

Sustaining Aquatic Biodiversity

Chapter 11

11-1 What Are the Major Threats to Aquatic Biodiversity?

▪ **Concept 11-1** *Aquatic species are threatened by habitat loss, invasive species, pollution, climate change, and overexploitation, all made worse by the growth of the human population.*

We Have Much to Learn about Aquatic Biodiversity

▪ Greatest marine biodiversity – three regions

- Coral reefs
- Estuaries
- Deep-ocean floor

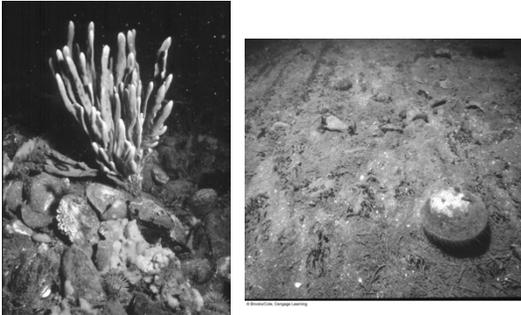
▪ Biodiversity is higher

- Near the coast than in the open sea
- In the bottom region of the ocean than the surface region

Human Activities Are Destroying and Degrading Aquatic Habitats

- HIPPCO
- Habitat loss and degradation
 - Marine
 - Coastal: greatest population; pollution
 - Ocean floor: effect of trawlers
 - Freshwater
 - Dams
 - Excessive water withdrawal

Natural Capital Degradation: Area of Ocean Bottom Before and After a Trawler



Invasive Species Are Degrading Aquatic Biodiversity

- Invasive species
 - Threaten native species
 - Disrupt and degrade whole ecosystems
- Three examples
 - Water hyacinth: Lake Victoria (East Africa)
 - Asian swamp eel: waterways of south Florida
 - Purple loosestrife: indigenous to Europe
 - Treating with natural predators—a weevil species and a leaf-eating beetle—Will it work?

Invasive Water Hyacinths



Population Growth and Pollution Can Reduce Aquatic Biodiversity

- Population growth (ca. 80% live near the coast)
- Pollution
 - Nitrates and phosphates mainly from fertilizers enter water
 - Leads to [cultural] eutrophication
 - Toxic pollutants from industrial and urban areas [remember Minamata]

Climate Change Is a Growing Threat

- Climate Change...
- Global warming: sea levels will rise and aquatic biodiversity is threatened
 - Coral reefs
 - Swamp some low-lying islands
 - Drown many highly productive coastal wetlands
 - Florida everglades

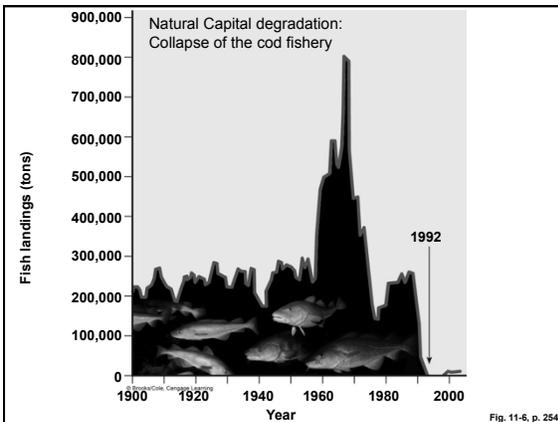
Science Focus: Protecting and Restoring Mangroves

- Protect and restore mangroves
 - Reduce the impact of rising sea levels
 - Protect against tropical storms and tsunamis
 - Cheaper than building concrete sea walls



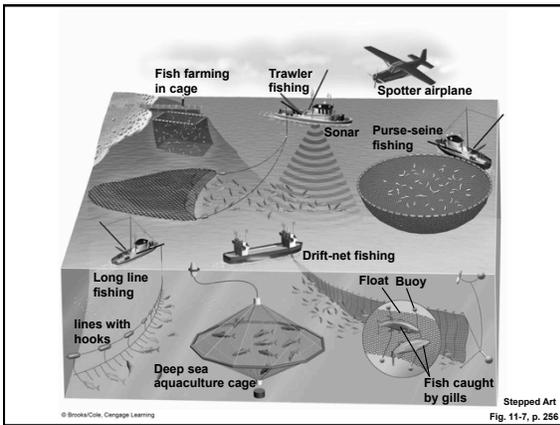
Overfishing and Extinction: Gone Fishing, Fish Gone

- **Overfishing (Overexploitation)**
- Marine and freshwater fish
 - Threatened with extinction by human activities **more** than any other group of species
- **Commercial extinction (recovery possible)**
- Collapse of the cod fishery and its domino effect
- **Bycatch [just what it sounds like]**



Case Study: Industrial Fish Harvesting Methods

- See Figure 11-17
- Trawler fishing
- Purse-seine fishing
- Longlining
- Drift-net fishing



11-2 How Can We Protect and Sustain Marine Biodiversity?

