NELSON EDUCATION | Canada's Learning Advantage

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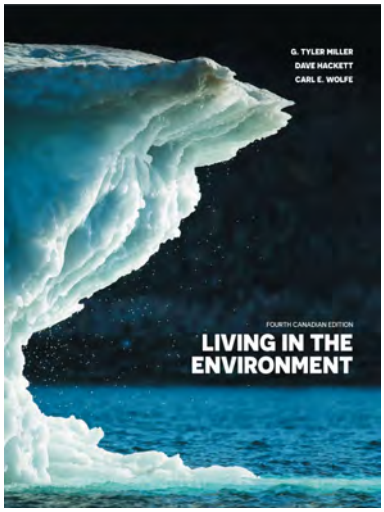


prepared by

Ian Dawe

Chapter 13

Sustaining Aquatic Biodiversity

Key Concepts

Aquatic biodiversity

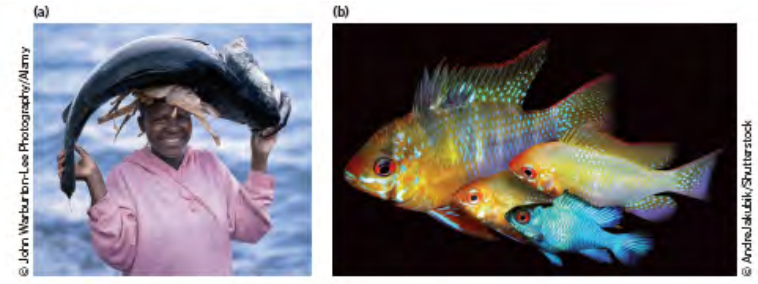
- Importance
- Human impacts
- Protect, manage, sustain, restore
  - Marine wildlife and fisheries
  - Lakes and rivers
  - Wetlands

Case Study: A Biological Roller Coaster Ride in Lake Victoria

Challenges to biodiversity since 1980

- Introduction of Nile perch
- Eutrophication resulting in loss of algae-eating cichlids
- Invasion of water hyacinth
- Nile perch now being overfished

Case Study: A Biological Roller Coaster Ride in Lake Victoria



Introduction of Nile perch Loss of native cilchilds

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Case Study: the Great Lakes

Case Study: Great Lakes

Lamprey introduced from the ballast of ships

Invasive species – parasitic on Lake Trout and other species

Sea lamprey were found in Lake Ontario in 1835. The Welland Canal was built to bypass Niagra Falls, which gave sea lamprey access to the rest of the Great Lakes. They reached Lake Superior by 1938

http://www.glfc.org/control.php

Zebra mussels – discovered in Great Lakes in 1986. Quagga mussels 1989

https://invasivemusselcollaborative.net/about/mussel-facts/

A grocery cart covered in mussels

Patterns of Marine Biodiversity

We know comparatively little about marine (and freshwater) biodiversity.

Highest diversity habitats are

- Coral reefs
- Estuaries
- Deep-ocean floor

Coastal diversity > Open sea

Benthic (bottom) diversity > Pelagic (surface)

Lowest diversity in the mid-depth open ocean

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Strategies to Protect North American Coastal Waters

- Comprehensive legislation
- Federal funding
- Focus fisheries management on whole ecosystems and habitats
- Establish marine network linked by corridors

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Why Should We Care About Aquatic Biodiversity?

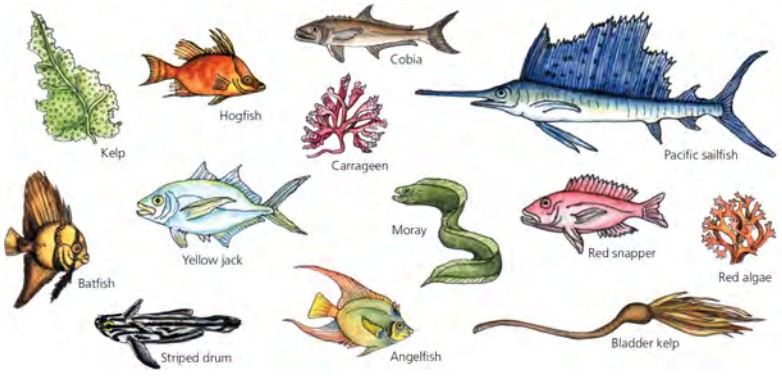
Marine habitats provide important economic and ecological services.

