Marine Pollution

- Oil

- Nutrient Pollution

- Invasive Species

- Plastic

Reading: 18.2-18.9, 18.13-18.16

Midterm 3: Thursday Nov 18

Graphic: (top) Caulerpa, a very invasive marine plant, photo courtesy of NOAA. (bottom) A waste-to-energy solid waste processing plant, photo courtesy of NY Dept of Environmental Conservation.

What is Pollution?

Substances that cause damage by interfering with an organism's physical or biochemical processes

Natural pollutants:

- example: volcanic eruptions (e.g., sulphuric acid)

"Anthropogenic" pollutants:

- introduced by human activity

- example: synthetic organic chemicals (e.g., pesticides)

Graphic: North Inlet - Winyah Bay National Estuarine Research Reserve. NOAA National Estuarine Research Reserve Collection.

Common Types of Marine Pollution

Oil*

Nutrients*

Introduced Species*

Plastics *

Heavy Metals

Synthetic Organic Chemicals

Heat

Sediment

Synthetic Organic Chemicals

Sources:

- pesticides (e.g., DDT)

- flame retardants

- industrial solvents

- cleaning fluids

- coolants (e.g., PCBs)

Toxicity:

- Ingestion of small amounts can cause illness or death

- Specific warnings for children and women of childbearing age

- Immunosuppressants

Graphic: Eastern brown pelican, now recovering from near extinction due to effects of pesticides. NOAA National Estuarine Research Reserve Collection.

Biological Amplification

Levels of synthetic organic chemicals in seawater are usually low

Effects are amplified as toxins accumulate in higher amounts in organisms that are higher in the food web

Graphic: Garrison, Fig. 18.8.

Graphic: Oil-containment boom. Photograph by M. Hollinger, NODC Biologist. Courtesy of NOAA.

Sources and Characterization of Marine Pollution

Quantity:

Amount of a particular pollutant present

Toxicity:

Amount of a pollutant required to cause damage

Persistence:

Length of time a pollutant lasts in an environment

Graphic: Garrison, Fig. 18.2.

The Fate of Pollutants

Solubility = the ability of a substance to be dissolved

Common types of solubility	Characteristics	Example
water soluble	dissolves in water	liquid sewage effluent
fat soluble (binds with fat)	accumulates in fatty tissues	DDT, PCBs, some heavy metals
insoluble	doesn't dissolve	oil, plastic

The fate of a pollutant depends on its solubility

Types of Oil Spills

Crude oil spills:

- large volume

- most common type of spill

- crude does not dissolve easily

Refined oil spills:

- smaller volume

- less common

- more disruptive for longer periods of time

- a growing concern, as more refined oil is transported by sea

Graphic: Oil scum one year after the Exxon Valdez incident. Cmmdr. J.Bortniak, photographer. Courtesy of NOAA.

Sources of Oil Pollution

Graphic: Garrison Table 18.1.

M/V Prestige and Exxon Valdez
Similar Problem, Different Outcomes

M/V Prestige:

- carried 23 million gallons of fuel oil

- sank in the open ocean far from land (Atlantic Ocean)

Exxon Valdez:

- carried 11 million gallons of crude oil

- sank in cold coastal waters (Alaska)

Graphics: (top) CNN.com, (bottom) Garrison ch 18.

Deepwater Horizon Blowout

Source: USCG image http://coastguard.dodlive.mil/index.php/2010/04/admiral-allen-briefs-president-obama-on-deepwater-horizon-operations/

- **What happened?**
- **Dealing with blowouts**
- **Outcomes**

Dealing with a blowout

Blowouts occur when pressurized oil and gas escape explosively from a well

Containment procedures

Prevent blowout by increasing drilling mud pressure

Cap well at the drilling floor

Employ blow out preventer

Containment vessel

Cap well at seafloor

Top Kill

Bottom Kill

Wait for pressure to dissipate naturally

After the blowout …

- Natural evaporation and dispersion
- Mechanical barriers (booms)
- Skimming vessels
- Burning
- Chemical dispersants (usually at surface; used subsurface in Deepwater Horizon)
- Collection/cleaning onshore

What Happens to Spilled Oil?

Natural Processes:

Evaporation

Bacterial degradation

Formation of tar balls,

which sink

Cleanup Efforts:

Recovery

Burning

Dispersal

Graphic: Garrison, Fig. 18.5.

Consequences of Oil Spills

Ecological impact depends on:

- Location of spill

- Distance to shore

- Water temperature

- Currents, weather

- Composition of affected marine communities

- Amount and type of oil

Graphics: Cleaning up following a 300,000 gallon spill off Rhode Island. Photo courtesy of NOAA Damage Assessment and Restoration Program.

