

## Chapter 10

### Sustaining Terrestrial Biodiversity: The Ecosystem Approach

#### Summary

1. 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/stop the loss of biodiversity in these systems. Bioinformatics manages, analyzes, and communicates basic biological and ecological information to help sustain biodiversity.
2. Forests provide important ecological and economic services, are storehouses of biodiversity, and affect weather and climate throughout the world. Forest resource management varies according to the type of forests. In diverse forests, the age and size of trees are preserved to foster natural regeneration. Government policies will primarily determine the future of forests, including old-growth forests.
3. Forests in the United States should be managed so as to retain as much of the forests as possible. Clear-cutting and seed-tree cutting methods of harvesting are scourges on the forest; selective cutting is the most reasonable way to harvest trees.
4. Deforestation is one of the most serious ecological problems of this century. The earth's forests have been reduced by 20–50% and the destruction continues to this day. Deforestation has many harmful environmental effects: reduces ecological services of forests, releases large amounts of carbon dioxide in the air, produces a drier and hotter climate; reduces the control of water movements, and increases soil erosion.
5. Tropical deforestation is one of the biggest threats to world economic health and climate. To help sustain tropical forests, nations of the world must unite to discourage deforestation and degradation.
6. Problems affecting parks run from little/no protection from their governments or being too small to sustain large animal species, to being too popular and, therefore, overused by people. Some methods for managing parks include: limiting the number of visitors, raising entry fees to provide funds for maintenance and management, managing parks in reference to nearby federal lands, discouraging development around already established parks, and providing more volunteers and better paid employees to maintain the parks.
7. 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. In order to adequately conserve biodiversity, at least 20% of the earth's land area should be protected in a global network of reserves.
8. Wilderness is an amount of land legally set aside to prevent/minimize harm from human activities. This is land 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 mental and physical health of visitors, and (4) their contributions to biodiversity and to evolutionary possibilities.
9. Ecological restoration is the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems.
10. Initiatives that would help to sustain the earth's biodiversity include:
  - Immediately preserving the world's biological *hot spots*
  - Protecting the remaining old-growth forests
  - Mapping the world's terrestrial and aquatic biodiversity
  - Identifying and taking action for the world's marine hot spots, just as for the terrestrial hot spots
  - Protecting and restoring the world's lakes and river systems
  - Developing a global conservation strategy that protects the earth's terrestrial and aquatic ecosystems
  - Making conservation profitable
  - Initiating ecological restoration projects worldwide

## Key Questions and Concepts

### 1. What are the major threats to forest ecosystems?

**CORE CASE STUDY:** In 1977 Wangari Maathai founded the Green Belt Movement, which is a women's self-help group directed at planting and protecting trees across rural Kenya. The movement has grown to 50,000 member and 6,000 tree nurseries. Maathai was awarded the Nobel Peace Prize for her efforts in 2004.

- A. Forests occupy about 30% of the earth's surface, excluding Greenland and Antarctica.
- B. Forests are classified according to their age and structure into two major types.
  - 1. Old growth/frontier forests are those that have not been seriously disturbed by human activities/natural disasters for hundreds of years. These forests are storehouses of biodiversity because of the ecological niches they provide for wildlife species.
  - 2. Second-growth forests develop in an area after human activities or natural forces have removed them.
    - i. Tree plantations/tree farms replant and clear-cut one species of trees in a regular cycle.
- C. 60% of all forests are second growth, 36% are primary forest, and 4% are tree plantations.
- D. Forests provide valuable ecological and economic services.
  - 1. Forests provide habitat for about 2/3 of all terrestrial species.
- E. The presence of logging roads has many negative consequences.
  - 1. Logging roads increase erosion and sediment runoff, fragment habitats, and contribute to loss of biological diversity.
  - 2. They expose forest to invasion by nonnative pests, diseases, and wildlife species.
- F. Different harvesting methods affect the continuing growth of forests.
  - 1. In selective cutting, intermediate-aged/mature trees are cut singly or in small groups.
  - 2. Clear-cutting removes every single tree in one cutting.
  - 3. Strip cutting removes a strip of trees along the contour of the land and spreads the cutting out over several decades.

**SCIENCE FOCUS:** Researchers have attempted to devise a method to place a monetary value on ecosystem services. They hope that these efforts will make people aware that: ecosystem services are essential for humans and their economies, the economic value of ecosystem processes is substantial, and sustainably managed ecosystems are a long-term source of income.