- Food
- Medication

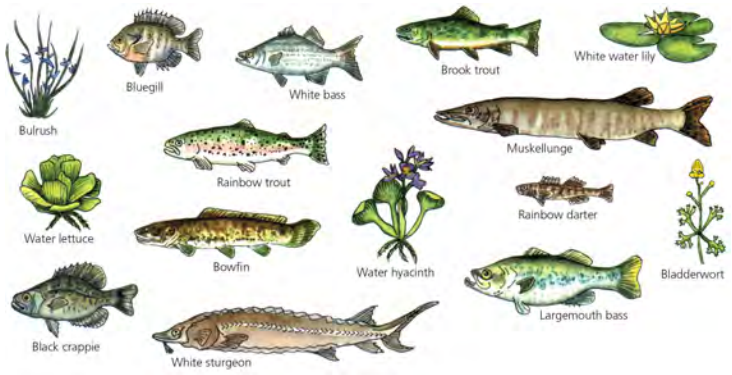
Freshwater also important

- Provide economic and ecological services worth trillions of dollars each year

Marine Biodiversity



Freshwater Biodiversity



Human Impacts on Aquatic Biodiversity: Habitat Loss and Degradation

Loss of 50% of coastal wetlands

Severe damage to >25% of coral reefs

– At current rate, another 70% lost by 2050

Loss of >33% of mangrove forest swamps

Degradation of bottom habits by trawling

Human Impacts on Aquatic Biodiversity: Commercial Fishing and Fish Populations

Seventy-five percent of species overfished

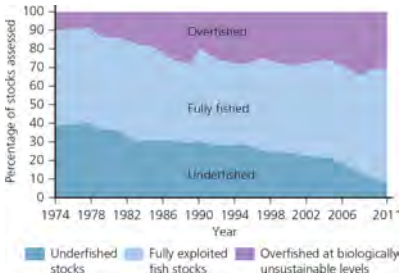
Commercial extinction

A 2010 UN report estimates commercially viable fish will be gone by 2050

Decrease in size and trophic level of fish

Stocks of some species down by 90%

Problems of bycatch



Source: FAO 2014, WWF 2014

Human Impacts on Aquatic Biodiversity: Non-Native Species

Introduced species may displace native ones

- Deliberate introduction
- Accidental introduction via ship ballast water

Eurasian ruffe

© WILDLIFE GmbH/Alamy

Round goby

© AP Photo-M. Spencer Green/ The Canadian Press

Purple Loosestrife

© Ivonne Wierink/Shutterstock

Protecting and Sustaining Marine Biodiversity

Challenges

- Rapid coastal development
- Damage not visible
- International waters under no single jurisdiction

Possible Solutions

- National fishing laws
- International treaties
  - 1975 Convention on International Trade in Endangered Species (CITES)
  - 1979 Global Treaty on Migratory Species
  - 1995 International Convention on Biological Diversity

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Endangered and Threatened Marine Mammals

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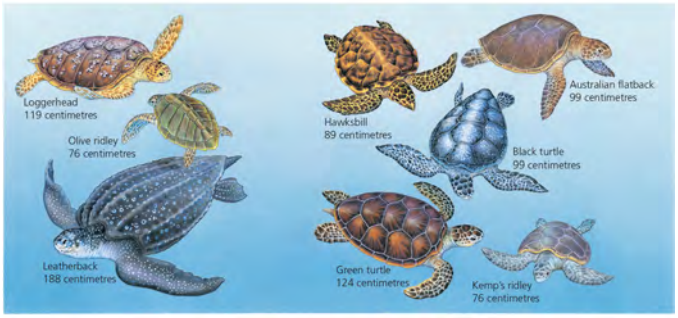
Major species of sea turtles



Endangered Sea Turtles

Leatherback
188 centimetres

Kemp's ridley
76 centimetres

Hawksbill
89 centimetres

Loss of beach habitat where eggs laid

Human removal of eggs

Use of turtles for food, medicine, clothing

Bycatching

Now international agreements to protect sea turtles

Case Study: Should Commercial Whaling Be Resumed?

Size and surfacing behaviour made whaling easy.