What happened?

- source: NOLA.com

Oil Plume reached the loop current on May 17

- Source: NASA http://earthobservatory.nasa.gov/NaturalHazards/event.php?id=43733

Deepwater Horizon: The blowout by the numbers

- 4.1 million barrels (172.2 million gallons) released over 103 days
- 0.8 million barrels (33.6 million gallons) contained.

- Source: NY Times http://www.nytimes.com/interactive/2010/05/01/us/20100501-oil-spill-tracker.html

Environmental impacts

- Source: Photos from the Times-Picayune - NOLA.com http://photos.nola.com/tpphotos/2010/09/troubled_waters_3.html
- Similar disasters (Persian Gulf War spill; Exxon Valdez) have had effects that lasted for decades
- It is too soon to determine the overall environmental effects of the spill for several reasons:

- Region is important nursery and breeding ground for many long-lived species
- Several “firsts” involved with the event (extremely large size; first subsurface use of dispersants).

Of the following, which do you think is the greatest introduced global source of marine oil pollution?

- Day to Day Shipping
- Offshore oil production
- Oil spills

Nutrient Pollution (Eutrophication)

Eutrophication:

Excessive growth of aquatic plants caused by high concentrations of nutrients

How it happens:

- excess nutrients enter an aquatic system
- plant growth booms
- plants die and decompose
- decomposition uses up oxygen in the water
- animals suffocate or are driven out of prime habitat

Graphic: Estuarine pond covered with green algae. Photograph by M.Hollinger (NODC), courtesy of NOAA.

Causes of Nutrient Pollution

Usual cause = excess nitrogen or phosphorous

"Point source" (source can be tracked to isolated locations)

- wastewater outflows

- factory effluent

"Non-point source" (source of

pollution is spatially distributed)

- agriculture runoff

- lawn chemicals

- septic tanks

Graphic: (top) Sewage treatment plant, photo courtesy of NOAA Restoration Center. (bottom) Agricultural pollution due to uncontained manure. Photo courtesy of EPA Region 10 and Washington State Dairy Assn.

Point source pollution is easier to correct that non-point source pollution.

- True
- False

Impacts of Eutrophication on Ecosystems…
How Much Oxygen is Enough?
Oxygen Depleted ("Dead") Zones

Nutrient pollution harms

- fisheries

- water quality (smell, taste, recreation potential)

<u>Gulf of Mexico</u>

- Low oxygen zone found off the Mississippi River outlet

- size ~5000 square miles

- impacts a $2.8 billion regional fishery

Graphic: (top) Gulf of Mexico Dead Zone and Mississippi River drainage, USDA(bottom) area of Gulf of Mexico Dead Zone 1985-2007, courtesy of Extent of the Gulf of Mexico "Dead Zone", NOAA.

What is an Exotic Species?

Non-native species (often with no natural predators)

Can disrupt ecosystems

Some are economically damaging

- **infrastructure**
- **water quality**
- **fisheries**
- **tourism/recreation**

Graphic: (top) Spiny water flea, photo courtesy of US Fish and Wildlife Service, (bottom) Zebra mussels, S.Van Mechelen, photographer, courtesy of Univ. of Amsterdam, courtesy of Great Lake Environmental Research Lab, NOAA.

Transport of Exotic Species
Controlling Exotic Species

Regulation

- **ballast water exchange**

Public education

Aggressive tactics

- **poisons**
- **introduce non-native predators**

Research

- **better understanding of the ecology of the nuisance species**

Graphics: Purple loosestrife, Lake Huron, K.Holland, photographer, courtesy of US EPA, (bottom) Zebra mussels washed up on a Lake Erie beach, Bay City Times, Courtesy Great Lake Environmental Research Lab, NOAA.

Case Study: Caulerpa (“killer algae”)

Solid Waste Pollution

Some Marine Debris Remains in the Environment for a Very Long Time

Solid Waste - Plastics

What Happens to Plastics in the Environment?

The Great Pacific Garbage Patch

Solutions to the Marine Debris Problem

Marine and Aquatic Pollution - Summary

Tsunami

What is a Tsunami?

Why are Tsunami so Destructive?

Review for Exam 3

Readings Ch 18: 18.2-18.9

Graphics: (top) Tsunami warning sign, commonly seen on the west coast of the US. (bottom) Fishing boat beached near a damaged fire truck. Photo by D.J. Sigrist International Tsunami Info. Center, Honolulu. Courtesy of NOAA.