

PART III
SUSTAINING BIODIVERSITY
CHAPTER 11
**SUSTAINING TERRESTRIAL BIODIVERSITY:
MANAGING AND PROTECTING ECOSYSTEMS**

Summary

1. Earth's biodiversity has been depleted and degraded by humans. Biodiversity needs to be protected for its intrinsic and instrumental values. Conservation biology attempts to slow down the rate at which we are destroying and degrading the Earth's biodiversity through the use of rapid response strategies. Hot spots, the most endangered and species-rich ecosystems, receive emergency action to slow down or stop the loss of biodiversity in these systems. Bioinformatics manages, analyzes, and communicates basic biological and ecological information to help sustain biodiversity.
2. Old-growth forests are ones that have not been disturbed to any great extent by human activities or natural disasters for at least several hundred years. Old-growth forests provide important ecological and economic services, are storehouses of biodiversity, and affect weather and climate throughout the world. Second-growth forests are the product of ecological succession, following tree removal. Tree farms have uniformly aged trees that are harvested by clear-cutting at maturity; then trees are replanted for future harvest.
3. Forest resource management varies according to the type of forests. Some management systems maintain trees, cut them down, and replant them, all at the same time. In diverse forests, the ages and sizes of trees are preserved to foster natural regeneration. Government policies will primarily determine the future of forests, even the old-growth forests that are so important to us all.
4. Sustainability can be encouraged if we include the economic value of ecological services that forests provide. Forest certification, recycling paper and sawmill fibres, and the use of tree-free fibres can also help preserve our forests.
5. Forests moderate climate, purify water, prevent erosion, act as carbon sinks, and provide habitat. Wood, pulp, paper, cardboard, maple syrup, furs, employment, recreation and tourism are all benefits that Canadian forests provide.
6. Surface fires burn primarily undergrowth and leaf litter, whereas crown fires are extremely hot, and may destroy most of the vegetation, kill wildlife, and increase erosion. Native species such as the forest tent caterpillar and spruce budworm are widespread and can affect large areas of Canadian forests. Invasive species, including the gypsy moth and the emerald ash borer, are also a problem as natural predators are absent.
7. Deforestation is one of the most serious ecological problems of this century. The Earth's forests have been reduced by 20 to 50%, and the destruction continues to this day. Tropical deforestation, caused by population growth, poverty, environmentally harmful subsidies, foreign debts to developed countries, and the lack of recognition of the

ecological value of forests, is one of the biggest threats to the world economic health and climate.

8. Deforestation has many harmful environmental effects: it reduces the ecological services of forests, releases large amounts of carbon dioxide into the air, produces a drier and hotter climate, reduces the control of water movements, and increases soil erosion. To help sustain tropical forests, nations of the world must unite to discourage deforestation and degradation. Such an effort would slow population growth, decrease or eliminate world poverty, provide environmentally supportive government subsidies, reduce or eliminate debts owed by developing countries, and place a monetary value on ecological services provided by tropical forests. Other efforts include practising small-scale sustainable agriculture and forestry; harvesting renewable resources from rain forests, such as fruits and nuts; and certifying timber that is produced by sustainable methods.
9. Only about 7% of the world's terrestrial areas are protected from potentially harmful human activities; these areas need to be expanded throughout the world. At least 20% of the Earth's land area should be protected in a global system of biodiversity. National governments and private cooperative ventures should be involved in setting aside land and sustaining it. Developers must be refused access to large areas of land; biodiversity must be preserved, despite the projected economic benefits of harvesting these forests.
10. Canada has a large area of public lands. They are used for resource extraction, recreation, education, research, and wildlife conservation. Land ownership is as follows: 16% federal, 77% provincial and territorial, and 7% private. There are 39 natural regions in Canada that should be, according to Parks Canada, represented in Canada's National Parks System. Canada has 43 national parks and two national marine conservation areas. Resource extraction is forbidden, and these protected areas play an important role in protecting biodiversity. Other than national parks, there are many other areas in Canada that protect biodiversity, including provincial parks, Ramsar sites that protect wetlands, bird sanctuaries, World Heritage sites, biosphere reserves, and small ecological reserves.
11. In the 1970s, Costa Rica implemented a system of reserves and national parks, committed to biodiversity conservation. Their megareserve system includes a protected inner core with buffer zones that may be used by indigenous people for logging, food growing, cattle grazing, hunting, and fishing. This unique commitment has brought in millions of tourist dollars to help sustain the country's economy.
12. Wilderness is an amount of land legally set aside to prevent or minimize harm from human activities. This is land affected by nature where human beings may visit but not remain. Wilderness areas are important for (1) their natural beauty, (2) their natural biological diversity, (3) their enhancement of the mental and physical health of visitors, and (4) their contributions to biodiversity. Roadless areas are needed to provide safety for wild species. Biosphere reserves have also proved effective. They have an inner protected core surrounded by two buffer zones.
13. Ecological restoration is the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems. It is important because we have so badly damaged the Earth's ecosystems. Unless we correct and then prevent this type of destruction, we may destroy the Earth and ourselves.

