ENVIRONMENT

THE SCIENCE BEHIND THE STORIES

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# Ch 16

## Marine and Coastal Systems: Resources, Impacts, and Conservation

Part 2: Environmental Issues the Search for Solutions

PowerPoint® Slides prepared by
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# Oceans cover most of the Earth's surface

- The oceans influence global climate, team with biodiversity, facilitate transportation and commerce, and provide resources for us
- They cover 71% of Earth's surface and contain 97% of Earth's surface water
- Oceans influence the atmosphere, lithosphere, and biosphere




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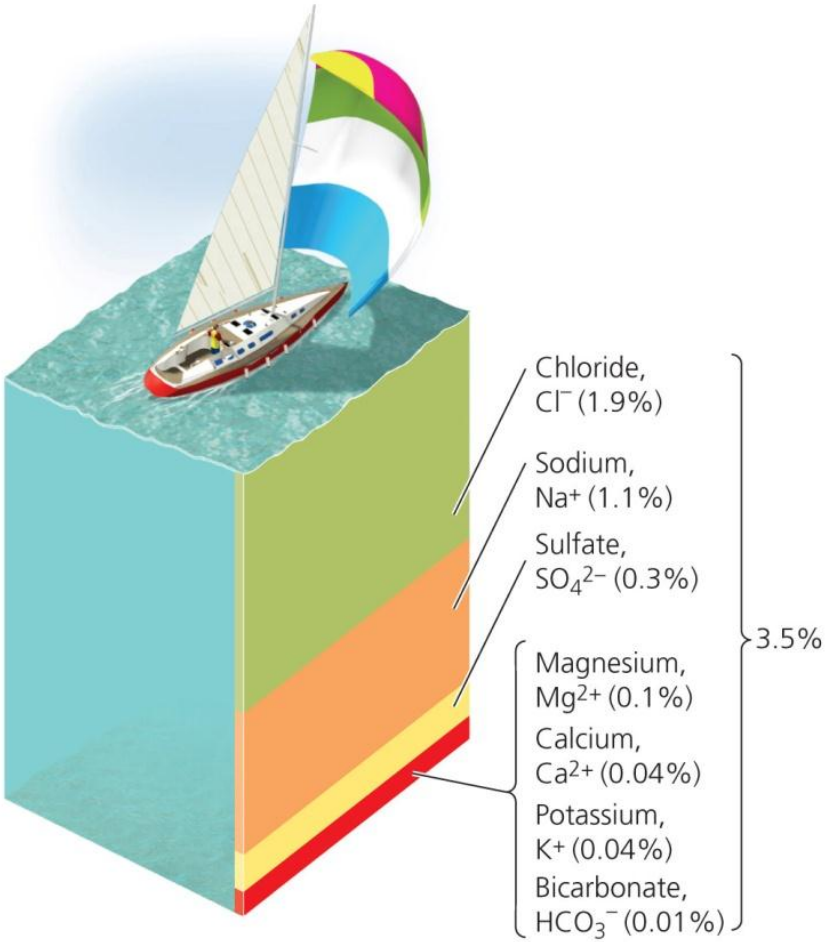
# The oceans contain more than water

- Ocean water is 96.5% water
  - Plus, ions of dissolved salts
- Evaporation removes pure water and leaves a higher concentration of salt
- Nutrients (nitrogen and phosphorus)
- Dissolved gas
  - Oxygen is added by plants, bacteria, and atmospheric diffusion

