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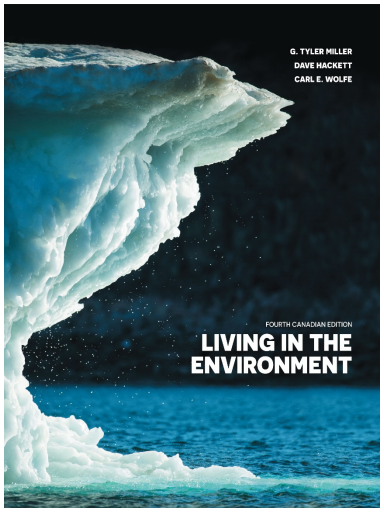


prepared by
Ian Dawe

Chapter 11

Sustaining Terrestrial Biodiversity: Managing and Protecting Ecosystems

Key Concepts

Human impacts on terrestrial biodiversity
Conservation biology
Types and uses of Canadian public lands
Forest resources and management in Canada
Tropical forests and deforestation
Parks and nature reserves
Ecological restoration
Sustaining biodiversity

Factors Increasing Biodiversity

Middle stage of succession
Moderate environmental disturbance
Small environmental changes
Physically diverse habitat
Evolution

Factors Decreasing Biodiversity

Extreme environmental conditions

Large environmental disturbance

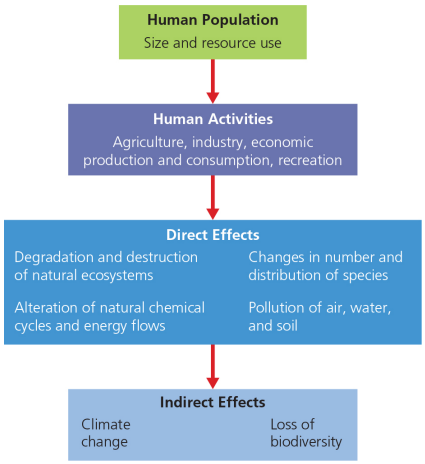
Intense environmental stress

Simplified habitat

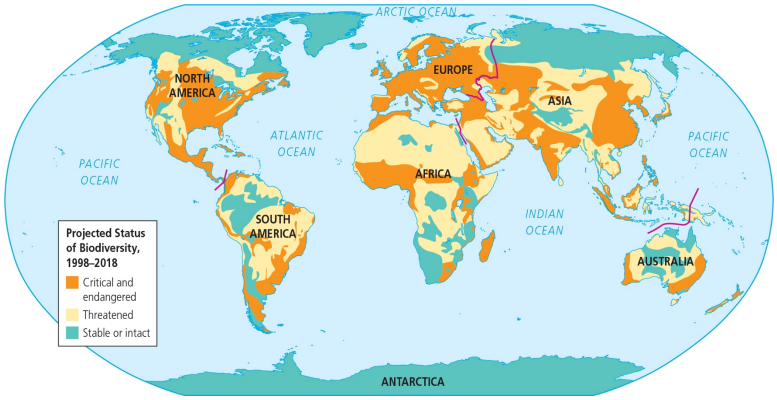
Introduction of non-native species

Geographic isolation

Human Impacts on Biodiversity



Human Impacts on Biodiversity



Source: Data from World Resources Institute, World Conservation Monitoring Center, and Conservation International

Why Should We Care About Biodiversity?

Intrinsic or existence value

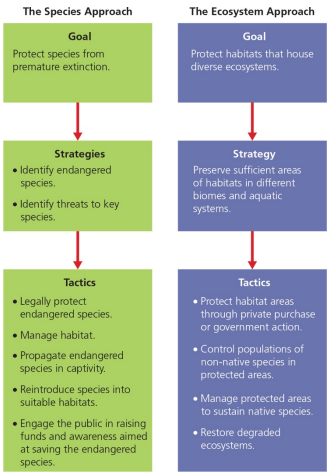
Instrumental value

– Use value (goods and services)

– Nonuse values

- Existence
- Aesthetic
- Bequest

Strategies for Protecting Biodiversity



What Is Conservation Biology?