14. To sustain the Earth's biodiversity, we need to do the following:
- immediately preserve the world's biological hot spots
 - protect the remaining old-growth forests and cease logging them
 - map the world's terrestrial and aquatic biodiversity
 - identify and take action for the world's marine hot spots, just as for the terrestrial hot spots
 - protect and restore the world's lake and river systems
 - develop a global conservation strategy that protects the Earth's terrestrial and aquatic ecosystems
 - make conservation profitable
 - initiate ecological restoration projects worldwide

Key Concepts and Learning Outcomes

After completing this chapter, students should be able to answer the following key questions.

11-1 How Have Human Activities Affected Global Biodiversity? Increasing Our Ecological Footprint

- A. Human activities have negatively affected global biodiversity, and degraded 50 to 83% of the Earth's land surface.
- We have cleared about 82% of temperate deciduous forests for crop fields and urban development.
 - Prior to the development of conservation programs in Canada, many wetlands were lost due to drainage and agriculture.
 - Only about 1% of the tallgrass prairie ecosystem remains, and there are only a few remnants left of the Carolinian forest of southern Ontario. Many invasive insect species are disrupting forest ecosystems.
 - Human use, waste, and destruction have affected 10 to 55% of the net primary productivity of Earth's terrestrial ecosystems.
 - The species extinction rate is now probably between 100 and 10 000 times what it was prior to human existence.

11-2 Why Should We Care about Biodiversity? Sustaining a Vital Part of the World's Life Support System

- A. Intrinsic or existence value refers to biodiversity components, regardless of their use to humans.
- B. Instrumental value refers to biodiversity components that are useful to humans. There are two major types.
- Use values benefit us in the form of economic goods and services, scientific information recreation, and ecological services.
 - Nonuse values include
 - existence value (knowledge that a species exists, even if we receive no direct benefit from it),
 - aesthetic value (the appreciation of a wild species for its existence or for its beauty), and
 - bequest value (the act of leaving natural capital for use by future generations).

11-3 What is conservation biology? Emergency Action to Sustain Biodiversity

- A. Conservation biology uses rapid response strategies to curb loss and degradation of world biodiversity. Hot spots of species-rich ecosystems are identified and Rapid Assessment Teams of biologists evaluate, make recommendations, and take emergency action to impede the loss of biodiversity.

11-4 How Can Bioinformatics Help Protect Biodiversity? Providing Good Information

- A. Bioinformatics is the applied science of managing, analyzing, and communicating biological information.
 1. Tools include high-resolution digitized images of species to assess biodiversity, and computer databases of these images.
 2. DNA sequences are established to identify bacteria and other organisms.

11-5 What Are the Major Types of Public Lands? Land for Current and Future Generations

- A. Canada has a large percentage of public lands.
 1. Public land is used for resource extraction, recreation, education, research, and wildlife conservation.
 2. The federal government manages 4% of forested land in Canada. These lands are used for national parks, national marine conservation areas, wildlife refuges, bird sanctuaries, and other protected areas.
 3. Provincial and territorial governments manage 90% of Canada's lands. They are used for forestry, resource extraction, provincial parks, and wildlife refuges.
 4. There are a great variety of biomes and ecozones in Canada. Parks Canada has stated that there are 39 natural regions in Canada that should be represented in Canada's National Parks System.