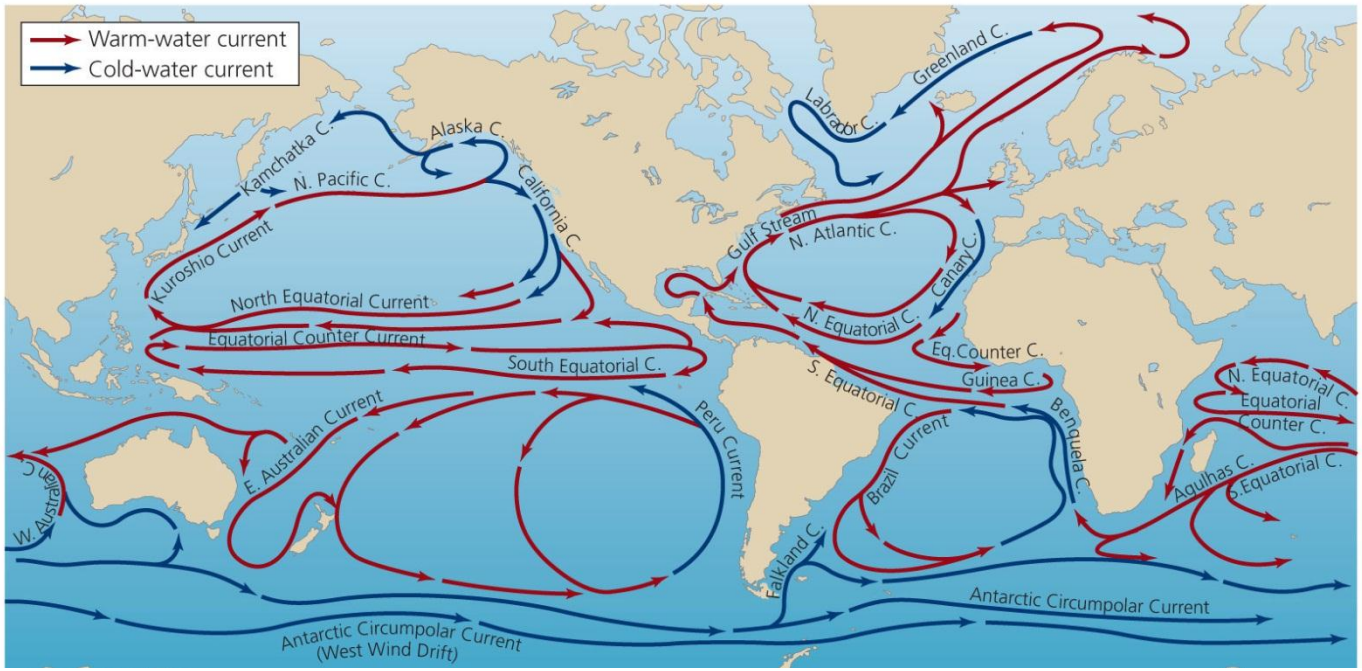


# Ocean water is vertically structured

- Temperature declines with depth
- Heavier (colder saltier) water sinks
  - Light (warmer and less salty) water remains near the surface
- Temperatures are more stable than land temperatures
  - Water's high heat capacity
  - It takes much more heat to warm water than air
- Oceans regulate the earth's climate
  - They absorb and release heat
  - Ocean's surface circulation

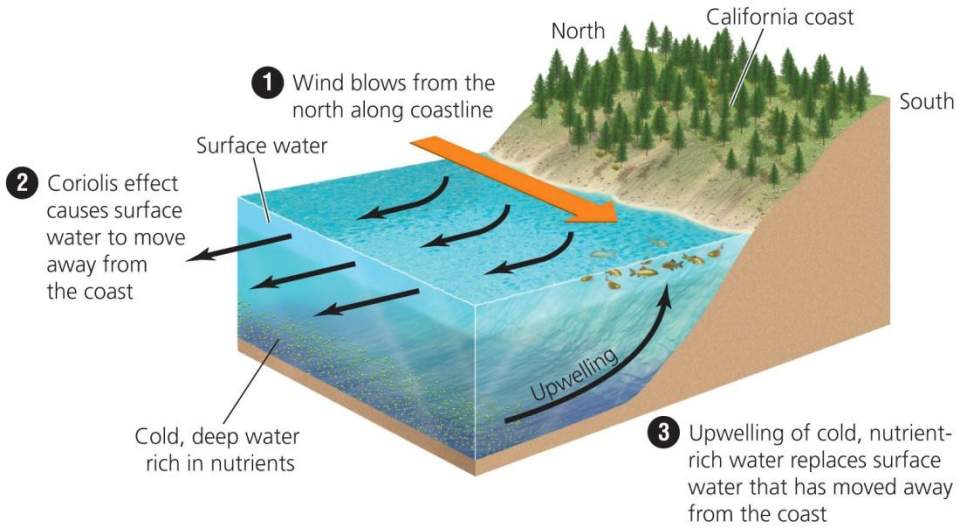
# Ocean water flows horizontally in currents

