Lesson III: The Water Planet at Risk

Keywords: *turbidity, deforestation, bioaccumulate, nutrients, debris, silt, toxic chemicals, pathogens and terrestrial*

The Water Planet is at Risk

Despite its vast size, we now realize that ocean resources are finite and marine life is susceptible to human influences. The oceans cover 70% of Earth and have a volume of 300 million cubic miles, weighing approximately 1.3 million million million tons. But, with the human population of the earth increasing every day, one small plastic cup from each person adds up to a lot of garbage. How can this effect something as large as our ocean? Everything that happens in our ocean makes a difference. There are many processes that affect our ocean, and they all act together. Ocean currents carry pollutants, overfishing in one area can decrease the fish in another as larval fish may be carried somewhat by the currents. Since the 1970's, commercial fisheries have pushed fish stock to collapse, pollution has claimed the lives of millions of seabirds, and untold numbers of mammals, birds, and turtles become entangled or snared in plastic debris that finds it way into the sea. Coastal habitats are being buried, damaged, altered, or destroyed by construction and development.

According to an EPA report, the major threat to coastal waters is from urban runoff, the water that runs over the streets of our cities, picking up pollutants and carrying them to the ocean. More than three-quarters of marine pollution begins as a **terrestrial** (land-derived) or man-made source. The types of pollutants can be classified as **nutrients, debris, silt, toxic chemicals, and pathogens.** There are also direct threats to the marine environment due to misuse from overfishing, development of coastal areas, and careless boaters.

What is happening at the Year of the Ocean?

Have you ever seen a developed area that had to be abandoned due to environmental changes? Or have you seen a waterway that has been destroyed because of the impact of development? Since all streams and rivers eventually drain into the ocean, problems in local towns and cities ultimately become marine pollution. Municipal officials fielding developers' requests often have to make decisions that will affect future water quality without access to good watershed data. A group of scientists at the University of Connecticut were among the first to develop a program called **NEMO (Nonpoint Educational Municipal Officials)** which applies satellite data to 'forecast' the changes that development will induce on a town

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NEMO TO THE RESCUE

NEMO project leaders bring their technology to the town hall with a computer model that contrasts the current impervious land cover (areas where the soil surface is covered by roads, parking lots, buildings, etc) with projected future levels. Maps of existing land usage are made using the Geographical Information System (GIS). These maps classify regions according to level of development, from undeveloped vegetated zones to fully-developed industrial zones. Future development plans can then be overlaid on maps of present usage, and planners can determine areas where a watershed will be unacceptably damaged. A watershed becomes seriously impacted when roughly 10-25% of its total area is covered by impervious surfaces. With advance planning, officials can make more informed decisions and waterways can be protected. NEMO's developers hope one day to bring NEMO's techniques to the Web, where officials and city planners could feed in their data and design their own crystal ball into their waterways' future.

NEMO is a University of Connecticut Cooperative Extension System project funded in part by NOAA's Sea Grant, which is celebrating the International Year of the Ocean this year.
For more information, call:

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NEMO Project Director
telephone:(860) 345-4511 fax:(860) 345-3357
Visit the NEMO home page at:
www.lib.uconn.edu/CANR/ces/nemo/

Nutrients

Nutrient pollution is caused by excessive amounts of chemicals such as nitrates and phosphates entering the oceans via runoff from fertilized land, sewage and the burning of fossil fuels. Nutrient pollution is a major contributor to the global epidemic of algae blooms. Algae blooms are a natural occurrence, but in recent years these algae blooms have increased in frequency and duration. Anoxia occurs when huge amount of organic material produced by algal blooms, or when raw sewage leaks into coastal waters, depletes the waters of oxygen needed by other marine organisms. This is the major cause of fish kills due to **anoxia**. Many developing nations still do not have sewage treatment, and raw sewage is dumped directly into coastal waters.

High nutrient loads also come from animal wastes. It is believed that the toxic blooms of *Pfisteria piscicida* (Pfisteria Hysteria), that has killed billions of fish and caused sickness in fishermen on the East Coast, is caused by the run off of waste products from chicken farms in the East.

Debris

Man-made debris in the marine environment comes from many sources and includes such discarded items as fishing nets, gloves, plastic sheeting, fishing lines, buckets, hardhats, buoys, small, round resin pellets, bottles, Styrofoam cups, and much more. In 1987, the United States produced more than 34 billion plastic bottles, more than one billion pounds of plastic trash bags, 201 million pounds of plastic for disposable diapers, and 450 million pounds of plastic to manufacture shipping sacks and pallet shrink wrap. It is estimated that plastic production has increased to more than 10 pounds of plastic for every person on Earth.