- Multidisciplinary science
- Uses rapid response strategies
- Aims to slow loss and degradation of biodiversity
- Prioritize most endangered, species-rich ecosystems or “hot spots”
- Leopold’s ethical principle

Public Lands in Canada

Ninety-four percent of Canada is public land

Federal government manages 4% of forested land

– Crown lands, provincial parks, wildlife refuges

Territorial and provincial governments manage other 90%

– National parks, national marine conservation areas, wildlife refuges, bird sanctuaries, and other protected areas

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Canadian Terrestrial Ecozones

Source: Based on Environment Canada, Terrestrial Ecozones of Canada, http://www.ec.gc.ca/soer-ree/ English/vignettes/Terrestrial/terr.cfm

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Major Types of Forests

Old-growth (36%)

Undisturbed for hundreds of years

Second-growth (57%)

Resulting from secondary succession

Tree plantations (7%)

Managed tract, trees of uniform age

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Natural Capital: Value of Forests

FIGURE 11-7 NATURAL CAPITAL

Forests

Forests provide many values, including ecological and economic services.

Ecological Services

- Support energy flow and chemical cycling
- Reduce soil erosion
- Absorb and release water
- Purify water
- Purify air
- Influence local and regional climate
- Store atmospheric carbon
- Provide habitats supporting biodiversity

Economic Services

- Fuelwood
- Lumber
- Pulp to make paper
- Biomass
- Non-wood forest products
- Ecotourism
- Recreation
- Many different jobs

(Left): © Richard A McMillin/Shutterstock (Right): © Cornfield/Shutterstock

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Major Types of Forest Management

Even-Aged Management

- Industrial forestry
- Tree plantations
- On or two fast-growth species
- Maintain trees at same size and age for harvest

Uneven-Aged Management

- Maintain trees of various sizes, ages, species
- Foster natural diversity and generation

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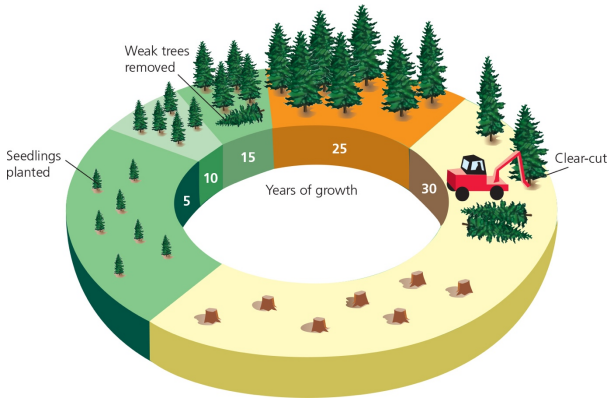
Forest Management: Even-Aged



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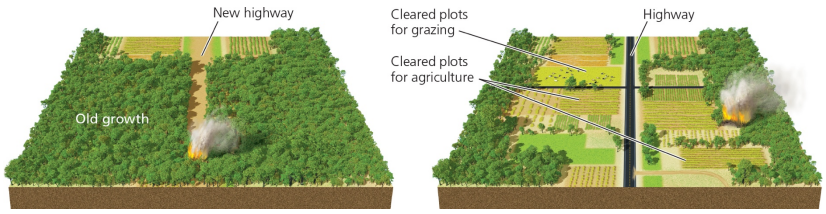
Forest Management: Access

Roads lead to degradation

- Increased erosion and sediment runoff
- Habitat fragmentation
- Pathways for non-native species
- Accessibility for human development

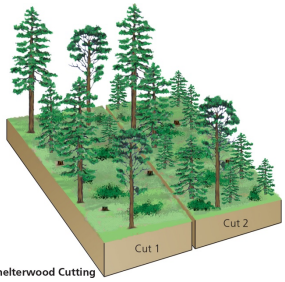
Forest Management: Access continued



How Are Trees Harvested? continued

Goal: Select **silvicultural** methods that incorporate both harvest and regeneration.

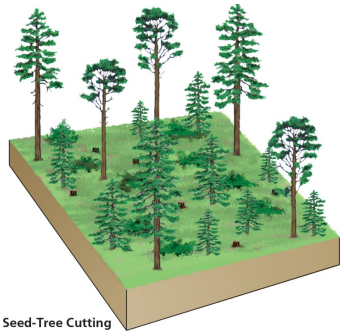
(a) Selection Cutting



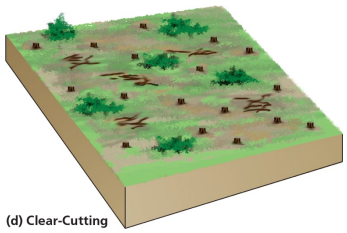
(b) Shelterwood Cutting

How Are Trees Harvested? continued 2

Goal: Select **silvicultural** methods that incorporate both harvest and regeneration.