- **Currents** = the ocean is composed of vast river-like flows
  - Driven by differences in water density due to temperature and salinity concentrations
  - Transport heat, nutrients, pollution, and the larvae of many marine species



# Surface winds and heating create vertical currents

- **Upwelling =** the vertical flow of cold, deep water towards the surface
  - High primary productivity and lucrative fisheries
  - Also occurs where strong winds blow away from, or parallel to, coastlines
- **Downwellings** = oxygen-rich water sinks where surface currents come together



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# Kelp forests harbor many organisms

- **Kelp** = large, dense, brown algae growing from the floor of continental shelves
- Dense strands form kelp forests along temperate coasts
- Shelter and food for organisms
- Absorbs wave energy and protects shorelines from erosion
- Eaten by people
- Alginates serve as thickeners in cosmetics, paints, paper, and soaps

# Coral reefs are treasure troves of biodiversity

- Located in shallow subtropical and tropical waters
- **Corals** = tiny colonial marine organisms
  - Related to sea anemones and jellyfish
  - Remain attached to rock or existing reef and capture passing food with stinging tentacles
  - Derive nourishment from symbiotic algae, *zooxanthallae*

# Coral reefs consist of millions of corals

(a) Coral reef community



- **Coral reef** = a mass of calcium carbonate composed of the skeletons of corals
  - Consists of millions of densely packed individuals
  - Protect shorelines by absorbing waves
  - Innumerable invertebrates and fish species find food and shelter in reef nooks and crannies

# Coral reefs are in worldwide decline

- **Coral bleaching** = occurs when *zooxanthellae* leave the coral
  - Coral lose their color and die, leaving white patches
  - From climate change, pollution, or unknown natural causes
- Nutrient pollution causes algal growth, which covers coral
- Divers damage reefs by using cyanide to capture fish
- Acidification of oceans deprives corals of necessary carbonate ions for their structural parts

(b) Bleached coral

# Ocean Acidification

- The ocean absorbs about ¼ of the CO2 we release into the atmosphere.
- Chemical reactions occur that reduce the seawater pH and carbonate ion concentrations.
- Initially thought to be a good thing (a place for excess CO2) scientists are noticing a downside.
- Biological impacts include:
  - Increase in photosynthetic algae and sea grasses
  - Calcifying of oysters, clams, corals, and plankton

# Intertidal zones undergo constant change

- **Intertidal (littoral) ecosystems =** where the ocean meets the land
  - between the uppermost reach of the high tide and the lowest limit of the low tide
- **Tides** = periodic rising and falling of the ocean's height due to the gravitational pull of the sun and moon
  - Intertidal organisms spend part of their time submerged in water and part of their time exposed to sun and wind

# Intertidal zones are a tough place to live



- But they have remarkable diversity
  - Rocky shorelines, crevices, pools of water (tide pools)
  - Anemones, mussels, barnacles, urchins, sea slugs, starfish, and crabs
- Temperature, salinity, and moisture change dramatically from high to low tide
  - Sandy intertidal zones have slightly less biodiversity

# Salt marshes occur widely

- **Salt marsh** = occur along coasts at temperate latitude
  - Tides wash  over gently sloping, sandy, silty substrates
  - High primary productivity
  - Critical habitat for birds and commercial fish and shellfish species
  - Filter pollution
  - Stabilize shorelines against storm surges

# Mangrove forests line coasts

- In tropical and subtropical latitudes
  - Replace salt marshes along sandy coasts
- **Mangroves** = trees with unique roots
  - Curve upwards for oxygen
  - Curve downwards for support
- Nurseries for commercial fish and shellfish
- Nesting areas for birds
- Food, medicine, tools, construction materials