Technology increased rate of mass slaughter

1975: Commercial extinction of 8 of 11 species

International Whaling Commission (IWC)

- 1946: Quotas failed due to poor estimates and unenforceability
- 1986: Complete moratorium

Disagreement between countries whether ban can be lifted

Continued whaling by some countries for "science"

What Is the Role of International Agreements and Protected Marine Sanctuaries?

Nations control 36% of ocean's surface and 90% of fish stocks.

Global system of **marine protected areas** protects 3.4% of ocean area.

Moveable **marine reserves**

But less than 1% of oceans are currently protected.

Managing and Sustaining Marine 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

Dump ballast water at sea and replace with deep-sea water

Managing and Sustaining Marine Fisheries

Maximum Sustained Yield (MSY)

– Difficult to estimate ecosystem interactions

– Hastened collapse of stocks

Optimum Sustained Yields (OSY)

– Provides more room for error

– Takes into account interaction with other species

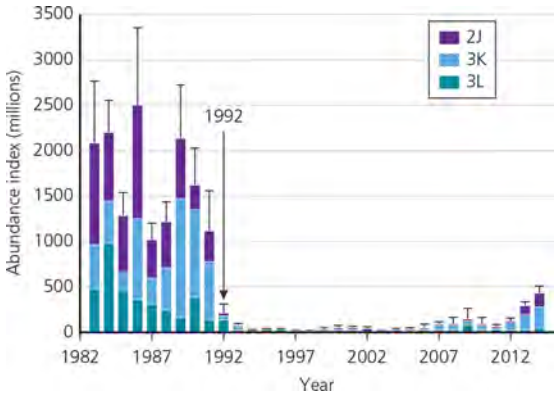
Multispecies Management

Case Study: Management Gone Wrong—Grand Banks Cod

- Technology enhanced fishing operations
- Canada declared 200-mile zone to protect cod
- NAFO set limits but some countries ignored
- Government ignored warnings for 12 years
- **1992** moratorium set on cod
- 1994 Canadian Fisheries Protection Act
- Seized Spanish trawler illegally fishing
- Groundfish catch collapsed by 78% from 1990 to 2002

Source: Department of Geography, Memorial University of Newfoundland

Grand Banks Cod Population Collapse



Source: Adapted from Fisheries and Oceans Canada, NORTHERN (NAFO DIVS. 2J3KL). This does not constitute an endorsement by Fisheries and Oceans Canada of this product. COD STOCK UPDATE, Canadian Science Advisory Secretariat Newfoundland and Labrador Region Science Response 2015/018. Page 3 at http://www.dfo-mpo.gc.ca/csas-sccs/publications/scr-rs/2015/2015_018-eng.pdf.

Diversifying Demands on the Fishery

NL response to 1992 cod moratorium

Pursuit of a wider range of food possibilities

- Turbot, redfish, yellowtail flounder, hake, herring, and mackerel
- Snow crabs, shrimps, lobsters, clams, whelks, and scallops

Diversifying Demands on the Fishery

Total seafood harvest value doubled by 2002

- Increased compared to when cod was the sole focus

Growth of aquaculture

- Atlantic salmon, steelhead trout, and blue molluscs
- Beginning to investigate farming cod

Case Study: Managing West Coast Salmon—A Complicated Issue

West Coast salmon fishery in decline

– Reduced by 80% of value between 1990–2002

Technology enhanced efficiency

International dimension with Canada and the United States

Life cycles complicate management.

Salmon fluctuate due to both human and environmental influences.

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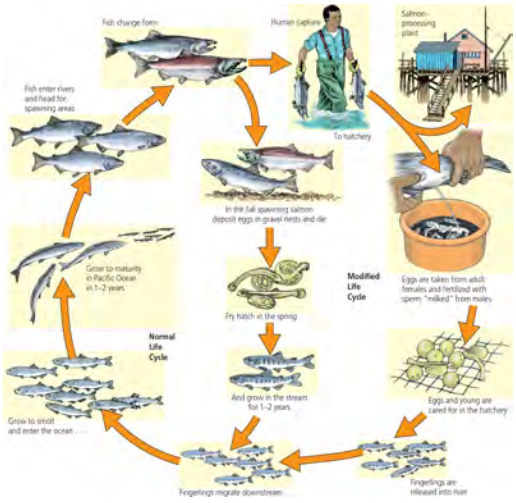
Life Cycle of Wild Salmon



