



SUSTAINING BIODIVERSITY

Chapter 10

Sustaining Terrestrial Biodiversity: The Ecosystem Approach



“It’s A Small World After All”

Outline

Human Impacts on Terrestrial Biodiversity

Human activities have negatively affected global biodiversity.

- A. Humans have disturbed from 50-83% of the earth’s land surface.
 - 1. We have logged about 95% of virgin forests in 48 states, 98% of tall grass prairie has disappeared, and California has lost 99% of native grassland and 85% of original redwood forests.
 - 2. Human use, waste, and destruction have affected 40% of the net primary productivity of earth’s terrestrial ecosystems.
 - 3. Species extinction rate is now probably between 100-10,000 times what it was prior to human existence.
- B. Preservation of biodiversity is important for several reasons such as intrinsic or existence value and also because of its usefulness to humans.
 - 1. Instrumental value consists of use values that benefit people for goods and services, scientific information, recreation, and ecological services.
 - 2. Nonuse values are existence value, aesthetic value (the appreciation of wild species, or a view for beauty alone), and bequest value, the act of leaving natural capital for use by future generations.

Managing and Sustaining Forests

Managing and sustaining forests is a long-term commitment.

- A. Forests with at least 10% tree cover occupy about 30% of the earth’s surface, excluding Greenland and Antarctica.
- B. Forests are classified according to their age and structure into three major types.
 - 1. Old growth/frontier forests are those, which 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.
 - 3. Tree plantations/tree farms replant and clear-cut one species of trees in a regular cycle.
- C. Harmful effects of deforestation (temporary/permanently removing trees) are given below:
 - 1. Deforestation reduces biodiversity and the ecological services that forests provide.
 - 2. Deforestation can change regional climate and forests will not regenerate.
 - 3. Deforestation emits carbon dioxide, which affects global climate change.
 - 4. Research indicates that at least 200 years is needed to accumulate the same amount of carbon stored in the original forest.
- D. Deforestation is widespread across the planet and is continuing.
 - 1. World Resources Institute surveys indicate that original forest cover has decreased by 20-50%.
 - 2. Global deforestation is occurring by at least 0.2 – 0.5% per year, with 4/5th of the losses occurring in the tropics.
 - 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.
- E. About half the wood harvested each year and three-fourths of that in developing countries is used for fuel.
 - 1. Rings of deforested land surround cities and the demand for fuelwood in urban areas exceeds the sustainable yield of nearby forests.
 - 2. Community forestry projects involve local people in and planting small plantations of fast-growing fuelwood trees in community woodlots.
 - 3. People can use more efficient, less polluting woodstoves, solar oven or electric hotplates powered by wind power.
- F. 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.

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2. They expose forest to invasion by nonnative pests, diseases, and wildlife species.
3. They provide access to the forest to all kinds of human pests.
4. Logging roads on public lands disqualify the land for protection as wilderness.
- G. 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. In high grading, selected trees of only the largest and best specimens of the most desirable trees are cut. This also removes other trees and the forest floor becomes warmer, dries and subject to erosion and fire.
 3. Shelterwood cutting removes trees that grow best in full/moderate sunlight. There may be two or three cuttings over a period of time. (This is another method of clear-cutting.)
 4. Seed-tree cutting removes all but a few evenly distributed trees whose seeds would begin a new generation. (This is a variation of clear-cutting.)
 5. Clear-cutting removes every single tree in one cutting. Strip cutting removes a strip of trees along the contour of the land and spreads the cutting out over several decades.
- H. We must harvest trees no faster than they are replenished and have systems in place that manage forests sustainably.

Case Study: Forest Resources and Management in the United States

Forests in the United States cover about 30% of U.S. land area provide habitat for >80% of wildlife species, and cover more area than was true in 1920.

