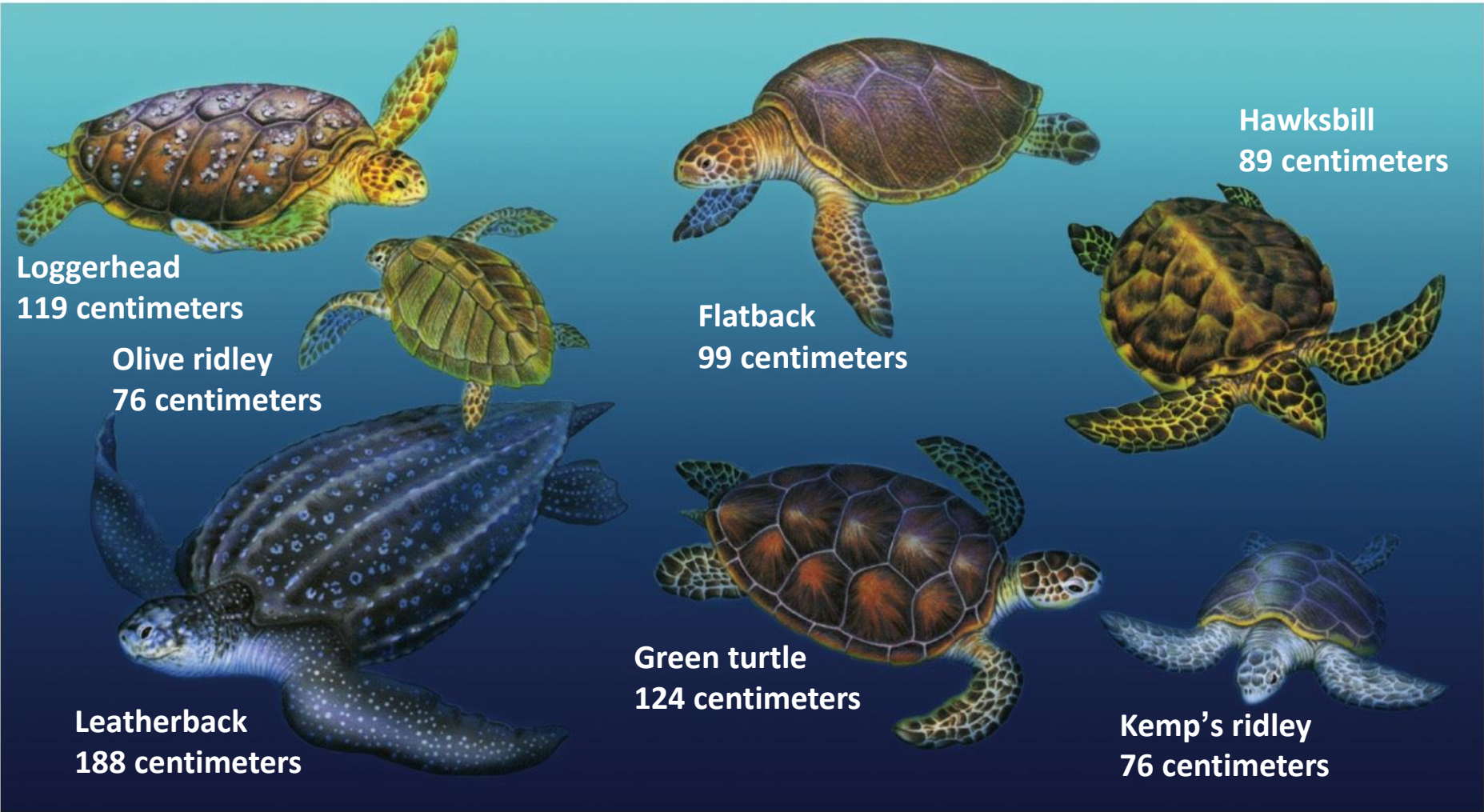# 11

Sustaining Aquatic Biodiversity and Ecosystem Services

Case Study: The Plight of Sea Turtles

- All seven species in danger through:
  - Trawler fishing
    - Destroyed many coral gardens that are turtle feeding grounds
  - Turtles hunted for leather
  - Eggs taken for food
  - Pollution of ocean water