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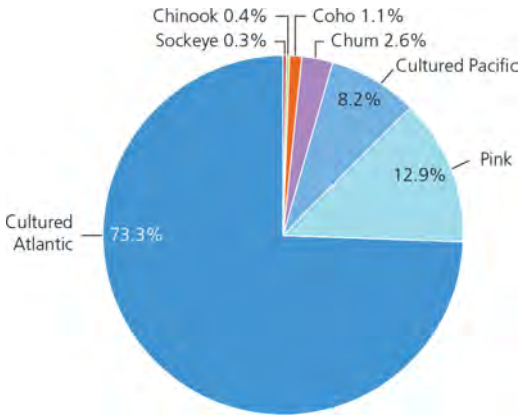
B.C. Salmon Harvest in 2013: 82% Farmed



Source: Data from the B.C. Ministry of Agriculture

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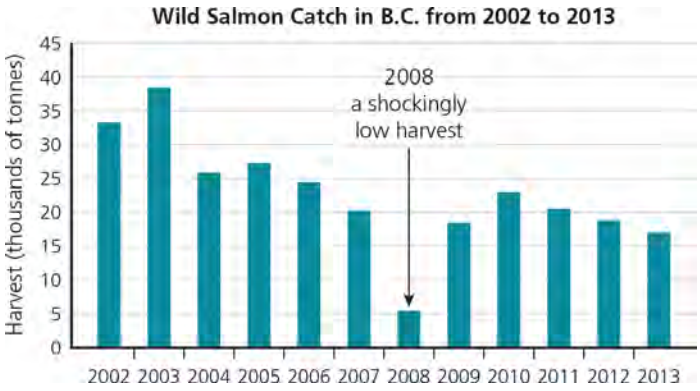
Declining Salmon Harvest



Source: Data from B.C. Wild Salmon Production Tables and British Columbia Seafood Industry 2013 Year in Review

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Rebuilding Salmon Populations

FIGURE 13-17 **SOLUTIONS**

Rebuilding Salmon Populations

Some strategies used to rebuild salmon populations in rivers

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- Allowing sufficient salmon to escape harvest
- Protecting the spawning beds
- Releasing juvenile salmon from hatcheries to underpopulated streams
- Releasing extra water from dams when needed
- Building fish ladders so adult salmon can bypass dams during upstream migration
- Reducing sediment, pollution, and heat in salmon rivers
- Banning dams from some stream areas

Important Ecological Services Provided by Lakes and Rivers

FIGURE 13-14 **NATURAL CAPITAL**

Ecological Services of Rivers

Important ecological services provided by rivers

© 2009/Rob Friends/Shutterstock

- Delivering nutrients to sea to help sustain coastal fisheries
- Depositing silt that maintains deltas
- Purifying water
- Renewing and renourishing wetlands
- Providing habitats for wildlife

Protecting, Sustaining, and Restoring Lakes and Rivers

Case Study: **Great Lakes Invasion**

Invaded by at least 162 species
- Lamprey one of biggest threats
- Zebra mussels
- Quagga mussel

Asian carp
- Escaped from aquaculture sites
- Working way toward Great Lakes

How Can Freshwater Fisheries Be Managed and Sustained?

Building and protecting populations

Preventing overfishing

Maintaining habitat quality

Public education

Enforcement

Science Focus: A Fish-Management Problem

Lake Nipissing walleye harvest

Management includes:

- Roving inspections
- Enforcing limits on size and quantity of fish in catch
- Studying conditions
- Counting eggs to assess fertility
- Measuring length, weight, age and gender of fish

Protecting, Sustaining, and Restoring Wetlands

How Are Wetlands Regarded in Canada?

Wetlands diminishing in Canada

– Over 70% of wetlands destroyed

North American Waterfowl Management Plan

Convention on Wetlands of International Importance (Ramsar)

Sackville Waterfowl Park

Checking Our Progress at Sustaining Biodiversity

Proportion of fish stocks within safe biological limits decreased

- Only 22% of stocks sustainable (40% in 1970)

Proportion of marine areas protected increased

- Still only 3.4% of marine ecosystems

Conclusion

Comparatively little is known about aquatic biodiversity.

Efforts at protection have been marginally effective.

Conservation efforts focus on gathering data—we need more information to make better decisions.