11-6 What Are the Major Types of Forests? Old-Growth, Second-Growth, and Tree Plantations

- A. Forests range from those that have been undisturbed to ones that have been cut or are being managed.
 1. Forests with at least 10% tree cover occupy about 30% of the Earth's surface, excluding Greenland and Antarctica.
 2. Forests are classified into three major types, according to their age and structure.
 - a. Old-growth forests (about 36% of the world's forests) are those that have not been seriously disturbed by human activities or natural disasters for hundreds of years. These forests are storehouses of biodiversity because of the ecological niches they provide for wildlife species.
 - b. Second-growth forests (about 57% of the world's forests) develop in an area after human activities or natural forces have removed them.
 - c. Tree plantations, or tree farms, (about 7% of the world's forests) consist of even-aged trees of one species that are clear-cut as soon as they become commercially valuable; they are replanted and then clear-cut again on a regular cycle.
 3. Thirty percent of the world's forests are used to produce wood and non-wood forest products.
 4. The remaining areas have other purposes: multiple-use, conservation and protection, social services, and other uses.

11-7 What Are the Major Types of Forest Management? Simple Tree Plantations and Diverse Forests

- A. Some forests consist of one or two species of commercially important tree species that are cut down and replanted, and others contain diverse tree species harvested individually or in small groups:
1. Even-aged management maintains trees in a specific stand at about the same age and size. In such industrial forestry, a stand of fast-growing, commercially lucrative trees replaces a biologically diverse old-growth or second-growth forest.
 2. Uneven-aged management maintains a variety of species of many ages and many sizes to foster natural regeneration. The goals in this type of management are as follows:
 - a. biological diversity
 - b. long-term sustainable production of high-quality timber
 - c. selective cutting of individual mature or intermediate-aged trees
 - d. multiple uses of the forest, such as timber, wildlife and watershed protection, and recreation
 3. A study by the World Wildlife Fund indicates that intensive, sustainable management of one-fifth of the world's forest would supply current and future demands for commercial wood and fibre, leaving the remaining old-growth forests untouched.

11-8 How Are Trees Harvested and Regenerated? Using a Variety of Silvicultural Method

- A. Trees can be harvested individually or the whole stand can be cut.
1. The presence of logging roads has many negative consequences.
 - a. They increase erosion and sediment runoff.
 - b. They fragment habitats and contribute to loss of biological diversity.
 - c. They expose forests to invasion by non-native pests, diseases, and wildlife species.
 - d. They provide access to the forest to miners, farmers, hunters, etc.
 2. Areas made accessible by roads can no longer be considered a wilderness.
 3. Different harvesting methods affect the continuing growth of forests.
 - a. In selective cutting, intermediate-aged or mature trees are cut singly or in small groups. High grading is an undesirable form of selective cutting.
 - 1) Selected trees, of only the largest and best specimens of the most desirable tree species, are cut.
 - 2) In this process, other trees are also damaged or pulled down, and the forest floor becomes warmer, drier, and subject to erosion and fire.
 - b. Shelterwood cutting removes all large trees, in two or three cuttings, over a period of time.
 - c. Seed-tree cutting removes all but a few trees that are evenly distributed to provide for a new generation.
 - d. Clear-cutting removes every single tree in one cutting. Strip cutting is a form of clear-cutting.
 - 1) A strip of trees is removed along the contour of the land.
 - 2) Cutting is spread out over several decades.
 - e. In addition to natural regeneration, whereby a forest perpetuates itself without assistance, there is human-assisted natural regeneration.

11-9 What Are the Harmful Environmental Effects of Deforestation? Biodiversity Loss and Climate Change

A. Harmful effects of deforestation (temporary or permanently removing trees) are as follows:

1. Biodiversity and the ecological services that forests provide are reduced.
2. Regional climate can be affected, and forests may not regenerate.
3. Carbon dioxide is released, affecting global climate change.
 - a. Research indicates that at least 200 years are needed to accumulate the same amount of carbon stored in the original forest.