- G. Different types of fires affect forest ecosystems.
  - 1. Surface fires usually burn underbrush, leaf litter, and small seedlings, but most wild animals survive. They have benefits such as burning flammable ground material to prevent more destructive fires and release nutrients, stimulate germination of some seeds, and control pathogens and insects.
  - 2. Crown fires are extremely hot and leap from treetop to treetop. Buildup of ground litter increases likelihood of crown fires that result in greater destruction and soil erosion.
- H. Accidental and deliberate introductions of forest diseases and insects are a major threat to forests.
- I. Climate change threatens many forests.
  - 1. Some species are sensitive to heat.
- J. Deforestation is widespread across the planet and is continuing.
  - 1. World Resources Institute surveys indicate that original forest cover has decreased by about 46%.
  - 2. Global deforestation is occurring by at least 0.2–0.5% per year, with most losses taking place in developing countries.
  - 3. If conditions don't change within the next 10–20 years, 40% of the world's remaining forests will have been logged or converted to other uses.

**CASE STUDY:** Forests cover about 30% of the land area in the United States. Early in the nation's history, forests were decimated. Today, however, forests cover more land area in the U.S. than they did in 1920. Much of this is second growth. On the other hand, much of the nation's old-growth forest has been replaced with simplified tree plantations.

- K. Tropical forests make up 6% of the earth's land area.
  - 1. They once covered twice as much area. Most destruction has occurred since 1950.
  - 2. At least half of the world's terrestrial plant and animal species are found in tropical rainforests.
- L. Four primary causes of tropical forest destruction are:
  - 1. Population growth and poverty drive subsistence farmers to tropical forests where they attempt to farm.
  - 2. Government subsidies make tropical forest resources cheap—relative to their full ecological value.

3. Degradation begins when roads are cut into the forest for logging. Selective cutting removes the best timber (high grade).
4. Healthy rain forests do not burn, but logging, settlements, grazing, and farming have fragmented the forest; they dry out, making them more flammable.
5. Burning contributes to global climate change, accounting for 17% of the annual greenhouse gas emissions.

### 10-2 How should we manage and sustain forests?

- A. Fire management can be improved.
1. The Smokey Bear educational campaign taught that fire is bad. Ecologists suggest that putting out all fires increases the risk of a catastrophic fire event.
  2. According to the Forest Service, severe fire could threaten 40% of federal forest lands due to fuel buildup.
  3. Risk can be reduced via prescribed fire, allowing natural fires to burn, clearing vegetation from around structures, and manual thinning in fire prone areas.

**SCIENCE FOCUS:** Scientific Certification Systems (SCS) is part of the Forest Stewardship Council (FSC), which certifies timber and products generated from environmentally sound and sustainable practices. Still, as of 2009, only 5% of the world's forested area is certified.

- B. Improving the efficiency of wood use would reduce pressure to harvest trees on public and private land.
1. Up to 60% of wood consumed in the U.S. is wasted due to inefficient use of construction materials, excess packaging and overuse of junk mail, inadequate paper recycling, and failure to reuse wooden shipping containers.
- C. Use of tree-free fibers for papermaking is another way to reduce pressure on tree harvest.
1. Use of fibers from agricultural residues and crops such as kenaf are alternatives to tree fibers.

**CASE STUDY:** About half the wood harvested each year in the U.S., and three-fourths of that in developing countries, is used for fuel. Rings of deforested land surround cities, and the demand for fuelwood in urban areas exceeds the sustainable yield of nearby forests. Community forestry projects involve local people in planting small plantations of fast-growing fuelwood trees in community wood lots. People can use more efficient, less polluting woodstoves, solar ovens, or electric hotplates powered by windpower to reduce the demand for fuelwood.

- D. In order to reduce deforestation and degradation of tropical forests:
1. We must help settlers learn methods to practice in small-scale sustainable agriculture and forestry.
  2. We must harvest sustainable fruits and nuts in the rain forests.
  3. We should consider using debt-for-nature swaps, which allow countries that owe foreign aid/foreign debt to act as custodians of protected forest reserves in order for debt to be forgiven.
  4. We can allow corporations and countries that emit a lot of carbon dioxide to pay tropical countries to protect their forests.
  5. Initiate replanting programs.
  6. We can reduce our demand for products that encourage unsustainable resource extraction.

### 10-3 How should we manage and sustain grasslands?

- A. Grasslands provide many important ecological services yet are the second-most altered ecosystem.
- B. Livestock often overgraze on rangelands (non-managed grasslands) and pastures (managed grasslands), causing soil and erosion and exploitation by invasive plants.

**CASE STUDY:** Grasslands are partially maintained by occasional wildfires. Ranchers in the Malpai Borderlands have overgrazed and suppressed fires for more than a century. Now, ranchers and environmentalists have joined forces to restore native grasses and animal species to this area..