Hawksbill
89 centimeters

Loggerhead
119 centimeters

Olive ridley
76 centimeters

Flatback
99 centimeters

Leatherback
188 centimeters

Green turtle
124 centimeters

Kemp's ridley
76 centimeters

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Fig. 11-1, p. 248

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

- Aquatic species and the ecosystem and economic services they provide are threatened by:
  - Habitat loss, invasive species, pollution, climate change, and overexploitation
  - All made worse by the growth of the human population and resource use

Human Activities Are Destroying and Degrading Aquatic Habitat

- Marine
  - Coral reefs
  - Mangrove forests
  - Seagrass beds
  - Ocean acidification
- Freshwater
  - Dams

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Fig. 11-2, p. 250
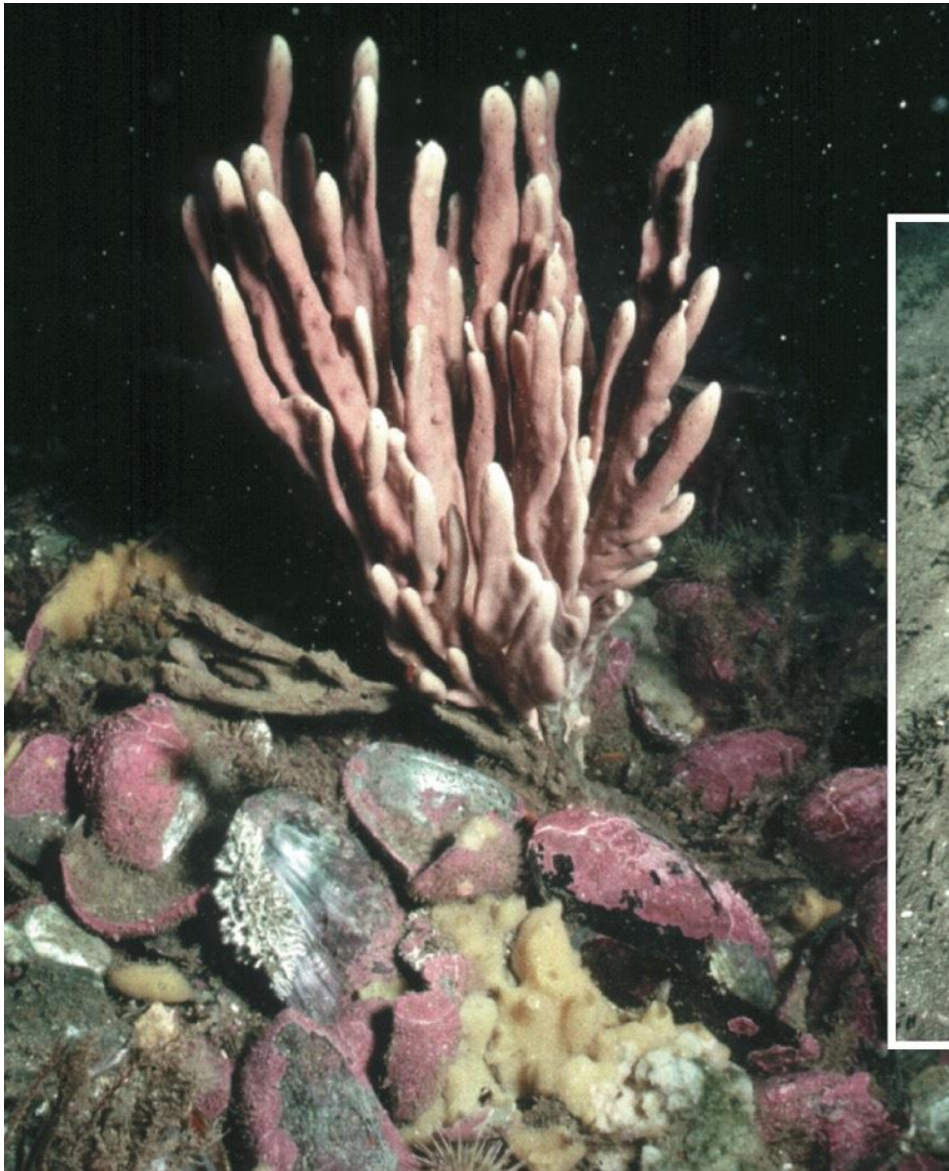
Invasive Species Are Degrading Aquatic Biodiversity

- Invasive species
  - Threaten native species
  - Disrupt and degrade whole ecosystems
  - Blamed for about two-thirds of all fish extinctions since 1900
- Example
  - Lionfish in the Atlantic