11-10 What Is Happening to the World's Forests? Mixed News

A. Deforestation is widespread across the planet and is continuing.

1. World Resources Institute surveys indicate that original forest cover has decreased by 50%.
2. Global deforestation is occurring by at least 0.13% per year, with 80% of the losses occurring in the tropics.
3. If conditions don't change within the next 10 to 20 years, 40% of the world's remaining forests will have been logged or converted to other uses.
4. Some temperate forests have increased slightly from reforestation by secondary ecological succession on cleared forestland and abandoned cropland.
5. Some previously cut areas of tropical forest have been replanted in tree plantations. However, there is much lower biodiversity in these areas.

11-11 How Much Are the World's Ecological Services Worth? Putting a Price Tag on Mother Nature's Services

A. The economic value of ecological services is seldom included in the decision-making process concerning the world's forests.

1. The ecological services that forests provide are more valuable than the trees themselves.
2. The estimated economic value of income from the forests' ecological services is at least \$4.7 trillion per year.
 - a. The estimates of the ecologists did not include the natural capital that generates these figures.
 - b. It also did not include the value of nonrenewable minerals and fuels.
3. The accounting system has not changed to include these values because of short-term profits, and current government subsidies and tax incentives that support the destruction and degradation of forests for short-term economic gain.

11-12 How Can We Manage Forests More Sustainably? Making Sustaining Forests Profitable

A. Forest sustainability will be increased if we include the economic value of ecological services.

1. Conservationists have four ways to estimate how much of the remaining forest to protect.
 - a. Include estimates of economic value of ecological services in decisions.
 - b. Protect enough so that the rate of loss or degradation is balanced by forest renewal.
 - c. Protect forest areas that are centres of biodiversity threatened by development.
 - d. Establish and use methods to evaluate timber grown sustainably.

11-13 How Can We Certify Sustainably Grown Timber? Set Standards and Bring in Outside Evaluators

- A. Timber can be grown sustainably. Standards certifying growing methods should be applied to all wood and wood products sold.
1. As of 2014, Canada's forest industry has certified 161 million hectares of forests. The Haliburton Forest and Wildlife Reserve Ltd. was Canada's first certified forest.
 2. Major certification programs in Canada are the following:
 - a. CSA (Canadian Standards Association) addresses environmental, social, and economic issues; requires public participation; and is based on national and international criteria.
 - b. SFI (Sustainable Forestry Initiative) Program integrates forestry with conservation goals, and includes environmental objectives and performance measures.
 - c. FSC (Forest Stewardship Council) uses environmental, social, and economic criteria; their goal is sustainable management, and they stress the need for national and regional standards.
 3. World Wildlife Fund, in 2001, called on the five largest companies that harvest and process timber, and buy wood products, to adopt FSC guidelines.

11-14 What Is the Status of the Canadian Forest? Many Uses

- A. Forests provide many economic and environmental benefits.
1. They moderate climate, purify water, stabilize soil, store carbon, provide habitat, provide employment and products, and are used for recreation, tourism, education and aesthetic appreciation.
 2. Forests in Canada cover about 54% of Canada's total land surface.
 - a. Approximately 47% of the land surface is considered to be forest land or productive.
 - b. About 7% of the land surface is classified as wild land, or other wooded land; trees in these areas, due to their size, distribution, or accessibility, are not commercially useful.
 - c. The annual allowable cut involves about 0.5% of the total forested lands.
 - d. Trees in the productive forests are mainly coniferous trees (softwoods).
 - e. Approximately 90% of trees are harvested by clear-cutting.
 - f. According to the Canadian Forest Service, at least 66% of Canada's biodiversity can be found in our forested ecosystems.
 3. There are 11 forest regions in Canada.
 - a. The largest region is the boreal forest.
 - b. Between the boreal forest and the tundra in the north, trees gradually become smaller and more scattered. This transition area is called the taiga.
 - c. Between the boreal forest and the open prairie in the south, the transition region is called the aspen parkland.
 4. The forest industry contributes \$20 billion annually to the Canadian economy.