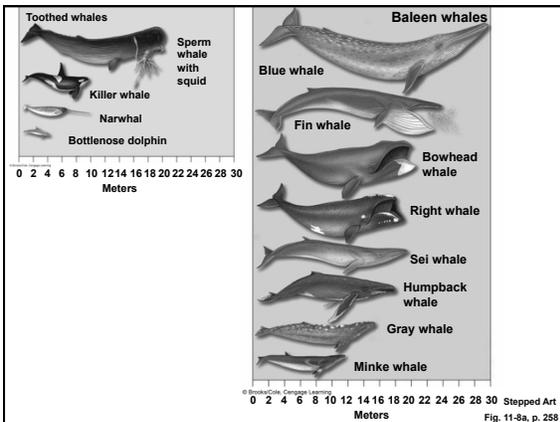
- **Concept 11-2** We can help to sustain marine biodiversity by using laws and economic incentives to protect species, setting aside marine reserves to protect ecosystems, and using community-based integrated coastal management.

Legal Protection of Some Endangered and Threatened Marine Species

- Why is it hard to protect marine biodiversity?
 - Human ecological footprint and fishprint are expanding
 - Much of the damage in the ocean is not visible
 - The oceans are incorrectly viewed as an inexhaustible resource
 - Most of the ocean lies outside the legal jurisdiction of any country

Case Study: Protecting Whales: A Success Story... So Far

- Cetaceans: Toothed whales and baleen whales
- 1946: International Whaling Commission (IWC)
- 1970: U.S.
 - Stopped all commercial whaling
 - Banned all imports of whale products
- 1986: IWC moratorium on commercial whaling
 - Pros
 - Cons



Norwegian Whalers Harpooning a Sperm Whale



Economic Incentives Can Be Used to Sustain Aquatic Biodiversity

- Tourism (whale watching; SCUBA diving; turtle walks...)
- Economic rewards
 - Reconciliation ecology

Case Study: Holding Out Hope for Marine Turtles

- Carl Safina, *Voyage of the Turtle*
 - Studies of the leatherback turtle
- Threats to the leatherbacks
 - Trawlers and longlines
 - Pollution
 - Climate change
- Communities protecting the turtles

An Endangered Leatherback Turtle is Entangled in a Fishing Net



Marine Sanctuaries Protect Ecosystems and Species

- Offshore fishing
 - Exclusive economic zones (EEZ = 200 miles)
 - High seas (outside EEZ)
- Law of the Sea Treaty
- Marine Protected Areas (MPAs)

Establishing a Global Network of Marine Reserves: An Ecosystem Approach (1)

- Marine reserves
 - Closed to
 - Commercial fishing
 - Dredging
 - Mining and waste disposal
 - Core zone
 - No human activity allowed
 - Less harmful activities allowed
 - recreational boating and shipping

Establishing a Global Network of Marine Reserves: An Ecosystem Approach (2)

- Fully protected marine reserves work fast
 - Fish populations double
 - Fish size grows
 - Reproduction triples
 - Species diversity increase by almost one-fourth

11-3 How Should We Manage and Sustain Marine Fisheries?

- *Concept 11-3 Sustaining marine fisheries will require improved monitoring of fish populations, cooperative fisheries management among communities and nations, reduction of fishing subsidies, and careful consumer choices in seafood markets.*

Estimating and Monitoring Fishery Populations Is the First Step

- **Maximum sustained yield (MSY):** traditional approach
- **Optimum sustained yield (OSY)**
- **Multispecies management**
- **Large marine systems:** using large complex computer models
- **Precautionary principle**

Government Subsidies Can Encourage Overfishing

- 2007: World Trade Organization, U.S.
 - Proposed a ban on fishing subsidies

- Reduce illegal fishing on the high seas and in coastal waters
 - Close ports and markets to such fishers
 - Check authenticity of ship flags
 - Prosecution of offenders

Consumer Choices Can Help to Sustain Fisheries and Aquatic Biodiversity

- 1997: Marine Stewardship Council (MSC), London
 - Supports sustainable fishing
 - Certifies sustainably produced seafood

- Manage global fisheries more sustainably
 - Individuals
 - Organizations
 - Governments