- A. More wood is grown each year in the U.S. than is cut and the total area planted with trees increases.
- B. About 40% of U.S. forests is in protected lands, mostly in national forests.
- C. On the other hand, the U. S. is losing its old growth and second-growth forests, replaced by biologically simplified tree plantations.
 1. As a result, forest biodiversity has been reduced.
 2. Ecosystem processes have been disrupted.
 3. Individuals like Julia Hill have protested this destruction but the carnage continues.
- C. Controversy of managing national forests is the same as that of managing public lands: do big business interest continues to steal the wealth of the forests from the citizens of the country? Why is the government unwilling to discontinue such practices and what can the individual do?
- D. Three types of fires affect forest ecosystems.
 1. Surface fires usually burn underbrush, burn 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, control pathogens, 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.
 3. Ground fires are most common in northern peat bogs where they go underground and burn decaying matter. They are hard to detect and extinguish.
- E. Protection of forest resources from fire includes fire prevention and prescribed burning.
- F. An educational campaign to prevent forest fires has been successful, but now the public thinks all forest fires are bad.
 1. Prevention of all forest fires can increase chances of devastating fires from buildup of underbrush and small trees.
 2. Logging practices of the 1980’s left logging debris.
 3. People now live in areas with high wildfire risk and this increases chances of fires occurring.
 4. In parts of California goats are used as an alternative to prescribed burns to avoid accidental large fires.
 5. Fires have been allowed to burn to help clear undergrowth in national parks and forests.
 6. A fire zone around homes of 150-200 feet and eliminating flammable building materials is advocated in fire-prone areas.
 7. Congress passed a law in 2003 that allows timber companies to cut down economically valuable medium and large trees in exchange for clearing smaller trees and underbrush.
 8. Biologists believe this will increase forest fires by a) removing more fire-resistant trees and by

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- b) leaving fire prone slash materials behind as evidenced that some of the worst fires in the 1990’s burned through cleared forest areas with slash.
- G. Forest thinning on public lands is needed, but should focus on two goals: reduce ground-level fuel in dry forest types and leave medium to large trees, and clear flammable vegetation around individual homes/buildings in vulnerable communities.
- H. This would cost less to taxpayers by having grants to communities for thinning forests and clearing around homes. This gives people a stake in the community.
- I. There is controversy over the use of resources in national forests.
1. Timber companies want to cut as much as possible at low prices.
 2. Biodiversity experts want reduction or elimination of tree cutting in national forests. They believe the forests should provide recreation and sustain biodiversity, water resources, and other ecological services.
 3. Incentives have been given to county governments and the Forest Service to increase timber sales.
 4. Cost of reforesting land by timber companies does not include the cost of road building, timber sale preparation, administration, and other overhead costs that are government subsidized. Timber sales have actually lost money for taxpayers in 97 of the last 100 years.
 5. Recreation, hunting, fishing in national forests add 10X more money to the economy than extracting timber and other resources.
- J. Improving the efficiency of wood use would reduce pressure to harvest trees on public and private land.
- K. Up to 60% of wood consumed in the U.S. is wasted:
1. Inefficient use of construction materials
 2. Excess packaging and overuse of junk mail
 3. Inadequate paper recycling
 4. Failure to reuse wooden shipping containers.
- L. Elimination of waste of wood by 4% would eliminate the need to use timber from the national forests.
- M. Use of tree-free fibers for papermaking is another way to reduce pressure on tree harvest. Use of fibers from agricultural residues and fast-growing crops such as kenaf are good alternatives to tree fibers.
1. Kenaf needs fewer herbicides/insecticides because it is able to outgrow most weeds.
 2. Kenaf is a nitrogen fixer, so does not deplete nitrogen from the soil.
 3. Fiber production takes less energy, fewer chemicals resulting in less toxic wastewater.
 4. This may replace tree fibers within 10-20 years.

Case Study: Tropical Deforestation

- 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 rate of destruction and degradation practices it may largely be gone in 40-50 years.
 2. Brazilian Atlantic rainforest once covered 12% of Brazil and 93% of it has been cleared, a major loss of biodiversity since there are 450 tree species in an area the size of two suburban house lots. The U. S. has about 865 native tree species.
 3. It is very difficult to estimate the actual loss of rainforest due to political and economic reasons and different ways of defining forest, deforestation/degradation.
 4. Loss of tropical forests is a loss of possible useful chemical products and also will contribute to global warming as we lose this storehouse for carbon as biomass.
- B. 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. The poor are given title to land they clear. It may reduce poverty, but degrades land if settlers are not taught to use forests sustainably
 4. International lending agencies encourage road building, mining, and drilling in tropical forests.