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Fig. 11-3, p. 251

Population Growth and Pollution Can Reduce Aquatic Biodiversity

- 80% of all humans living along coasts

- Nitrates and phosphates, mainly from fertilizers, enter water
  - Leads to eutrophication

- Toxic pollutants from industrial and urban areas

- Plastics
  - Ocean garbage

Climate Change Is a Growing Threat

- Sea levels will rise and aquatic biodiversity is threatened
    - Coral reefs
    - Swamp some low-lying islands
    - Drown many highly productive coastal wetlands
    - Warmer ocean water stresses phytoplankton

# Overfishing and Extinction: Gone Fishing, Fish Gone

- Fishery – concentration of a particular wild aquatic species suitable for commercial harvesting in a specific area

- Fishing key factor in the depletion of up to 80% of the population of some wild fish species in only 10-15 years

- Trawlers

  – Destroy ocean bottom habitat

- Purse-seine fishing
  - Can kill dolphins

- Long-lining
  - Kills large numbers of sea turtles, dolphins, and seabirds

- Drift net fishing
  - Large bycatch

- Fishprint – area of ocean needed to sustain the fish consumption of an average person, nation, or the world

- Overfishing leads to commercial extinction
  - Commercially valuable fish become scarce
  - Bluefin tuna ranching

- Some marine mammals are also threatened due to overfishing
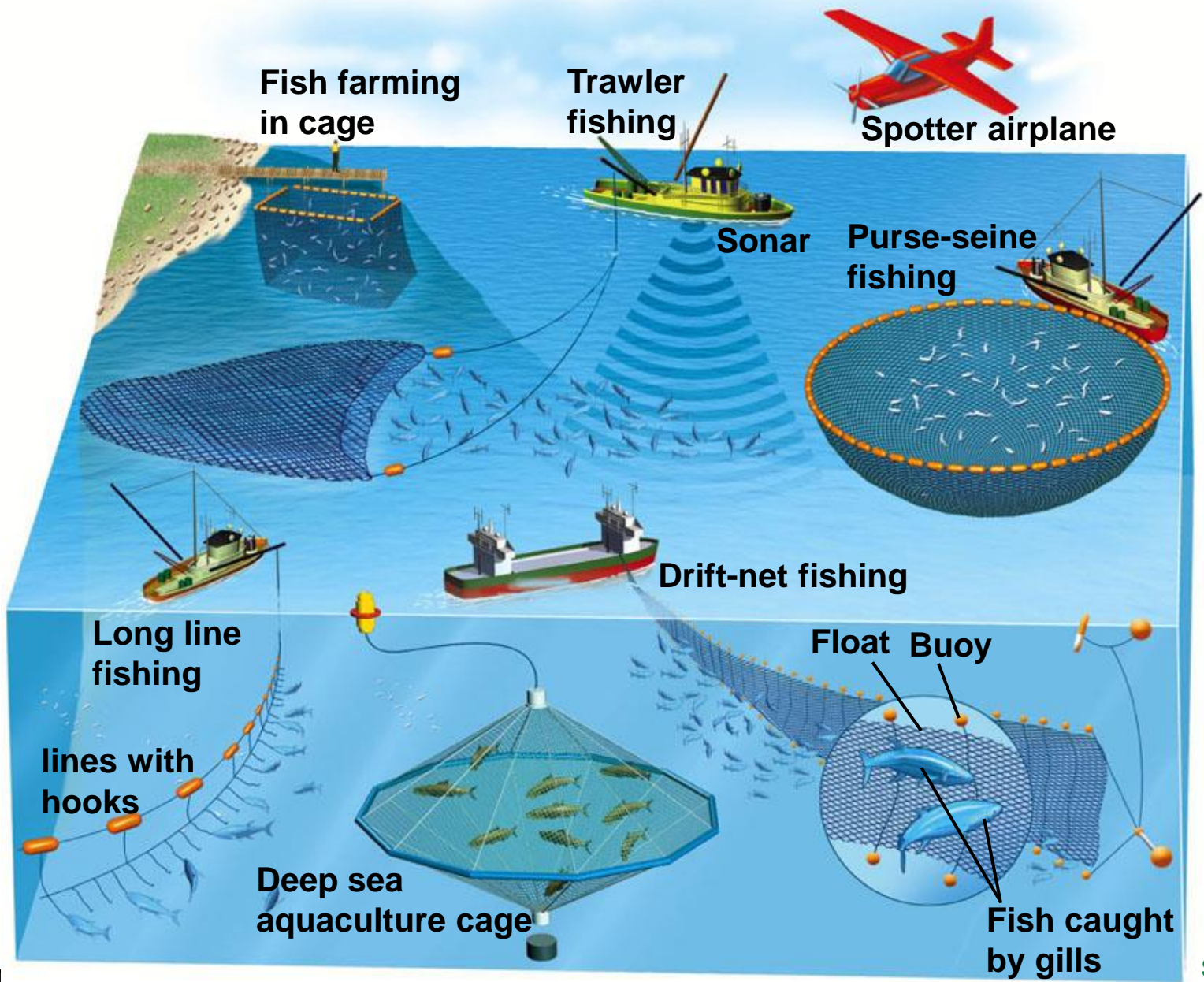
Fish farming in cage