SOLUTIONS

Managing Fisheries

<p>Fishery Regulations Set catch limits well below the maximum sustainable yield Improve monitoring and enforcement of regulations</p> <p>Economic Approaches Sharply reduce or eliminate fishing subsidies Charge fees for harvesting fish and shellfish from publicly owned offshore waters</p> <p>Protect Areas Certify sustainable fisheries Establish no-fishing areas Establish more marine protected areas Rely more on integrated coastal management</p> <p>Consumer Information Label sustainably harvested fish Publicize overfished and threatened species</p>	  	<p>Bycatch Use wide-meshed nets to allow escape of smaller fish Use net escape devices for seabirds and sea turtles Ban throwing edible and marketable fish back into the sea</p> <p>Aquaculture Restrict coastal locations for fish farms Control pollution more strictly Depend more on herbivorous fish species</p> <p>Nonnative Invasions Kill organisms in ship ballast water Filter organisms from ship ballast water Dump ballast water far at sea and replace with deep-sea water</p>
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11-4 How Should We Protect and Sustain Wetlands?

- **Concept 11-4** *To maintain the ecological and economic services of wetlands, we must maximize preservation of remaining wetlands and restoration of degraded and destroyed wetlands.*

Coastal and Inland Wetlands Are Disappearing around the World

- Wetlands are highly productive
- Provide natural flood and erosion control
- Maintain high water quality; natural filters
- Effect of rising sea levels?

Case Study: Can We Restore the Florida Everglades? (1)

- "River of Grass": south Florida, U.S.
- Since 1948: damaged
 - Drained
 - Diverted
 - Paved over
 - Nutrient pollution from agriculture
 - Invasive plant species
- 1947: Everglades National Park unsuccessful protection project

Case Study: Can We Restore the Florida Everglades? (2)

- 1970s: political haggling

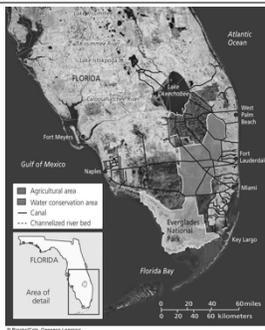
- 1990: Comprehensive Everglades Restoration Plan (CERP)
 - Restore the curving flow of most of the Kissimmee River
 - Remove canals and levees in strategic locations
 - Flood 240 sq. km farmland to create artificial marshes
 - Goal?

Case Study: Can We Restore the Florida Everglades? (3)

- Comprehensive Everglades Restoration Plan (CERP) cont...
 - Create reservoirs and underground water storage areas
 - Build new canals, reservoirs and efficient pumping systems

- Why isn't this plan working?

The World's Largest Restoration Project



11-5 How Can Protect and Sustain Freshwater Lakes, Rivers, and Fisheries?

- **Concept 11-5** *Freshwater ecosystems are strongly affected by human activities on adjacent lands, and protecting these ecosystems must include protection of their watersheds.*

Freshwater Ecosystems Are under Major Threats

- **Remember: HIPPCO**

- **Habitat destruction, degradations and fragmentation**
- **Invasive species**
- **Population and resource use growth**
- **Pollution**
- **Climate Change**
- **Overexploitation**

Case Study: Can the Great Lakes Survive Repeated Invasions by Alien Species?

- Collectively, world's largest body of freshwater

- Invaded by at least 162 nonnative species
 - Sea lamprey
 - Zebra mussel
 - Good and bad
 - Quagga mussel
 - Asian carp

Zebra Mussels Attached to a Water Current Meter in Lake Michigan, U.S.



Managing River Basins Is Complex and Controversial

- Columbia River: U.S. and Canada
 - Dam system
 - Pros and cons

- Snake River: Washington state, U.S.
 - Hydroelectric dams
 - Pros and cons

Natural Capital: Ecological Services of Rivers

NATURAL CAPITAL

Ecological Services of Rivers

- Deliver nutrients to sea to help sustain coastal fisheries
- Deposit silt that maintains deltas
- Purify water
- Renew and renourish wetlands
- Provide habitats for wildlife

11-6 What Are the Priorities for Sustained Biodiversity, Ecosystem Services?

▪ **Concept 11-6** *Sustaining the world's biodiversity and ecosystem services will require mapping terrestrial and aquatic biodiversity, maximizing protection of undeveloped terrestrial and aquatic areas, and carrying out ecological restoration projects worldwide.*

We Need to Set Priorities for Protecting Biodiversity, Ecosystem Services

- 2002: Edward O. Wilson
 - Complete the mapping of the world's terrestrial and aquatic biodiversity
 - Keep old-growth forests intact; cease their logging
 - Identify and preserve hotspots and deteriorating ecosystem services that threaten life
 - Ecological restoration projects
 - Make conservation financially rewarding