The greatest threats to the marine environment appear to be entanglement or entrapment in plastic objects. Recent studies show that 30,000 marine mammals die annually due to entanglement.

Fish, birds, sea turtles and marine mammals mistake plastic debris for food and starve to death.

Balloons and plastic bags are the biggest culprits here. Plastic sheeting has been found in the stomachs of pygmy whales, sperm whales, and round-toothed dolphins. Sea turtles frequently swallow plastic bags, mistaking them for their favorite food, jellyfish. They also eat other marine trash such as Styrofoam, fishing line, and other types of man-made drifting items. One turtle found in New York had actually consumed 590 feet of fishing line.

Marine debris endangers the safety and livelihood of fishermen and recreational boaters as well as animals. Nets and fishing line can obstruct propellers and plastic sheeting and bags can block the cooling intakes of boats. Such damage is hazardous for ships at sea and repairs cost both time and money. This effects everyone because it increases the cost of goods and services provided via shipping. It is estimated that the average cost of damage due to plastic debris amounts to $2725 per vessel.

Sediment

Marine habitats such as seagrass beds, wetlands, and coral reefs are being destroyed by sediment from soil erosion. **Deforestation,** or the clearing of land for construction or agriculture, increases sediment loads, increasing water **turbidity**. Excessive dredging in coastal waterways also increases turbidity. Many plants and animals require clear water, including sea grasses and corals. These organisms need light for growth. Animals such as clams also are harmed by high turbidity, because the filters they use to capture their plankton food are clogged by sediment. Coastal development can destroy wetlands directly by draining, dredging, and filling wetlands.

Toxic chemicals

Most of the oil that ends up in the ocean is not due to oil spills but instead comes from terrestrial runoff. Only 5% of marine oil pollution comes from large tanker spills! Home oil changes and industrial waste water are major sources. Routine shipping operations, such as cleaning bilges, releases many million of gallons of oil into the ocean each year. Both industry and cars release hundreds of tons of hydrocarbons into the air. These airborne particles then settle into the ocean or are carried in by rain and runoff.

Metals and toxic chemicals which enter the ocean sink to the sea floor, where they are become part of the food web of **benthic** organisms, those animals which live and feed on the ocean bottom. Some heavy metals, such as mercury, and pesticides like PCB's (polychlorinated biphenyls) are known to **bioaccumulate.** These compounds are not easily broken down by animals, but rather, are passed on to animals higher in the food web. As the concentrations of these compounds increase in higher organisms, their dangerous effects are magnified, eventually causing disease or death. Heavy metals such as mercury and lead as well as organochlorine compounds such as PCB's and DDT have been linked to mortality and malformation in fish as well as humans.

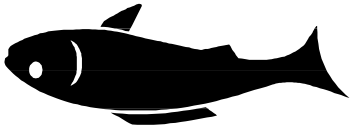
Pathogens

Sewage treatment plants are designed to kill bacteria and viruses, especially the **pathogens**, which can cause human diseases. When raw sewage leaks into the coastal waters from faulty treatment plants, leaking or open septic systems, or overboard discharge from boats, it can contaminate waters and shellfish with diseases, such as Hepatitis A, cholera and many others.

Misuse: overfishing, recreational destruction, freshwater reduction

Humans also cause direct damage to marine systems by their actions. Overfishing removes all the big fish from an area, upsetting the balance between species. Another problem is **bycatch**, which is any marine life that is caught during fishing operations for a different targeted species. It is estimated that about 20 million tons of marine fish and other animals are killed and discarded annually. Bycatch contributes significantly to the overfishing problem because much of the bycatch is juvenile fish. North Atlantic swordfish populations have declined by 70% in the last 20 years. Bycatch is detrimental in hindering the ability for a species to make a comeback after the population has declined in number.

Boat propellers and anchors can damage coral reefs and other sensitive bottom organisms. Tourists and collectors break off coral as souvenirs or to sell.



Dams drastically change coastal and riverine environments. There are more than 75,000 working dams in the U.S. Dams block the migration routes for feeding and spawning of fish. They also reduce natural freshwater runoff, hence higher salinity waters occur at the mouths of rivers, destroying the estuaries. This has devastating consequences for estuarine plants and animals. Also, the water that is released after a long storage time behind a dam is often polluted and low in oxygen content, making it unhealthy for fish and other animals.