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5. Degradation begins when roads are cut into the forest for logging. Selective cutting removes the best timber (high grade). Domestic use accounts for 80% of the trees cut in developing countries.
6. Ranchers come in behind the timber cutters and overgraze land, they then move on and subsistence farmers come in and practice slash and burn farming to complete the destruction of the land.
7. Healthy rain forests do not burn but logging, settlements, grazing, and farming have fragmented the forest, they dry out, making them easier for lightning and people to start fires.
- C. 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 might use a debt-for-nature swap which allows countries that owe foreign aid/foreign debt to act as custodians of protected forest reserves in order for the debt to be forgiven.
 4. We must develop an international system for evaluating and certifying that tropical timber has been produced by sustainable methods.
 5. Loggers can harvest trees more gently: canopy vines’ being cut saves damage to near-by trees; use the most open paths to remove felled trees.
 6. Governments and individuals can reforest and rehabilitate degraded tropical forests and watersheds.
 7. We must prevent illegal logging.
- D. Develop programs like the Green Belt Movement in Kenya. Members of a women’s self-help group established tree nurseries, raised seedlings, and are planting and protecting a tree for each of Kenya’s people.
- E. We must protect the plants of the tropical rainforest because, like the Neem tree of India, many medicinal applications can improve health the world over.
 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 alternatives to 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 5-7 years, in poor soil and semiarid lands.
 - c. chemicals in its leaves and seed repel/kill insects.
 - d. this tree is a ‘village pharmacy’.
 - e. its oil is an effective spermicide and may contribute to development of a male birth control pill
 - f. Ecologists caution against widespread planting of the tree outside its native habitat, it could become an invasive species elsewhere.

Managing and Sustaining 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.
- C. Grasslands also suffer from undergrazing, which can reduce the net primary productivity of the area.
- D. To utilize grasslands in a sustainable way, we must control the number and distribution of livestock.
- E. Ranchers, ecologist, and environmentalists in the United States are working together to protect the grasslands in the western states by forming land trust groups, proving conservation easements, and rotating livestock.

National Parks

National parks, established by governments, are popular with people all over the world.

- A. Several threats to national parks must have a sustainable response.
 1. Parks, especially in developing countries, need protection.
 - a. People search for wood, game animals, etc.

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- b. Loggers, miners, and poachers take all they want from the parks.
- c. Money must be available to protect parks from these rapists.
- d. Parks are too small to sustain many large animals.
- 2. People illegally remove native species.
- 3. Nonnative species invade parks.
 - a. European wild boars threaten vegetation in parts of the Great Smoky Mountains National Park; Mountain goats in Washington’s Olympic National Park trample vegetation and hasten soil erosion.
- 4. Cars are congesting the roads; trails are eroded causing stress for visitors instead of solitude.
- 5. Visitors often expect to have urban type facilities in national and state parks.
- 6. Parks have too many tourists and not enough staff members and rangers spend more time on law enforcement than on conservation, management and education.
- 7. Human activities compromise the environment everywhere; parks are no exception. They are supporting mining, grazing, coal-burning power plants, polluted air, and urban development.
- 8. All kinds of vehicles: dirt bikes, dune buggies, snowmobiles and OVRs (off road vehicles) destroy vegetation and disturb wildlife and people.
- B. To stabilize park conditions, the Gray wolf has been re-introduced to Yellowstone National Park.
 - 1. The wolves kept the populations of bison, elk, caribou, mule deer and coyotes under control.
 - 2. Without the wolves, a keystone species, the environment was being undermined by expanding animal herds that devastated vegetation, increased erosion and threatened the ecological niches of other types of wildlife.
 - 3. The re-introduced wolves have benefited the environment. Aspen and willow trees growth has expanded and in so doing has attracted beavers to new areas. Wolves killing elk has provided grizzlies another food source. The wolves have decreased the coyote population that has helped grow smaller animals like ground squirrels and foxes.
- C. Private concessionaires provide campgrounds, restaurants, hotels, and other services while paying 6-7% of gross receipts in franchise fees. Some analysts call for raising fees to 22% of gross receipts.

Nature Reserves

- In order to sustain the earth’s biodiversity, we need to establish and manage more nature reserves.
- A. Conservations biologists call for a strict protection of at least 20% of earth’s global system as biodiversity reserves that include multiple examples of all the earth’s biomes.
 - 1. Some progress is occurring with Brazil, Gabon and Canada establishing more national parks.
 - 2. Developers and resource extractors generally oppose protecting any of the earth’s remaining undisturbed ecosystems.
 - B. The most impressive country in conserving its land and natural resources has been Costa Rica.
 - 1. It has established a system of reserves and national parks that included ¼ of its land by 2003.
 - 2. It has consolidated its parks and reserves into eight mega reserves, which sustain 80% of the country’s biodiversity. Almost 2/3s of its yearly tourism business comes from eco-tourism!
 - 3. Tourism may also undermine the protected areas without careful government control.
 - C. The Nature Conservancy, founded in 1951, has created the world’s largest system of private natural areas and wildlife sanctuaries in 30 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.
 - D. 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.
 - E. 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.