11-15 What Threatens Certain Tree Species across Canada? Insects

- A. Many insects cause forest damage in Canada.

1. They include tent caterpillars, spruce budworms, mountain pine beetles, large aspen tortrix, and balsam fir sawflies.
2. Invasive insects, such as the gypsy moth and the emerald ash borer, lack predators and competition to keep populations under control.

11-16 How Do Fires Affect Forests? Surface, Crown, and Ground Fires

- A. Forest fires cause varying degrees of damage.
1. Three types of fires affect forest ecosystems.
 - a. Surface fires usually burn underbrush, burn leaf litter, and small seedlings.
 - 1) Most wild animals survive.
 - 2) These fires are beneficial because they burn flammable ground material, which prevents more destructive fires, and they release nutrients, stimulate germination of some seeds, and control pathogens and insects.
 - b. Crown fires are extremely hot and leap from treetop to treetop. Buildup of ground litter increases the likelihood of crown fires that result in greater destruction and soil erosion.
 - c. Ground fires are most common in northern peat bogs where they go underground and burn decaying matter. They are hard to detect and extinguish.
 2. One-third of all fires in the Canadian forest are caused by lightning; two-thirds are caused by people.
 3. Fires cause destruction, but there are also benefits.
 - a. Jack pines need fire to open their cones.
 - b. Nutrients and sunlight reach the forest floor following a fire.
 - c. Fire helps to maintain biodiversity by creating gaps.
 - d. Many organisms are dependent on the changes that take place in forest succession.

11-17 How Can We Reduce the Need to Harvest Trees for Timber and Papermaking? Stop Waste and Make Paper from Tree-Free Fibres

- A. Improving the efficiency of wood use would reduce the pressure to harvest trees.
1. Up to 60% of wood consumed in North America is wasted by
 - a. inefficient use of construction materials,
 - b. excess packaging and overuse of junk mail,
 - c. inadequate paper recycling, and
 - d. failure to reuse wooden shipping containers.
 2. China uses tree-free pulp from rice straw and other agricultural wastes left after harvest to make its paper.
 3. The use of tree-free fibres for papermaking is another way to reduce pressure on tree harvest. Fibres from agricultural residues and fast-growing crops, such as kenaf, can be used as alternatives to tree fibres.
 4. Compared to pulpwood, tree-free kenaf has the following advantages:
 - a. It needs fewer herbicides because it is able to outgrow most weeds.
 - b. It does not deplete nitrogen from the soil as it is a nitrogen fixer.
 - c. It takes less energy and fewer chemicals to break it down.
 - d. It produces less toxic wastewater.
 5. Canada's use of recycled paper and sawmill fibres is growing.
 6. About 80% of Canadian paper comes from recovered paper (24%) and sawmill residues (56%).

11-18 *How Fast Are Tropical Forests Being Cleared and Degraded, and Why Should We Care? Protecting the Priceless*

- A. Most destruction of tropical forests has occurred since 1950.
1. Brazil has about 40% of the world's remaining tropical rain forest, but at the current rate of deforestation and degradation, it may largely be gone in 40 to 50 years.
 2. Brazilian Atlantic rain forest once covered 12% of Brazil, and 93% of it has been cleared.
 - a. This represents a major loss of biodiversity.
 - b. There are 450 tree species in an area the size of two suburban house lots. (Canada has only about 180 native tree species in total.)
 3. It is very difficult to estimate the actual loss of rain forest, due to political and economic reasons, and different ways of defining forests, deforestation, and degradation.
 4. Loss of tropical forests is a loss of possibly useful pharmaceuticals, and also contributes to global warming because forests store carbon in their biomass.