Indirect ocean pollution also occurs in the form of ozone depletion. Increased levels of UV-B radiation reach the earth's surface as a result of ozone depletion. UV-B radiation is harmful to many organisms especially marine species living in the upper layers of the ocean. Harmful effects range from death to decreased productivity.

What is being done to help?

Conservation

In an effort to save our seagrass beds and coral reefs, human beings are starting to take pride in their environment. The boats now hook up to special '**mooring buoys**' instead of dropping anchor on the reef. Instructors teach swimmers not to touch or stand on corals. In many coastal states (Florida, for one), many of the reefs are protected by a National Marine Sanctuary, which can keep marine creatures and their homes safe for many years.

Restoration

Coastal wetlands are nature's fish nurseries. By destroying swamps and marshes, we are eliminating tomorrow's population of fishes, shrimps, and crabs. Not only do wetlands literally crawl with life, they also filter out pollution, protect inland areas from heavy storms, and provide food for the human population.

The Coastal Cleanup is an annual event organized by the Center for Marine Conservation (CMC) where volunteers join together to remove debris from shorelines, waterways, and beaches, and record the types of and amounts of trash found. During the 1994 Coastal Cleanup, 139,746 volunteers gathered 2,820,789 pounds of trash from more than 5,148 miles of U.S. shoreline.

Prevention

Physical Oceanographic Real Time System (PORTS), a new high-tech metering system uses data on current speeds and directions and water level to help barges and vessels navigate more safely. PORTS is being used in Tampa Bay, FL, San Francisco, CA, New York Harbor, NY, and Galveston Bay, Texas. The first permanent, fully integrated, operational PORTS was deployed in Tampa Bay during 1990 and 1991. It became fully operational in 1992. In Florida, the system is managed, operated, and maintained by the Greater Tampa Bay Marine Advisory Council-PORTS under a cooperative agreement with NOS and the University of South Florida.

PORTS is very helpful because is provides data about the currents, water levels, winds, wave height, visibility, air and water temperature, and barometric pressure. Its purpose is to provide safer navigation because it provides a complete picture of the body of water, and to aid in the forecasting of where an oil slick from a spill will go.

How does PORTS work? Data is transmitted via radio waves from the instruments every six minutes to a computer. The computer then translates the information and sends the information to the maritime public. People may access this data via the telephone through a voice synthesized data information unit, the worldwide web (http://ompl.marine.usf.edu/PORTS/ports.html), or via the their computer.

Since PORTS has been used in Tampa Bay, ship grounding has decreased by two thirds. That means only 1 in 1000 ship transits ever runs aground!

What Can I Do?

The first thing is to become educated. There are hundreds of little things you can do. The following list of **"Top 10 Things You Can Do To Help Our Oceans"** comes from the International Year of the Ocean Fact Sheets, published by NOAA (National Oceanic and Atmospheric Administration) This and other information can be found on the web site: Http:///www.yoto98.noaa.gov

Top 10 Things You Can Do To Help Our Oceans

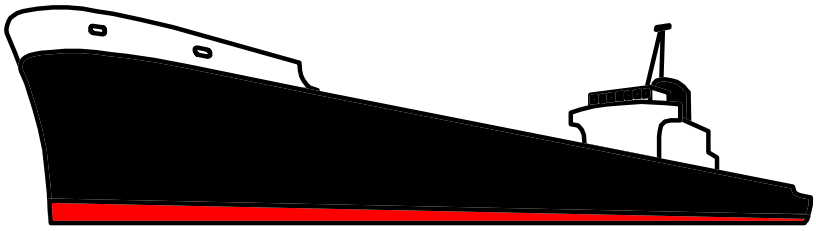
1. **Learn all you can about the ocean.**
2. **Be a smart shopper. Know the source and quality of your seafood.**
3. **Conserve water. Be careful when washing your car, or watering your lawn. Use a broom instead of a hose to clean your driveway and sidewalk.**
4. **Reduce household pollutants. Cut down and properly dispose of herbicides, pesticides and cleaning products.**
5. **Reduce waste. Dispose of trash properly. Where possible, recycle, re-use and compost.**
6. **Reduce automobile pollution. Use efficient vehicles or carpool. Recycle motor oil. Repair oil and air conditioning leaks.**
7. **Protect ocean wildlife. Don't dispose of fishing lines, nets or plastic items in or near the water.**
8. **Be considerate of sea life habitats. Don't feed sea birds, mammals and turtles or disturb their nesting grounds. Support marine protected areas.**
9. **Get involved. Take part in a beach cleanup or other ocean-oriented activities!**
10. **Care! Pass on knowledge.**

Get more information on the internet: www.yoto98.noaa.gov, and the Year of the Ocean Information Line: 1-888-4YOTO98

For more interesting facts visit the YOTO web site at http://drifters.doe.gov or the Center for Conservation's web site at http://www.cmc-ocean.org/mdio/facts.html

DID YOU KNOW?