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- F. People with competing interest 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 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.
 - 2. Conservation biologists use an emergency action strategy to identify and protect biodiversity hot spots. These are areas especially rich in biodiversity found nowhere else on earth and are in danger of extinction.
- G. Wilderness consists of undeveloped land affected primarily by forces of nature and man is a visitor.
 - 1. Wilderness areas should be at least 1,500 square miles so as not to be affected by air, water, and noise pollution.
 - 2. People can enjoy nature’s beauty and observe the natural diversity. They can also help mental and physical health of visitors.
 - 3. These areas are centers for evolution and the preservation of biological diversity, a type of natural savings account.
 - 4. Wild species that inhabit wilderness also have a right to exist without human interference.
- H. The Wilderness Act was not passed in the U.S. until 1964. Only about 4.6% of U.S. land is protected as wilderness with almost $\frac{3}{4}$ of it in Alaska.
 - 1. Only about 1.8% of the lower 48 states are protected as wilderness.
 - 2. Only 81 of the 233 distinct ecosystems are protected in wilderness and most are smaller than the 1,500 square miles recommended.
 - 3. About 150,000 square miles could qualify for wilderness status and about 60% of it is in national forests.
 - 4. Industries see these areas as sources of increased profits and short-term economic growth.
 - 5. The Bush administration stopped protection of areas under consideration for wilderness status in 2003.
 - 6. Wilderness advocates call for creating wilderness recovery areas where roads would be removed from public lands and wildlife habitats restored.
 - 7. Strong opposition to these projects makes them unlikely to occur.

Ecological Restoration

- A. Environmental degradation can be partially reversed through ecological restoration. These include restoration of wetlands, replanting forests, reintroducing native species, removing invasive species and removing dams on rivers.
- B. Scientists study how natural system recover and are learning to speed up repair operations by the following approaches:
 - 1. Return a degraded habitat to a condition as close to its natural state as possible. Changes in climate, soil, and species composition may make this impossible.
 - 2. Rehabilitation involves trying to restore an ecosystem to a functional state rather than its original state.
 - 3. Remediation involves cleaning up chemical contaminants from a site in order to use it again.
 - 4. Replacement is replacing a degraded ecosystem with a productive pasture or tree farm.
 - 5. Creating artificial ecosystems is another possibility.
- C. Five basic principles are suggested for ecological restoration:
 - 1. Mimic nature and natural processes, let nature do most of the work
 - 2. Recreate important ecological niches that may be lost
 - 3. Rely on pioneer species, keystone species, foundation species and natural succession.
 - 4. Control or remove nonnative species

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5. Reconnect small patches to form larger ones with corridors.
- D. Preventing ecological damage is cheaper and more effective than restoring degraded ones.
- E. A restore ecosystem is better than a degraded one and we have only been able to preserve about 7% of nature from harm.
- F. Costa Rica is in the process of restoring a tropical dry deciduous forest degraded by cattle raising and farming. Making the local people a part of the project will give these people educational, economic and environmental benefits. Eco-tourism in this area stimulates the local economy.
 1. This is a good training ground for scientists.
 2. Training today’s children will increase chances of future politicians protecting the area.
 3. It is thought that the best ways to restore degraded ecosystems is with education, awareness, and involvement.

What Can We Do?

Edward O. Wilson’s nine priorities for protecting the world’s ecosystems and species are:

- A. immediately take action to preserve the world’s biological hot spots
- B. keep the world’s remaining frontier forest intake, our last true wilderness areas.
- C. cease all logging of old-growth forests everywhere.
- D. protect and restore the world’s lakes and river systems.
- E. identify the world’s marine hot spots and give them the same priority as land hot spots.
- F. finish mapping the world’s terrestrial and aquatic biodiversity.
- G. ensure that the earth’s terrestrial and aquatic ecosystems be in a global conservation strategy.
- H. make conservation profitable.
- I. start ecological restoration products worldwide to heal damage and increase the share of the earth allotted to the rest of nature. This could be funded by a 1cent tax on a cup of coffee.
- J. Bottom-up political pressure is necessary from every individual citizen and all groups.