Trawler fishing

Spotter airplane

Sonar

Purse-seine fishing

Drift-net fishing

Long line fishing

lines with hooks

Float   Buoy

Deep sea aquaculture cage

Fish caught by gills

© Cen

Fig. 11-5, p. 254

Fish landings (tons)

900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0

1900   1920   1940   1960   1980   2000

Year

1992
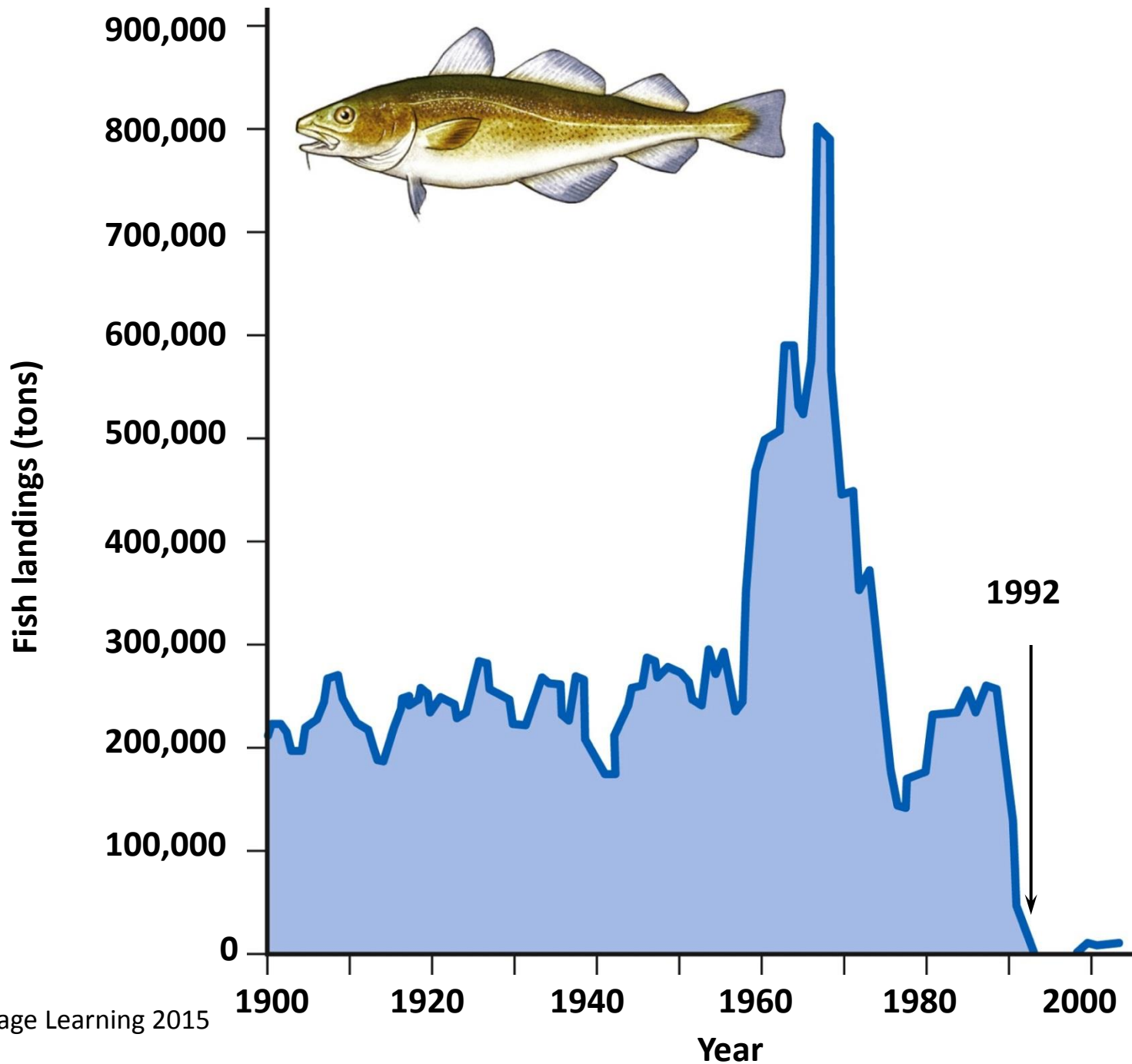
(Data from Millennium Ecosystem Assessment.)