- A National Academy of Sciences review estimates that more than 14 billion pounds of garbage enters the oceans from land-based sources alone. This is man-made debris.
- Beaches in the United States were closed to swimmers 2,400 times in 1993 due to sewage contamination. The problem is, however, larger than this. Many beaches do not even monitor water quality. As for those that do, there is no federal requirement to notify the public when water quality standards are violated
- Oily road runoff from one city of 5 million can contribute as much oil as a large tanker spill.



- Of the 109 countries with coral reefs, 90 of them have reefs being damaged by cruise ship anchors and sewage discharge. A cruise ship anchor dropped in a coral reef can destroy an area the size of a football field. The rubble created can destroy even more coral. This type of damage would take approximately 50 years to recover.

If you find any interesting facts, or have any questions that you would like to share with the staff at Project Oceanography, please feel free to send them to us at: askocean@marine.usf.edu or call us toll-free at 1-888-51-OCEAN. Visit our web page for more exciting information http://www/marine.usf.edu/pjocean/

Activity III-1. Environmental Booby traps and Pitfalls

Modified from the Center for Marine Conservation 1998 (for more information, write to 1725 DeSalle St. NW, Suite 600, Washington, D.C. 20036 or call (202) 872-0619)

This activity ties together the information that was learned in Year of the Ocean '98, Fall 1998 series show numbers II and III. In doing so, the idea of a food web will be discussed and created, as will the means that the oceanic food web is destroyed. In the end, the students should have two strong take home points:

1. Understand that living organisms are interconnected either directly or indirectly with everything in their environment and the action of one organism or change in one physical factor can affect all other organisms within that habitat
2. Discover that humans' careless use of the beach habitat may adversely affect the entire food web.

Objective: Students learn the principle of 'interconnections and interdependence of each role that each animal takes in the ocean and sustaining life on Earth.

Materials: masking tape, 2 or 3 balls of colored yarn, pictures of living creatures and 'boobytrap' items, and actual items from 'boobytrap/trash list

Living: phytoplankton, zooplankton, mussels, sand dollar, sea star, sea anemone, anchovy, rays, people, sea turtles, catfish, barnacles, shore crabs, sandpiper, gulls, sea lions, harbor seals, jellyfish, kelp, salmon, otters, trout, seagrass, tubeworms, baleen whale, killer whale, corals, garibaldi fish, sand shark

Boobytrap/trash: plastic pieces, polystyrene pieces, fishing line, nets, drops of oil, rubber tires, plastic soda rings, and plastic bags

Procedure: You many want to photocopy the picture onto card stock and make the copies stronger. Cut the photocopies into cards and laminate with clear contact paper.

1. Write the list of living creatures on the board.
2. Review vocabulary words such as herbivore, scavenger, predator, etc.
3. Discuss interdependence, food webs/chains and ways in which animals can be dependent on one another within their physical environment.
4. Have the students' form a circle holding heir pictures so that everyone can see them. Have the student highest on the food web start and give him/her the ball of yarn. Ask who or what they are dependent upon and

have them throw the ball of yarn to the student holding that picture. The second student then throws the ball of yarn to someone holding a picture of something that they are dependent on. Before they can toss the yarn to another student, they must be able to describe to the rest of the class how they are dependent on the pictured item to which they threw the yarn. Remind each student that they should hold onto a piece of the yarn before they toss it and the yarn should be held taut between links in the web.