11-19 *How Can We Reduce Deforestation and Degradation of Tropical Forests? Prevention Is Best*

- A. There are many ways to reduce the deforestation and degradation of tropical forests.
1. Help settlers learn how to practise more sustainable small-scale agriculture and forestry.
 2. Harvest sustainable fruits and nuts in the rain forests.
 3. Use debt-for-nature swaps, which allow countries that owe foreign aid or foreign debt to act as custodians of protected forest reserves in order for their debts to be forgiven.
 4. Develop an international system for evaluating and certifying that tropical timber has been produced by sustainable methods.
 5. Loggers can harvest trees more gently by
 - a. cutting canopy vines before felling trees, and
 - b. using the most open paths to remove felled trees.
 6. Governments and individuals can reforest and rehabilitate degraded tropical forests and watersheds.
 7. Prevent illegal logging.

11-20 *The Incredible Neem Tree*

- A. The neem tree of India has many medicinal applications that can improve human health.
1. The neem tree is a broadleaf evergreen of the mahogany family.
 2. This tree can reforest degraded land quickly, supply fuelwood and lumber, provide natural pesticides, be used to treat various diseases, and help control population growth.
 - a. It is a native of India and Burma.
 - b. It is full-grown in five to seven years if planted in poor soil and on semiarid lands.
 - c. Chemicals in its leaves and seeds repel or kill insects.
 - d. This tree is a "village pharmacy."

- 1) Its oil is an effective spermicide.
- 2) It may contribute to development of a male birth control pill.
- e. Ecologists caution against widespread planting of the tree outside its native habitat as it could become an invasive species elsewhere.

11-21 *What Are National Parks, and How Are They Threatened? Under Assault*

- A. Many countries have established national parks, but many are threatened by human activities.
1. Only 1% of parks in developing countries receive protection, and many are impacted by human activities.
 - a. People exploit wood, game animals, etc.
 - b. Loggers, miners, and poachers take all they want from the parks.
 2. Money is needed to protect parks from these invasions.
 3. Parks are too small to sustain many large animals.
 4. Many non-native species invade parks, causing ecological disruption.

11-22 *How Much of the Earth's Land Should We Protect from Human Exploitation? The Answer Is More*

- A. To sustain Earth's biodiversity, we need to establish and manage more nature reserves.
1. Conservation biologists call for a strict protection of at least 20% of the Earth's land area in a global system of biodiversity reserves that includes multiple examples of all the Earth's biomes.
 2. Developers and resource extractors generally oppose protecting the Earth's remaining undisturbed ecosystems.

11-23 *The Nature Conservancy: Land Conservation through Private Action*

- A. The Nature Conservancy, founded in 1951, has created the world's largest system of private natural areas and wildlife sanctuaries in 35 countries.
1. Private and corporate donations maintain a fund for buying ecologically important pieces of land or wetlands.
 2. Landowners who donate land to the Nature Conservancy, in exchange for lifetime occupancy rights, also receive sizable tax deductions.

11-24 *Should Reserves Be as Large as Possible? Generally, but Not Always*

- A. Large reserves are usually the best way to protect biodiversity, but in some locales, several well-placed, medium-sized, isolated reserves may be a better way to protect a variety of habitats.
1. Establishment of habitat corridors helps to support more species and allows migration of vertebrates with large ranges.
 2. Migration of individuals can occur when environmental conditions deteriorate within a range.
 3. Corridors permit gene flow and help prevent inbreeding.
 4. The Yellowstone-to-Yukon (Y2Y) Conservation Initiative is a joint Canada–U.S. organization seeking to protect wild ecosystems from Yellowstone National Park to the Yukon.
 5. In Ontario, a number of wildlife corridors centred on Algonquin Provincial Park are in various stages of planning.

6. Oak Ridges Moraine Wildlife Corridor, north of Toronto, is one of the last continuous wildlife corridors in southern Ontario.