# Mangrove forests have been destroyed

- Development for residential, commercial, and recreational uses
- Shrimp farming
- Half the world's mangrove forests are gone
- Once destroyed, coastal areas no longer
  - Slow runoff
  - Filter pollutants
  - Retain soil
  - Protect communities against storm surges
- We are protecting only 1% of remaining mangroves

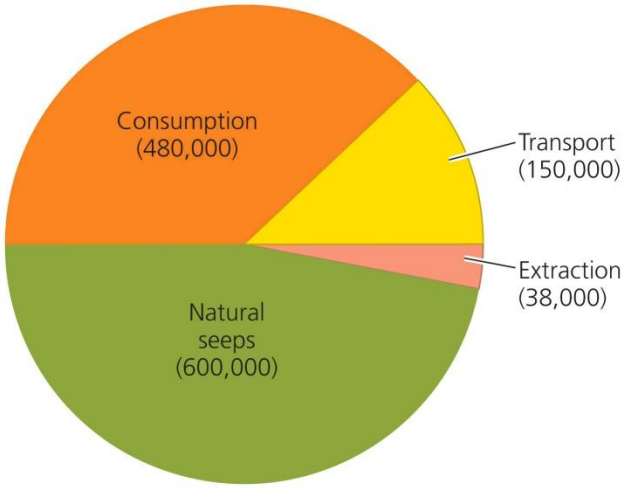
# Marine pollution threatens resources

- Even into the mid-20th century, coastal U.S. cities dumped trash and untreated sewage along their shores
- Oil, plastic, chemicals, excess nutrients make their way from land into oceans
- Raw sewage and trash from cruise ships
- Abandoned fishing gear from fishing boats

*In 2006, 359,000 Ocean Conservancy volunteers from 66 nations picked up 3.2 million kg (7 million lbs.) of trash*

# Oil pollution comes from spills of all sizes

- Major oils spills (i.e., the *Exxon Valdez*, *BP* ) make headlines and cause serious environmental problems
- Most pollution comes from small sources
  - Boat leakage and runoff from land
  - Naturally occurring leaks from the seabed
- Oil spills coat and poison wildlife



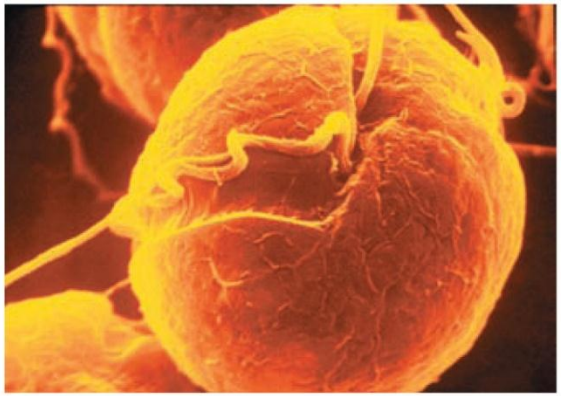

(a) Sources of petroleum input into oceans (metric tons)

# Toxic pollutants contaminate seafood

- Mercury contamination
  - From coal combustion and other sources
  - Bioaccumulates and biomagnifies
  - Dangerous to young children and pregnant or nursing mothers
  - Avoid eating swordfish, shark, and albacore tuna
  - Eat seafood low in mercury (catfish, salmon, canned light tuna)
- Avoid seafood from areas where health advisories have been issued

# Excess nutrients cause algal blooms

- **Harmful algal blooms** = nutrients increase populations of algae that produce powerful toxins
- **Red tide** = algal species produce reddish pigments that discolor water
  - Illness and death to wildlife and humans
  - Economic losses to fishing industries and beach tourism
- Reduce runoff and prevent consumption of affected organisms



(a) Dinoflagellate (*Gymnodinium*)



