – we call that photodegrading. Plastic is a highly useful material that was designed specifically NOT to break down easily. It has many important uses in our society. However, BECAUSE it doesn't degrade, it's important that we find a way to properly dispose of it or recycle it. Otherwise it will simply collect in greater and greater amounts in the ocean. Refer to the video tutorial on ocean currents to learn more about where and how plastics collect in the ocean.

Other types of marine pollution include discarded fishing nets, many, unfortunately, trapping and killing animals as they float across the world's oceans, oil, and radioactive waste. There have been a few nations that have discarded their radioactive waste in barrels in the oceans. It was a practice performed by the US Navy right after World War 2, and there are thousands of these barrels right now around the Farallon Islands off the coast of San Francisco sitting in the sediment. Mapping projects have located a number of these dump sites, but they are in waters around 200 to 1000 meters deep, and are thought, at this point, to be better left alone than disturbed. Oil is an emotionally impactful pollutant for humans, because of its immediate and disastrous impact on bird and mammals that live in the area. However, oil breaks down quite quickly relative to many other pollutants – and the oil that floats atop the ocean surface will break down with the aid of sunlight and bacteria and be gone in a few weeks. Some of that floating oil can even be collected immediately after a spill, if contained, using skimmers. However, denser oils can sink to the bottom or collect on beaches will take longer to degrade, but they will eventually do so naturally, within a few decades at most. Oil pollution is a short-term catastrophe, but not a long-term issue, like radioactive waste and plastics, the former of which can last for millions of years, the latter for thousands.

Other pollutants include heavy metals like copper, mercury, and lead and long-chain molecules like DDT, a pesticide. These tend to collect in sediments along the shorelines and become highly concentrated in the organisms that live in these areas through bioaccumulation. Basically the material is ingested faster than the body can eliminate it, so it accumulates in greater and greater amounts each day. Although DDT has mostly been eliminated in usage in the United States, it is still in use in other parts of the world. And its legacy lives on in the sediment in which it collected. A similar legacy was left behind after the Gold Rush of 1849 in California. Mercury was used to remove gold from the river sediments, and it collected in large amounts in the Sacramento River and its sediments, eventually making its way into the San Francisco Bay. Today's bay sediments are continually moved around by tidal currents moving in and out under the Golden Gate Bridge, and these moving sediments can mean the uncovering of old deposits of mercury-rich material. That's especially a problem in areas where we dredge to maintain the shipping channels. It is for this reason that people are warned not to eat, with frequency, fish caught within San Francisco Bay.

Other pollutants to the ocean include heat and carbon dioxide. This image of coral bleaching shows what happens to corals when the water becomes too warm. This happens as the ocean's temperature increase due to global warming or near where power plants dump hot waters that have cooled their structures. Healthy coral have a garden of brightly colored microscopic dinoflagellates (algae) living within them. The corals harvest these gardens as their primary food source. These dinoflagellates cannot survive water that is too hot. When they die, the corals lose their colored gardens and become just white calcium-carbonate apartment buildings, within which live tiny coral polyps that have lost their primary food source. If the temperatures stay warm, and no dinoflagellates return, the corals will starve and die. As for increased carbon dioxide, as discussed in detail in the carbonated oceans video tutorial, increased carbon dioxide can lead to a drop in pH and more acidic seawater, which will dissolve the calcium carbonate shells of organisms that live in these waters.

Another ways humans pollute the ocean is through fertilizers and detergents picked up and carried to the oceans by rivers. Fertilizers and detergents are nutrients, which accumulat in high amounts at the river deltas and lead to dead zones. Why? High nutrients cause a bloom in algae. Algae populations have quick turnover, so as one population dies and the next takes over, there can be a glut of decomposing material in the water. Decomposition requires oxygen, and with so much oxygen going into decomposition, the water can end up with extremely low oxygen levels, otherwise known as **hypoxic**. Heterotrophs can't survive and will have to migrate away or die en masse. This image shows some of the locations in the world where dead zones have been identified. You'll notice they concentrate around major river deltas and cities. One of the key indicators that a dead zone has developed is when there's a big die off of fish in the area, as this beach in Narragansett Bay, Rhode Island demonstrates.

In the San Francisco Bay area, humans have wrought many changes on the marine environment, including the loss of 95% of the original wetlands that lined the edges of the Bay. Wetlands are necessary nurseries for young fish and invertebrates. Without the wetlands, populations of these organisms will be lower. Wetlands are also areas where toxins can be pulled out of the water and settle into the sediment eventually broken down by plants and transformed into nontoxic byproducts. Fewer wetlands means less of a natural cleaning system for the bay.