5. When every student has had the yarn tossed to him or her at least once, the game can be stopped. The class has now formed a complex food web wherein everyone is connected directly or indirectly to each other and the physical environment.
6. Introduce the boobytrap cards into the game. Select only one boobytrap at a time. Give a student holding either the jellyfish, salmon, crab, or kelp the corresponding boobytrap card as follows: Replace the jellyfish card with plastic bag; fish card with fish entangled in net; crab card with plastic pieces; drift kelp with fishing line.
7. Once a boobytrap card has been passed out, describe the corresponding scenario to the students as follows: The jellyfish (the sea turtle's favorite food) now takes on its previously hidden form of a plastic bag. Thinking the jellyfish was a food item, the turtle actually swallowed a plastic bag and starved or choked to death; the sea lion was chasing a fish and did not see that the fish was caught in a net, the sea lion then became entangled in the net and drowned or strangled; birds feeding on crabs mistook the brightly colored plastic pieces for their food items, fed them to their chicks which then starved; gulls scavenging in the drift kelp became entangled in fishing line and then were unable to fly or eat.
8. The student connected to the boobytrap card (e.g. sea turtle connected to jellyfish/plastic bag boobytrap) must lift the piece of yarn above his or her head because s/he has been removed from the food web.
9. Then have the students raise their piece of yarn, one at a time, as they feel the pull in the yarn web.
10. After each student has raised his or her piece of yarn, review interdependence and the importance of each creature to a healthy food web and how different animals might be affected by the loss of one species.

Activity III-2. Marine Debris is Trouble for Me!!

Modified from the Center for Marine Conservation 1998 (for more information, write to 1725 DeSalle St. NW, Suite 600, Washington, D.C. 20036 or call (202) 872-0619)

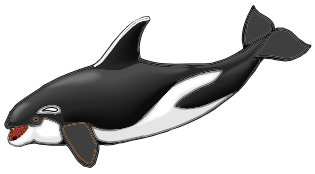
Trash thrown into the water by people on boats can be a real problem for a long time. Animals can eat trash and die, or they can get entangled in it and become injured. It is hard to swim with a ripe caught on your flipper, neck or leg! Plastic debris can get tangled in boat propellers, damage the engine and threaten the safety of boaters. A boat in the water that will not work can be very dangerous. Answer the math questions below. Match the numerical answer to the letter code for that number. Find out what or who is hurt by marine debris.

CODES: A=1, B=2, C=3, D=4, E=5, F=6, G=7, H=8, I=9, J=10, K=11, L=12, M=13,N=14, O=15, P=16, Q=17, R=18, S=19, T=20, U=21, V=22, W=23, X=24, Y=25, Z=26

1. _____ _____ _____ _____ _____ _____ _____
(10x10)/2 7+8 (9*3)-6 3*6 (33)/3 10+9 18+2

2. _____ _____ _____ _____ _____ _____ _____
12 + 7 ((4*25)/4)-2 6+3 (1/2)*26 5+8 (22)+1 (32)*2

3. _____ _____ _____ _____
(10*5)/25 63/7 (32)-9 22



4. _____ _____ ____ _____
3*2 81/9 17+2 23

5. _____ _____ _____ _____ _____
(7*3)+2 4*2 19-18 6*2 3+2

6. _____ _____ _____ _____ _____
23 3*5 200/5 3+2 48/4

_____ _____ _____ _____ _____
45/3 17+6 7*2 20/4 98-80

7. _____ _____ _____ _____ _____ _____
(2*5)+3 13-12 6*3 3*3 7*2 13

5*3	64/4	4+1	3*6	(3*7)-1	(101)*2	48/4

5*6

Activity III-3. The Dirty Dozen Exercise

During the 1994 Coastal Cleanup volunteers collected 5,635,288 pieces of trash. The "Dirty Dozen" represents the twelve objects most commonly found on U.S. beaches. 58.75% of this was plastic. For each of the "Dirty Dozen" find the percent of total debris.

Debris Item	**Total Number Reported**	**Percent of Total Debris Collected**
1. Cigarette Butts	1,283,718	
2. Plastic Pieces	354,689	
3. Foamed Plastic Pieces	301,793	
4 Plastic food bags/ wrappers	259,143	
5. Paper Pieces	244,468	
6. Glass Pieces	242,256	
7. Plastic caps/lids	215,822	
8. Glass beverage bottles	195,503	
9. Metal beverage cans	182,878	
10. Plastic straws	179,986	
11. Plastic beverage bottles	140,971	
12. Metal bottle caps	125,826	
Total Dirty Dozen	**3,727,053**	

Activity III-4. What is Your Watershed Address?

Trace the drainage path from your home to the ocean. What stream, river, aquifer, reservoir, or coast does the land around your home drain to? This exercise will help you understand that everything is carried to the ocean

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STUDENT INFORMATION SHEET LESSON III

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- Don't dispose of fishing lines, nets or plastic items in or near the water
- Support marine protected areas

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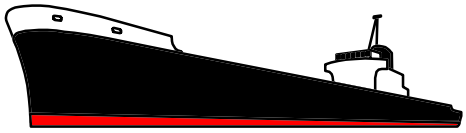

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