Summary

1. Mankind has depleted and degraded much of the earth’s biodiversity. This impact is expected to increase.
2. 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.
3. Forests provide important ecological and economic services, are storehouses of bio-diversity, and affect weather and climate throughout the world. Forest resource management varies according to the type of forests. Some management systems maintain like trees, cut them down, and replants 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 which are so important to us all.
4. Forests in the United States should be managed so as to retain as much of the forests as possible. Logging is an invasive action which undermines the health of any forests so it should be undertaken as carefully 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.
5. 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 have many harmful environmental effects: reduces ecological services of forests, release large amounts of carbon dioxide in the air, produces a drier and hotter climate; reduces the control of water movements and increases soil erosion. We need to reduce the rate of forest loss and degradation and balance the loss by the renewal of forest areas. We need to include the value of forest ecological services in all decisions

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related to forests. And we need to protect the forests that we have from destruction: fires, insect infestations, etc.

6. Tropical deforestation is one of the biggest threats to world economic health and climate. To help sustain tropical forest, nations of the world must unite to discourage deforestation and degradation. Such an effort would slow population growth, decrease/eliminate world poverty, provide environmentally supportive government subsidies, reduce/eliminate debts owed by the developing countries, and place a monetary value on ecological services provided by tropical forests. Other efforts include: practice small-scale sustainable agriculture and forestry; harvest renewable resources from rain forests, such as fruits and nuts; and certify timber that is produced by sustainable methods.
7. Parks’ problems run from little/no protection from their governments to being too small to sustain large animal species, to being too popular and, therefore, being overused by people. Some methods for managing parks include: limiting the number of visitors, raising entry fees to provide funds for maintenance and management; manage parks in reference to nearby federal lands; discourage development around already established parks; provide more volunteers and better paid employees to maintain the parks.
8. 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.
9. Wilderness is an amount of land legally set aside to prevent/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 mental and physical health of visitors, (4) their contributions to biodiversity and to evolutionary possibilities.
10. Ecological restoration is the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems. It is important because mankind has so badly damaged the earth’s ecosystems that we may destroy the earth and ourselves unless we correct and, then, prevent this destruction.
11. To sustain the earth’s biodiversity, we need to:
 - 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 lakes 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

Objectives

1. Differentiate between intrinsic value and instrumental value of biodiversity.
2. Distinguish between old-growth and second-growth forests and give one example of each. Distinguish between a second-growth forest and a tree farm.
3. List five reasons why forests are commercially important. List five reasons forests are ecologically important.

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4. Summarize the range of estimates of rates of tropical deforestation. Explain why there is so much variation among estimates. List five ways that tropical forests touch lives in the temperate zones. Summarize the impact of deforestation on some of the world's indigenous cultures. Describe a plan to protect indigenous peoples.
5. List three factors underlying causes of tropical deforestation. List six human activities which actually destroy the tropical forests. Evaluate Japan's environmental track record. Summarize the fuelwood crisis.
6. List four types of tree harvesting, indicating which type of management they are most likely to be used for.
7. Distinguish among surface fires, crown fires, and ground fires. Summarize threats to forests from fires, pathogens, and air pollution and strategies for dealing with each threat.
8. Distinguish among industrial forestry, "New Forestry," and sustainable forestry. List eight ways to move toward sustainable forestry management. List at least five ways to reform federal forest management. List three ways to reduce demand for wood products. Explain the roles that straw and kenaf can play in reducing demand for wood.
9. List ways to help reduce the interlocking problems of tropical deforestation and the fuelwood crisis. Address scientific data collection, economic strategies, policy-making strategies, cultural strategies, and strategies to reduce demand for fuelwood.
10. Summarize Costa Rica's efforts to protect and restore forests. Evaluate the "debt-for-nature" experiment in Bolivia. Describe one case where individual actions made a difference in helping to reduce forest destruction.
11. Define *wilderness*. Describe a *biosphere reserve*. Summarize the status of the national Wild and Scenic Rivers System and the National Trails System.
12. Explain the advantages and disadvantages of whole ecosystem and species-by-species approaches to increasing sustainability. Explain how gap analysis can be used as a tool to improve conservation efforts.

Key Terms (**Terms are listed in the same font style as they appear in the text.**)

aesthetic value (p. 193)
bequest value (p. 193)
biodiversity (p. 192)
clear-cutting (p. 198)
community forestry (p. 196)
community-based conservation (p. 215)
conservation concession (p. 207)
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