11-25 *What Are Biosphere Reserves? A Great Idea*

- A. Biosphere reserves have an inner protected core surrounded by two buffer zones that can be used for the sustainable extraction of resources, food, and fuel.
 1. UNECSO created the Man and the Biosphere Programme in 1971 to establish biosphere reserves in each of the 193 biogeographical zones.
 - a. The core area of the reserve is protected from all human activities except non-destructive research and monitoring.
 - b. A buffer zone surrounds the core zone and protects it.
 - c. A second buffer zone or transition zone surrounds the inner buffer and can be used by local people for sustainable forestry, grazing, hunting, fishing, agriculture, and recreation.
 2. Presently, most biosphere reserves are underfunded and fall short of the ideal.
 3. A fund of about \$100 million per year would help countries protect and manage biosphere reserves.

11-26 *What Is Adaptive Ecosystem Management? Cooperation and Flexibility*

- A. People with competing interests can work together to develop adaptable plans to manage and sustain nature reserves.
 1. One way to do this is with adaptive ecosystem management, based on using the following four principles:
 - a. Integrate ecological, economic, and social principles to maintain and restore diversity of reserves.
 - b. Find a way to get diverse agencies, private conservation organizations, scientists, business interests, and landowners to reach a consensus on achievement of common conservation goals.
 - c. Look at all decisions as experiments, learn from failures, and improve.
 - d. Continually gather information, monitor, reassess, be flexible, adapt, and innovate when faced with uncertainty.

11-27 *What Areas Should Receive Top Priority for Establishing Reserves? Hot Spots*

- A. If we protect biodiversity hot spots, we can prevent or slow down biodiversity losses.
 1. Conservation biologists use an emergency action strategy to identify and protect biodiversity hot spots. These areas are
 - a. especially rich in biodiversity,
 - b. found nowhere else on Earth, and
 - c. in danger of serious ecological destruction.

11-28 *What Is Wilderness, and Why Is It Important? Land Protected from Us*

- A. Wilderness is land legally set aside that is large enough to prevent or minimize negative effects from humans.
 1. Land is protected
 - a. to allow people to see the beauty and diversity in nature,
 - b. to enhance the mental and physical health of visitors,
 - c. to preserve biodiversity, and
 - d. to protect them as centres for evolution.

11-29 How Can We Rehabilitate and Restore Damaged Ecosystems? Making Amends for Our Actions

- A. Environmental degradation can be partially reversed through ecological restoration and the creation of artificial ecosystems.
1. For example, wetlands can be restored, forests can be replanted, native species can be reintroduced, invasive species can be eradicated, and dams on rivers can be removed.
 2. Scientists study how natural systems recover, and they are learning to speed up repair operations by taking actions such as the following:
 - a. Return a degraded habitat to a condition as close to its natural state as possible; however, changes in climate, soil, and species composition may make this impossible.
 - b. Rehabilitation involves trying to restore an ecosystem to a functional state rather than its original state.
 - c. Remediation involves cleaning up chemical contaminants from a site in order to use it again.
 - d. Replacement entails replacing a degraded ecosystem with a productive pasture or tree farm.
 - e. Creating artificial ecosystems is another possibility.
 3. Five basic principles are suggested for ecological restoration:
 - a. Mimic nature and natural processes; let nature do most of the work.
 - b. Recreate important ecological niches that may have been lost.
 - c. Rely on pioneer species, keystone species, foundation species, and natural succession.
 - d. Control or remove harmful non-native species.
 - e. Reconnect small patches to form larger ones with corridors.
 4. Preventing ecological damage is cheaper and more effective than ecological restoration.
 5. A restored ecosystem is better than a degraded one, and so far we have preserved only about 5% of nature from the effects of human activity.

11-30 What Should Be Our Priorities? An Eight-Step Program

- A. Edward O. Wilson's priorities for protecting the world's ecosystems and species are as follows:
1. Immediately take action to preserve the world's biological hot spots.
 2. Keep the world's remaining old-growth forests intact.
 3. Finish mapping the world's terrestrial and aquatic biodiversity.
 4. Identify the world's marine hot spots, and give them the same priority as land hot spots.
 5. Protect and restore the world's lake and river systems.
 6. Ensure that the Earth's terrestrial and aquatic ecosystems are in a global conservation strategy.
 7. Make conservation profitable.
 8. Start ecological restoration projects worldwide to heal damage, and increase the share of the Earth allotted to the rest of nature.