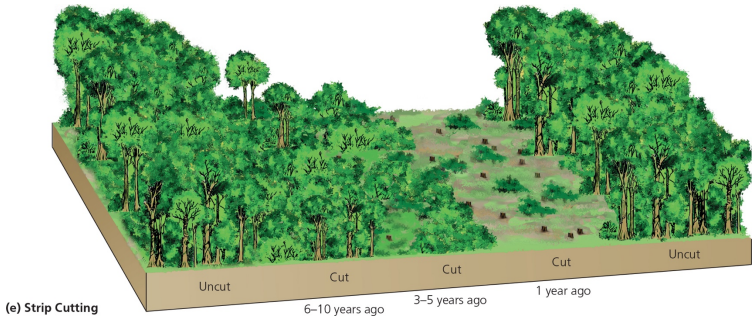
(c) Seed-Tree Cutting



(d) Clear-Cutting

How Are Trees Harvested? continued 3

Goal: Select **silvicultural** methods that incorporate both harvest and regeneration.



(e) Strip Cutting

Clear-Cutting Forests: Trade-offs

FIGURE 11-11 **TRADE-OFFS**

Clear-Cutting Forests

Advantages and disadvantages of clear-cutting forests. Pick the single advantage and disadvantage that you think are the most important.

Advantages

- Higher timber yields
- Maximum economic return in shortest time
- Can reforest with genetically improved fast-growing trees
- Short time to establish new stand of trees
- Needs less skill and planning
- Best way to harvest tree plantations
- Good for tree species needing full or moderate sunlight for growth

Disadvantages

- Reduces biodiversity
- Disrupts ecosystem processes
- Destroys and fragments some wildlife habitats
- Leaves moderate to large openings
- Increases soil erosion
- Increases sediment water pollution and flooding when done on steep slopes
- Eliminates most recreational value for several decades

(Left): © TFoxFoto/Shutterstock; (Right): © Karin Hildebrand Lau/Shutterstock

What Are the Harmful Effects of Deforestation?

- Decreased soil fertility from erosion
- Runoff of eroded soil into aquatic systems
- Premature species extinction
- Regional climate change
- CO_2 released from burning and decay
- Flooding acceleration

Sustainable Forestry

- Longer rotations
- Selective or strip cutting
- Minimize fragmentation
- Reduce road building
- Leave most dead trees and fallen timber
- Certify sustainably grown timber
- Add ecological value of trees to economic models

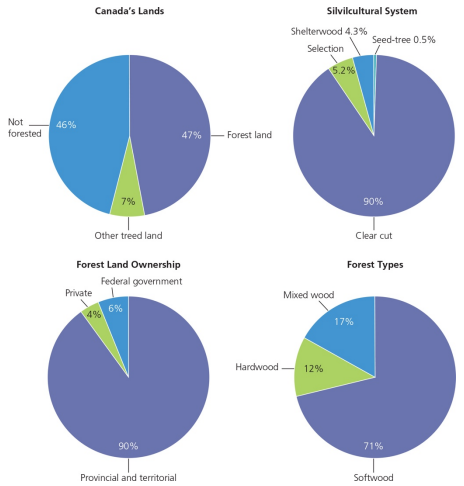
Certified Forests in Canada (2014)

TABLE 11-1 CERTIFIED FORESTS IN CANADA

Standard Used	Area Certified (in hectares)
CSA **Canadian Standards Association** (Canada's National Sustainable Forest Management Standards) Based on national and international criteria for sustainable forestry management; addresses environmental, social, and economic issues and requires public participation	41 million
SFI **Sustainable Forestry Initiative Program** (Developed by the American Forestry and Paper Association) Includes environmental objectives and performance measures; integrates forestry with conservation goals	80 million
FSC **Forest Stewardship Council** Aimed at sustainable management of the world's forests using environmental, social, and economic criteria; stresses the need for national and regional standards	56 million
Total certified forest with double-counting removed	161 million

Sources: Canadian Sustainable Forestry Certification Coalition, http://www.certificationcanada.org; and The National Forestry Database (2014).

What Is the Status of the Canadian Forest?



Source: The State of Canada's Forests 2011, Canadian Forest Service, Natural Resources Canada

Canada's Forest Regions and Model Forests

Source: Based on The Atlas of Canada and The Canadian Model Forest Network

What Threatens Certain Tree Species Across Canada?

Native and non-native insect species

- Forest tent caterpillars
- Spruce budworm
- Mountain pine beetles
- Aspen tortix
- Balsam fir sawflies
- Gypsy moths

Emerald ash borer

David Cappaert, Michigan State University, Bugwood.org

How Do Fires Affect Forests?