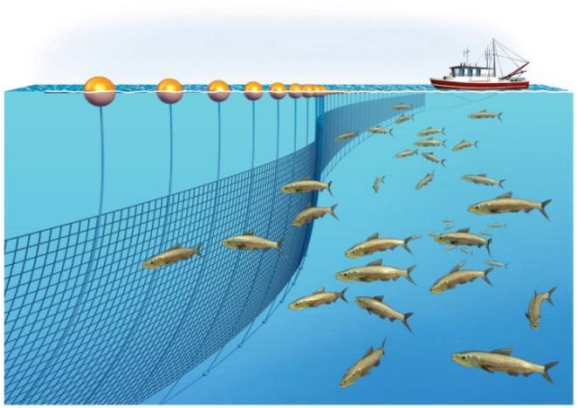
(b) Red tide, Gulf of Carpentaria, Australia

# Emptying the oceans

- We are placing unprecedented pressure on marine resources
  - Half the world's marine fish populations are fully exploited
  - 25% of fish population are overexploited and heading to extinction
- Total fisheries catch leveled off after 1998, despite increased fishing effort
  - It is predicted that populations of all ocean species we fish for today will collapse by the year 2048

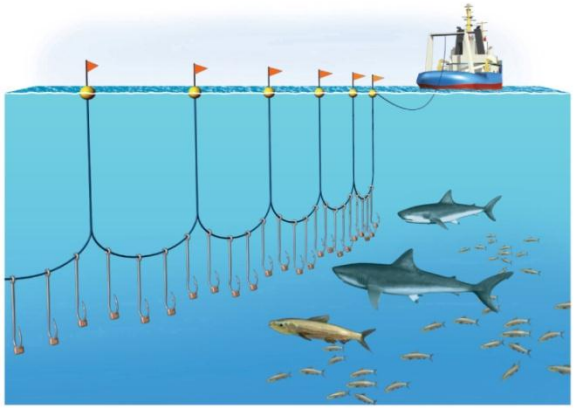
# Fishing has industrialized

- **Factory fishing** = highly industrialized, huge vessels use powerful technologies to capture fish in huge volumes
  - Even process and freeze their catches while at sea
- **Driftnets** for schools of herring, sardines, mackerel, sharks
- **Longline** fishing for tuna and swordfish
- **Trawling** for pelagic fish and groundfish



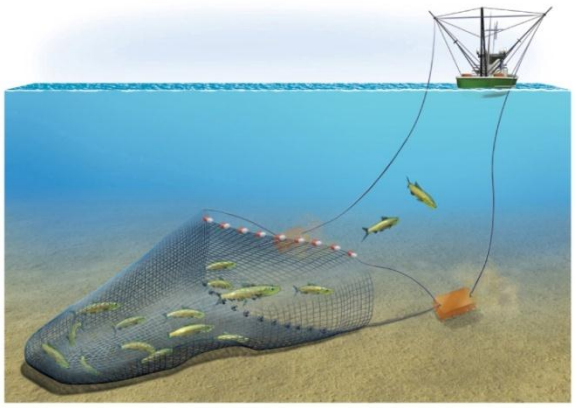
(a) Driftnetting





(b) Longlining





(c) Bottom-trawling

# Fishing practices kill nontarget animals

- **By-catch** = the accidental capture of animals
- Driftnetting drowns dolphins, turtles, and seals
  - Fish die from air exposure on deck
  - Banned or restricted by many nations
- Longline fishing kills turtles, sharks, and albatrosses
  - 300,000 seabirds die each year
- Bottom-trawling destroys communities
  - Likened to clear-cutting and strip mining

(a) Before trawling



(b) After trawling

# Several factors mask declines

- Industrialized fishing has depleted stocks, global catch has remained stable for the past 20 years
  - Fishing fleets travel longer distances to reach less-fished portions of the ocean
  - Fleets spend more time fishing and have been setting out more nets and lines, increasing effort to catch the same number of fish
  - Improved technologies: faster ships, sonar mapping, satellite navigation, thermal sensing, aerial spotting
  - Data supplied to international monitoring agencies may be false

# We are “fishing down the food chain”

- Figures on total global catch do not relate the species, age, and size of fish harvested
- As fishing increases, the size and age of fish caught decline
  - 10-year-old cod, once common, are now rare
- As species become too rare to fish, fleets target other species
  - Shifting from large, desirable species to smaller, less desirable ones
  - Entails catching species at lower trophic levels