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Fig. 11-7, p. 255

Brian J. Skerry/National Geographic Creative

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Fig. 11-8, p. 256

Case Study: The Great Jellyfish Invasion

- Most jellyfish feed on zooplankton, fish eggs, small fish, and other jellyfish

- Often found in blooms of thousands of individuals

  - Numbers of blooms rising in recent years

    - Overfishing of species that prey on jellyfish

    - Excessive nutrients in land runoff

    - Warmer waters

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Fig. 11-9, p. 257

Case Study: Why Should We Protect Sharks?

- Sharks are keystone species
  - If they become extinct, their ecosystems will suffer

- For every shark that injures a person, people kill about 1.2 million sharks
  - 32% of open-ocean shark species are threatened with extinction

Left: Colin Parker/National Geographic My Shot/National Geographic Creative. Right: Westend61/SuperStock.

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Fig. 11-10, p. 257

Extinction of Aquatic Species Is a Growing Threat

- Biological extinction
  - Overfishing, water pollution, wetlands destruction, excessive removal of water from lakes and rivers
  - 34% of marine species are threatened
  - 71% of freshwater species are threatened
- How are we protecting sea turtles?

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Fig. 11-11, p. 258

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

- We can help to sustain marine biodiversity by:
    - Using laws and economic incentives to protect species
    - Setting aside marine reserves to protect ecosystems and ecosystem services
    - Using community-based integrated coastal management

Laws, Treaties, and Economic Incentives (cont'd.)

- Some examples:
  - 1975 Convention on International Trade in Endangered Species
  - 1979 Global Treaty on Migratory Species
  - U.S. Endangered Species Act of 1973
  - U.S. Whale Conservation and Protection Act of 1976
  - 1995 International Convention on Biological Diversity

Marine Sanctuaries Protect Ecosystems and Species

- Offshore fishing
  - Exclusive economic zones for countries
    - 200 nautical miles
  - High seas governed by treaties that are hard to enforce
- Law of the Sea Treaty
  - Misused
- Marine protected areas (MPAs)
  - Protected from human activities

Establishing a Global Network of Marine Reserves: An Ecosystem Approach

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

Establishing a Global Network of Marine Reserves (cont'd.)

- Fully protected marine reserves work fast
  - Fish populations double
  - Fish size grows
  - Reproduction triples
  - Species diversity increase by almost one-fourth
- Cover less than 1% of world's oceans
  - Marine scientists want 30-50%