Benefits of occasional surface fires

- Prevent larger fires
- Release minerals
- Control insects
- Habitat maintenance

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© A. T. Willett/Alamy

Reducing the Need for Forest Harvest

Improve efficiency of wood use

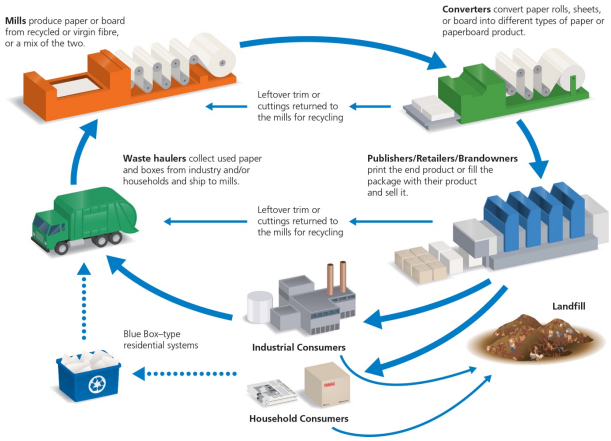
– Up to 60% wasted in North America

Use tree-free fibres

– Agricultural wastes or rapid-growth crops

Paper and sawmill fibre recycling

Paper Recycling



Source: From the Paper & Packaging Environmental Council, 2011

Consequences of Tropical Deforestation

Most substantial source of biodiversity

– More than 50% of all terrestrial species

Loss of economically valuable resources

Climate change

Some estimate that half of the world's tropical forests will be gone in 35 years.

Sustaining Tropical Forests

FIGURE 11-20 **SOLUTIONS**

Sustaining Tropical Forests

Ways to protect tropical forests and use them more sustainably. Which two of these solutions do you believe are the most important?

Prevention

- Protect most diverse and endangered areas.
- Educate settlers about sustainable agriculture and forestry.
- Phase out subsidies that encourage unsustainable forest use.
- Add subsidies that encourage sustainable forest use.
- Protect forests with debt-for-nature swaps and conservation easements.
- Certify sustainably grown timber.
- Reduce illegal cutting.
- Reduce poverty.
- Slow population growth.

Restoration

- Actively plant appropriate trees.
- Rehabilitate degraded areas.
- Encourage regrowth through secondary succession.
- Concentrate farming and ranching on already cleared areas.

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National Parks: How Are They Threatened?

6600 parks worldwide

Inadequate protection

Often too small to sustain biodiversity

Invasion by non-native species

Too many human visitors

Too little funding and too few park staff

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Case Study: National Parks and Marine Conservation Areas in Canada

Source: Based on National parks and national marine conservation areas, National Parks Directorate Operational Services

Case Study (continued): National Parks and Marine Conservation Areas in Canada

- Top priority to protect ecosystem
- Occupy only 3% of Canada's land mass, but 70% plant and 80% vertebrate animal species represented there
- Pivotal roles in species protection
- Identified 29 marine regions

Solutions: National Parks

FIGURE 11-23 **SOLUTIONS**

National Parks

Suggestions for sustaining and expanding a national park system in Canada, the United States, and other countries. Which two of these solutions do you believe are the most important?

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- Integrate plans for managing parks and nearby federal lands.
- Add new parkland near threatened parks.
- Buy private land inside parks.
- Locate visitor parking outside parks and use shuttle buses for entering and touring heavily used parks.
- Increase funds for park maintenance and repairs.
- Survey wildlife in parks.
- Raise entry fees for visitors and use funds for park management and maintenance.
- Limit number of visitors to crowded park areas.
- Increase number and pay of park rangers.
- Encourage volunteers to give visitor lectures and tours.
- Seek private donations for park maintenance and repairs.

Source: Wilderness Society and National Parks and Conservation Authority

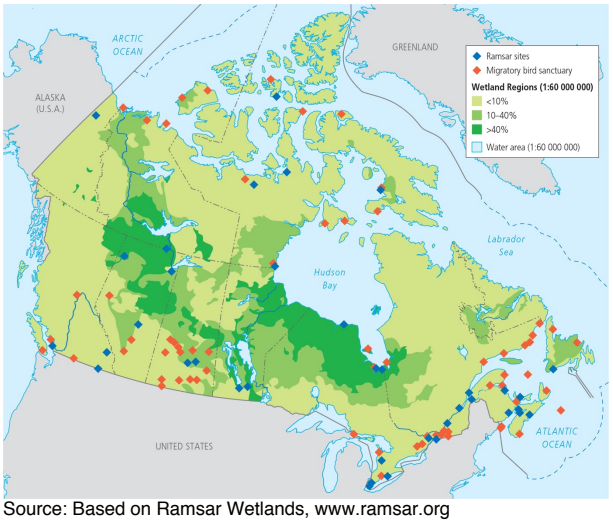
Nature Reserves

- Include moderate to large tracts of land
- Involve government, private sector, and citizens
- Adaptive ecosystem management
- Protect most important areas (“hot spots”)
- Wilderness areas and habitat corridors