# Fisheries management

- Based on maximum sustained yield
  - Maximal harvest while keeping fish available for the future
  - Managers may limit the harvested or restrict gear used
- Despite management, stocks have plummeted
  - It is time to rethink fisheries management
- Ecosystem-based management
  - Shift away from species and toward the larger ecosystem
  - Consider the impacts of fishing on habitat and species interactions
  - Set aside areas of oceans free from human interference

# We can protect areas in the ocean

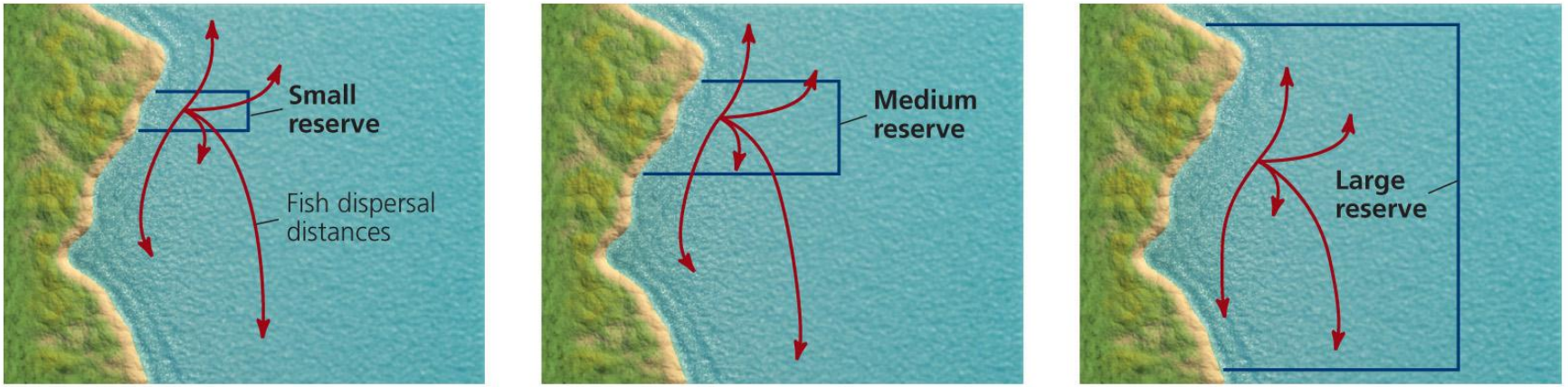
- **Marine protected areas (MPAs)** = established along the coastlines of developed countries
  - Still allow fishing or other extractive activities
- **Marine reserves** = areas where fishing is prohibited
  - Leave ecosystems intact, without human interference
  - Improve fisheries, because young fish will disperse into surrounding areas
- Many commercial, recreation fishers, and businesses do not support reserves

# Reserves work for both fish and fisheries

- Found that reserves do work as win-win solutions
- Overall benefits included…
  - Boosting fish biomass
  - Boosting total catch
  - Increasing fish size
- Benefits inside reserve boundaries included…
  - Rapid and long-term increases in marine organisms
  - Decrease mortality and habitat destruction
  - Lessen the likelihood of extirpation of species

# How should reserves be designed?

- 20-50% of the ocean should be protected in no-take reserves
  - How large?
  - How many?
  - Where?
- Involving fishers is crucial fisheries in coming with these answers



- **Marine Sanctuaries Act:**
  - authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries.
- **The Oceans Act of 2000**
  - To establish a commission to make recommendations for a coordinated and comprehensive national ocean policy
- **Magnuson Act**
  - is the primary law governing marine fisheries management in United States federal waters. To manage the fisheries and promote conservation
- **Ocean Dumping Act**
  - The Marine Protection, Research, and Sanctuaries Act has two basic aims: to regulate intentional ocean disposal of materials, and to authorize related research. Permit and enforcement provisions of the law are often referred to as the Ocean Dumping Act.
- **Marine Mammal Protection Act**
  - The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.