Climate change and oil drilling

Overfishing

Overfishing

Coral bleaching

Trawler fishing

Mediterranean Sea

PACIFIC OCEAN

ATLANTIC OCEAN

PACIFIC OCEAN

INDIAN OCEAN

Potential ocean floor mining

Trawler fishing

Climate change
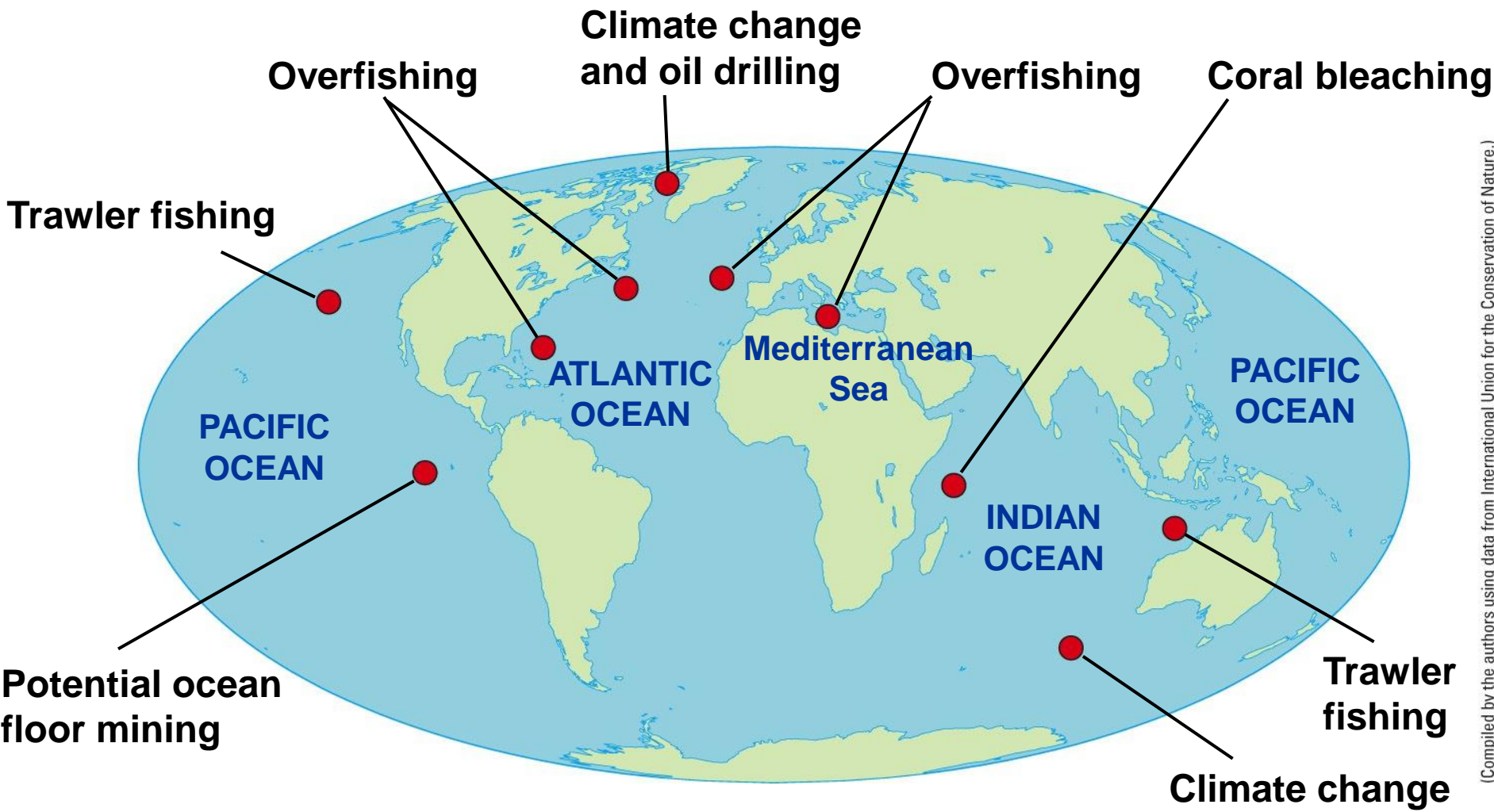
(Compiled by the authors using data from International Union for the Conservation of Nature.)

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Fig. 11-13, p. 261

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

- Sustaining marine fisheries will require:
  - Improved monitoring of fish and shellfish populations
  - Cooperative fisheries management among communities and nations
  - Reduction of fishing subsidies
  - Careful consumer choices in buying seafood

Estimating and Monitoring Fishery Populations Is the First Step

- Maximum sustained yield (MSY)
  - Traditional approach
  - Projects maximum annual harvest without causing population drop
- Optimum sustained yield (OSY)
  - Attempts to account for interactions among species
- Multispecies management

Estimating and Monitoring Fishery Populations Is the First Step (cont'd.)

- Large marine systems
  - Using large complex computer models
- Precautionary principle
  - Sharply reducing fish harvests
  - Closing overfished areas

Government Subsidies Can Encourage Overfishing

- Governments spend over 30 billion dollars per year subsidizing fishing
  - Often leads to overfishing
  - Discourages long-term sustainability of fish populations

Consumer Choices Can Help to Sustain Fisheries and Aquatic Biodiversity

- Need labels to inform consumers how and where fish was caught

- 1999 – Marine Stewardship Council (MSC)
  - Certifies sustainably produced seafood

- What is the proper use of sustainable aquaculture?