Case Study: Other Lands That Protect Canadian Biodiversity

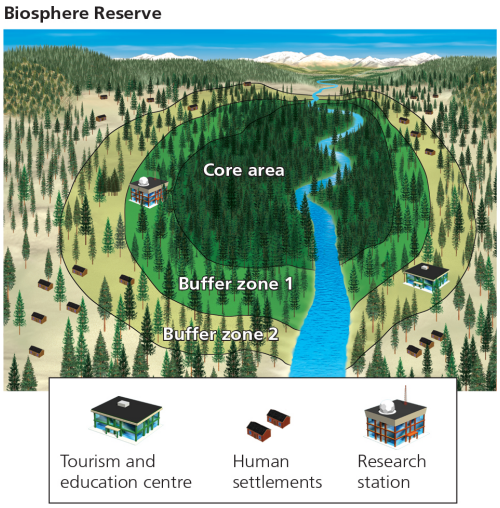
- Ramsar sites to protect wetlands
- Migratory bird sanctuaries
- World Heritage sites
- Biosphere reserves
- Unofficial local parks, ecological reserves, wetlands

Ramsar Sites and Migratory Bird Sanctuaries



Source: Based on Ramsar Wetlands, www.ramsar.org

Biosphere Reserves



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Canadian Biosphere Reserves

Source: Canadian Biosphere Reserves Association, Natural Resources Canada

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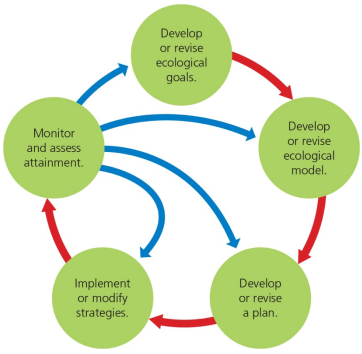
Adaptive Ecosystem Management

Integrate ecological, economic, and social principles.

Stakeholder consensus

Decisions and strategies are experiments to be improved.

Continued monitoring and innovation



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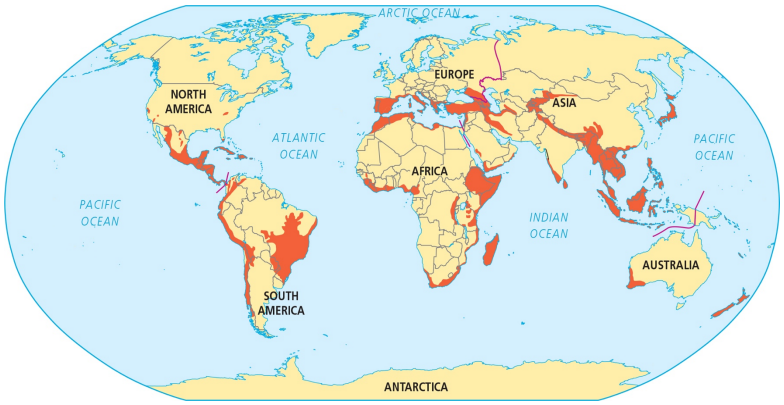
Hot Spots: Important but Endangered



Source: Data from the Center for Applied Biodiversity Science at Conservation International

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Ecological Restoration

Approaches

- Restoration
- Rehabilitation
- Remediation
- Replacement
- Artificial ecosystems

Principals

- Mimic nature
- Recreate lost niches
- Rely on pioneer species
- Control non-native species
- Reconnect small patches

What Can We Do?

- Immediate action to preserve hot spots
- Preserve intact old-growth forest
- Complete mapping of Earth's biodiversity
- Determine marine hot spots
- Concentrate on lake and river ecosystems
- Ensure the full range of ecosystems is considered
- Make conservation profitable
- Initiate ecological restoration projects

Conclusion

Biodiversity is essential for sustainable ecosystems.

Biodiversity is threatened by resource management practices.

Better management and ecological restoration is a help.