- C. To utilize grasslands in a sustainable way, we must control the number and distribution of livestock.
- D. Ranchers, ecologist, and environmentalists in the United States are working together to protect grasslands by rotating livestock.

E. Invasive plants can be combated with herbicides, mechanical removal, and controlled burning.

**CASE STUDY:** Since 1980, there has been a population surge in the ranch country in the Southwestern United States. This has led to uncontrolled urban development. Now, ranchers and environmentalists are working together to conserve ranchland as a means of sustaining the remaining grassland habitats. One strategy is to pay ranchers for conservation easements, which bar future owners from developing land.

### 10-4 How should we manage and sustain parks and nature reserves?

- A. There are more than 1,100 national parks in more than 120 countries.

1. Parks in developing countries possess the greatest biodiversity, but are least protected.

**CASE STUDY:** The U.S. National Park system includes 58 major national parks. Their popularity brings pollution and associated problems with overuse. Non-native species threaten biodiversity in parks, which are often isolated amidst development. Inadequate budgets add to the challenges faced by our national parks.

**SCIENCE FOCUS:** Scientists are monitoring the gray wolves that have been reintroduced to Yellowstone National Park. The effects of this reintroduction have been many. They are impacting the populations and behaviors of large grazing animals. This has helped to restore riparian zones that were degraded by elk. Coyote populations have also been decreased. It will take decades of research to understand the way these animals impact the functioning of their ecosystem.

B. Conservation biologists call for strict protection of at least 20% of earth's global system as biodiversity reserves that include multiple examples of all the earth's biomes.

C. 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. Buffer zones establish an inner zone of intact habitat.

2. The United Nations has established 553 biosphere reserves globally, based on this principle.

D. Establishment of habitat corridors helps to support more species and allows migration of vertebrates with large ranges.

1. Migration of individuals can occur when environmental conditions deteriorate within a range.

2. They can also threaten isolated populations by allowing movement of pest species, disease, fire, and exotic species between reserves.

3. They may be costly to acquire, protect, and maintain.

**CASE STUDY:** The most impressive country for conserving its land and natural resources has been Costa Rica. It has established a system of reserves and national parks, and it devotes a larger portion of its land to biodiversity conservation than any other country. It has consolidated its parks and reserves into eight megareserves, which help generate a \$1 billion per year in ecotourism industry. Costa Rica once had one of the highest rates of deforestation and now has one of the lowest.

E. The wilderness concept provides for large tracts of undeveloped land.

**CASE STUDY:** The Wilderness Act was not passed in the U.S. until 1964. Only about 4.7% of U.S. land is protected as wilderness, with almost three-fourths of it in Alaska. Only about 1.8% of the lower 48 states are protected as wilderness. Only 81 of the 233 distinct ecosystems are protected in wilderness. However, in 2009, the US government granted wilderness protection to 2 million acres of public land.

### 10-5 What is the ecosystem approach to sustaining biodiversity?

A. We should focus on protecting ecosystems and their biodiversity rather than distinct species.

1. Map and inventory ecosystems.

2. Identify the most endangered ecosystems.

3. Restore degraded ecosystems.

4. Make development biodiversity-friendly via tax breaks.

B. Biodiversity hotspots are areas especially rich in species, and in great risk of extinction.

1. In all 34 hotspots, a total of 86% of habitat has been destroyed.

C. Another approach to biodiversity conservation is to protect those areas where vital ecosystem processes are being impaired.

D. Life-raft ecosystems are those in which people live in extreme poverty and must degrade ecosystem processes to survive.

E. Environmental degradation can be partially reversed through ecological restoration.

F. Scientists study how natural systems recover and are learning to speed up repair operations by the following approaches:

1. Restoration returns a degraded habitat to a condition as close to its natural state as possible.

2. Rehabilitation involves trying to restore an ecosystem to a functional state rather than its original state.

3. Replacement is replacing a degraded ecosystem with a productive pasture or tree farm.

4. Creating artificial ecosystems is another possibility.

**SCIENCE FOCUS:** Guanacaste National Park in Costa Rica is the site of one of the world's largest ecological restoration projects. The project involves local community members in the restoration effort. Many local students have been trained in restoration ecology. This project is guided by the belief that it will ultimately fail unless the local communities see some economic benefit in its success.

G. Reconciliation Ecology involves inventing, establishing, and maintaining new habitats for species to coexist with humans.

**CASE STUDY:** The Blackfoot River comprises a large and diverse watershed. It is also home to many people who witnessed environmental degradation due to poor mining, logging, and grazing practices. This stimulated activism at the community level. In 1993, community members organized the Blackfoot Challenge. This resulted in drastic improvements, and became a classic example of reconciliation ecology.