Solutions

Managing Fisheries

Fishery Regulations

Set low catch limits

Improve monitoring and enforcement

Economic Approaches

Reduce or eliminate fishing subsidies

Certify sustainable fisheries

Protect Areas

Establish no-fishing areas

Establish more marine protected areas

Consumer Information

Label sustainably harvested fish

Publicize overfished and threatened species

Bycatch

Use nets that allow escape of smaller fish

Use net escape devices for seabirds and sea turtles

Aquaculture

Restrict coastal locations of fish farms

Improve pollution control

Nonnative Invasions

Kill or filter organisms from ship ballast water

Clean aquatic recreation gear

NO-FISHING NEXT 25 MILES by Govt. Order

Sustainably Harvested

MARINE PROTECTED AREA
No Fishing, No Hooking, No Hunting By Order of the Government

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Fig. 11-16, p. 264

Coastal and Inland Wetlands Are Disappearing around the World

- Wetlands have been disturbed for centuries

- Sea level rise
  - Will inundate coastal wetlands

We Can Preserve and Restore Wetlands

- Laws for protection
  - Zoning laws steer development away from wetlands
  - In U.S., a federal permit is required to fill wetlands greater than three acres
- Mitigation banking
  - Can destroy wetland if one is created of equal area
  - Ecologists argue that this as a last resort

Case Study: Can We Restore the Florida Everglades?

- Damage in the 20th century
  - Drained
  - Diverted
  - Paved over
  - Nutrient pollution from agriculture
  - Invasive plant species
- 1947 – Everglades National Park was an unsuccessful protection project

- 1990 – Comprehensive Everglades Restoration Plan (CERP)
  - Restore curving flow of ½ of Kissimmee River
  - Remove canals/levees in strategic locations
  - Flood farmland to create artificial marshes
  - Create 18 reservoirs to create water supply for lower Everglades and humans
  - Recapture Everglades water flowing to sea and return it to Everglades

ATLANTIC OCEAN

Kissimmee River

SOUTHERN FLORIDA

Lake Okeechobee

Gulf of Mexico

Historic Everglades

Florida Bay

FLORIDA KEYS

Photo: ©slowfish/Shutterstock.com

ATLANTIC OCEAN

Kissimmee River

SOUTHERN FLORIDA

West Palm Beach

Lake Okeechobee

Gulf of Mexico

Miami

Florida Bay

FLORIDA KEYS

Agricultural area
Water conservation area
Urban area
Everglades National Park
--- Outline of original Everglades system
···· Channelization of river

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Fig. 11-18, p. 267

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

- Freshwater ecosystems are strongly affected by human activities on adjacent lands, and protection of these ecosystems must include protection of their watersheds

Freshwater Ecosystems Are in Jeopardy

- 40% of world's rivers are dammed
- Many freshwater wetlands destroyed
- Invasive species
- Overfishing
- Human population pressures

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
  - Quagga mussel
  - Asian carp

Fig. 11-20, p. 268

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Fig. 11-21, p. 269

Managing River Basins Is Complex and Controversial

- Columbia River – U.S. and Canada
  - 119 dams

- Dams
  - Provide hydroelectric power
  - Provide irrigation water
  - Hurt salmon

Natural Capital

Ecosystem 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

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Fig. 11-22, p. 270

We Can Protect Freshwater Ecosystems By Protecting Watersheds

- Freshwater ecosystems protected through:
  - Laws
  - Economic incentives
  - Restoration efforts
- Wild rivers and scenic rivers
  - 1968 National Wild and Scenic Rivers Act

Freshwater Fisheries Need Better Protection

- Sustainable management
  - Support populations of commercial and sport fish species
  - Prevent overfishing
  - Reduce or eliminate invasive species

11-6 What Should Be Our Priorities for Sustaining Aquatic Biodiversity?

- Sustaining the world's aquatic biodiversity requires:
  - Mapping it
  - Protecting aquatic hotspots
  - Creating large and fully protected marine reserves
  - Protecting freshwater ecosystems
  - Restoring degraded coastal and inland wetlands

We Can Use an Ecosystem Approach to Sustain Aquatic Biodiversity

- Complete the mapping of the world's aquatic biodiversity

- Identify and preserve aquatic diversity hotspots

- Create large and fully protected marine reserves

- Protect and restore the world's lakes and rivers