Since human populations have migrated along coastlines, we have actively introduced new species into the ecosystems of coastal bays. These species are ones that traveled along, unbeknownst to humans, attached to boats, fishing gear, and bait. Sometimes they were purposely brought in to create new fisheries, like Striped Bass and East Coast Oyster species. These little Asian Clams came in from ports in China as microscopic larvae carried in the ballast water of ships. The result? A complete transformation of the local ecosystem as new, more competitive species take over and the native species are squeezed out. The repercussions of these introduced species can be felt all the way up the food chain. For example, the Asian Clam has completely taken over the bottom sediment in many parts of the Bay. Their filter-feeding has removed large amounts of plankton from the water column and caused fish that depend on that food source to migrate to other areas. Meanwhile, other fish, like sturgeon, that bottom feed on mollusks have a new food source and have grown in their populations.

Fish is a major food source for a significant portion of the world's population. To satisfy these food needs, fishing industries all over the world's oceans have removed as much as 90% of the populations of many of the world's major fisheries, including Atlantic Cod and Blue Fin Tuna. Though there are some sustainably managed fisheries, these are dependent on decisions made by individual countries and only for waters in which they have management. In addition to overfishing, we have also managed to destroy a large amount of the ocean's fish population through **bycatch and ecosystem destruction**. Indonesia, for example, has removed entire swaths of mangrove forest to support shrimp farming. And the fishing technique of trawling, which drags a net behind a boat along the bottom of the seafloor, will remove and destroy everything in its path. The amount of wasted marine life is immense. Bycatch is a problem in all types of fishing, especially with trawling and nets.

So what can we do about all these problems? Education – understanding the problems yourself and then spreading the word to others. We can develop technology that limits bycatch like the turtle exclusion device. And another thing that helps is international cooperation. In the 1980s many nations of the world got together to create a few "rules of the sea" around national borders and waters. One of the things that was developed was a definition of the **Exclusive Economic Zone** or EEZ. This is an area over which a nation has control of fishing, mining, and pollution regulations. In comparison, a nation's territorial waters, over which it has all jurisdiction and can prevent other nations from entering, extends only 12 nautical miles off its shoreline or about 22

kilometers. But its EEZ extends 370 km or 200 nautical miles. And its seabed rights extend up to 648 km. Here's what the U.S.'s EEZ looks like across the Pacific and Atlantic Oceans. What have we done with these areas? In some cases we've created National Marine Monuments and Sanctuaries to protect the local sea life. In all of them we try to control pollution and regulate fishing industries, both in numbers of catch and in types of fishing that are allowed. And to help us determine, among other things, the mineral potential of these zones, right after the EEZ was developed, the U.S. government commissioned the development of side-scan sonar images of the continental shelves and slopes within the EEZ. That work allows to see far more detail of the continental slope including all of its detailed submarine canyons.

What can you do to limit the negative impact of humans on the oceans? Recycle. Reuse. Dispose of garbage responsibly. Support legislation to produce more marine sanctuaries. And participate in local beach cleanup days. When you see garbage on the ground, pick it up, so it doesn't end up in the ocean. Clean up oil spills on our streets. And spread the word. Stewardship of our oceans is a role the entire world must play.

Pause now.

[end credits]

Marine Environmental Issues
Geoscience Video Tutorial
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**Healthy coral – Jim Maragos -- USFWS*
**Bleached coral – NOAA*
**Coral bleaching explanation – NOAA*
**Ocean acidification – NOAA*
**Satellite image – Mississippi River Delta – Google Earth – Image: Landsat, NOAA; Data: SIO, NOAA, US Navy, NGA, GEBCO.*
**Mississippi Dead Zone – nutrients in the wtershed – NOAA*
**Eutrophication – Univ. North Carolina*
**World Dead Zones – Review paper (SCIENCE Aug 15 2008) by Robert Diaz of the Virginia Institute of Marine Science*
**Fish kill Narragansett, RI – http://www.geo.brown.edu/georesearch/insomniacs/FishkillsPhotos/*
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**Fish larvae – flounder – NOAA*
**Fish larvae – walleye – EPA*
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**Wetland Sign, Longswamp Township, Berkshire County – From Water Resources Education Network*
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**Global fish stocks – UN FAO Fisheries; Fisheries at the Limit?; www.fao.org*
**Bluefin tuna caught on deck – Fishwatch.gov*
**Bluefin tuna swimming – Fishwatch.gov*
**Cod fishery collapse – Millenium Ecosystems Assessment*
**Cod swimming – Hans-Petter Fjeld – CC BY-SA 2.5*
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**Sorting trawl catch for scallop fishery – National Marine Fisheries*
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**Global world relief map – NOAA*
**California continental shelf – satellite imagery – Google Earth –Image: Landsat; Data: SIO, NOAA, US Navy, NGA, GEBCO.*
**EEZ – NOAA*
**Northwestern Hawaiian Islands Marine National Monument – NOAA*
**California National Marine Sancuaries – NOAA*
**No-fishing zones lead to more and bigger fish – Bay Area News Group – data from California Ocean Science Trust and California Department of Fish and Wildlife*