

Sustaining Biodiversity: The Ecosystem Approach

**WHAT ARE THE MAJOR THREATS
TO FOREST ECOSYSTEMS?**

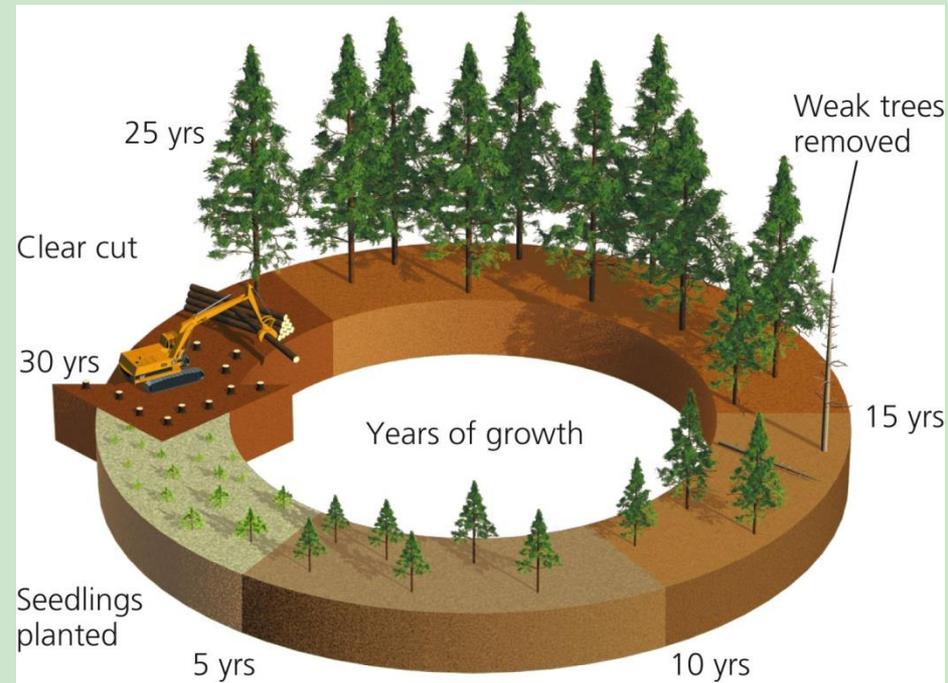
Forests vary in their age, make-up, and origins

- Natural and planted forests occupy about 30% of the earth's land surface (excluding Greenland and Antarctica).
- Two major types based on their age and structure:
 - **Old growth forest:** Uncut or regenerated primary forest that has not been seriously disturbed by human activities or natural disasters for several hundred years or more.
 - **Second-growth forest:** A stand of trees resulting from secondary ecological succession that develops after the trees in an area have been removed by human activities such as clear-cutting for timber or cropland or by natural forces such as fire, hurricanes, or volcanic eruption.

Forests vary in their age, make-up, and origins

- A tree plantation (tree farm, commercial forest), is a managed tract with uniformly aged trees of one or two genetically uniform species that usually are harvested by clear-cutting as soon as they become commercially valuable.
- Forests provide important economic and ecological services.
 - **Forests remove CO₂ from the atmosphere and store it in organic compounds (biomass) through photosynthesis.**
 - **Forests help to stabilize the earth's temperature and slow projected climate change.**

The short rotation cycle of cutting and regrowth of a monoculture tree plantation



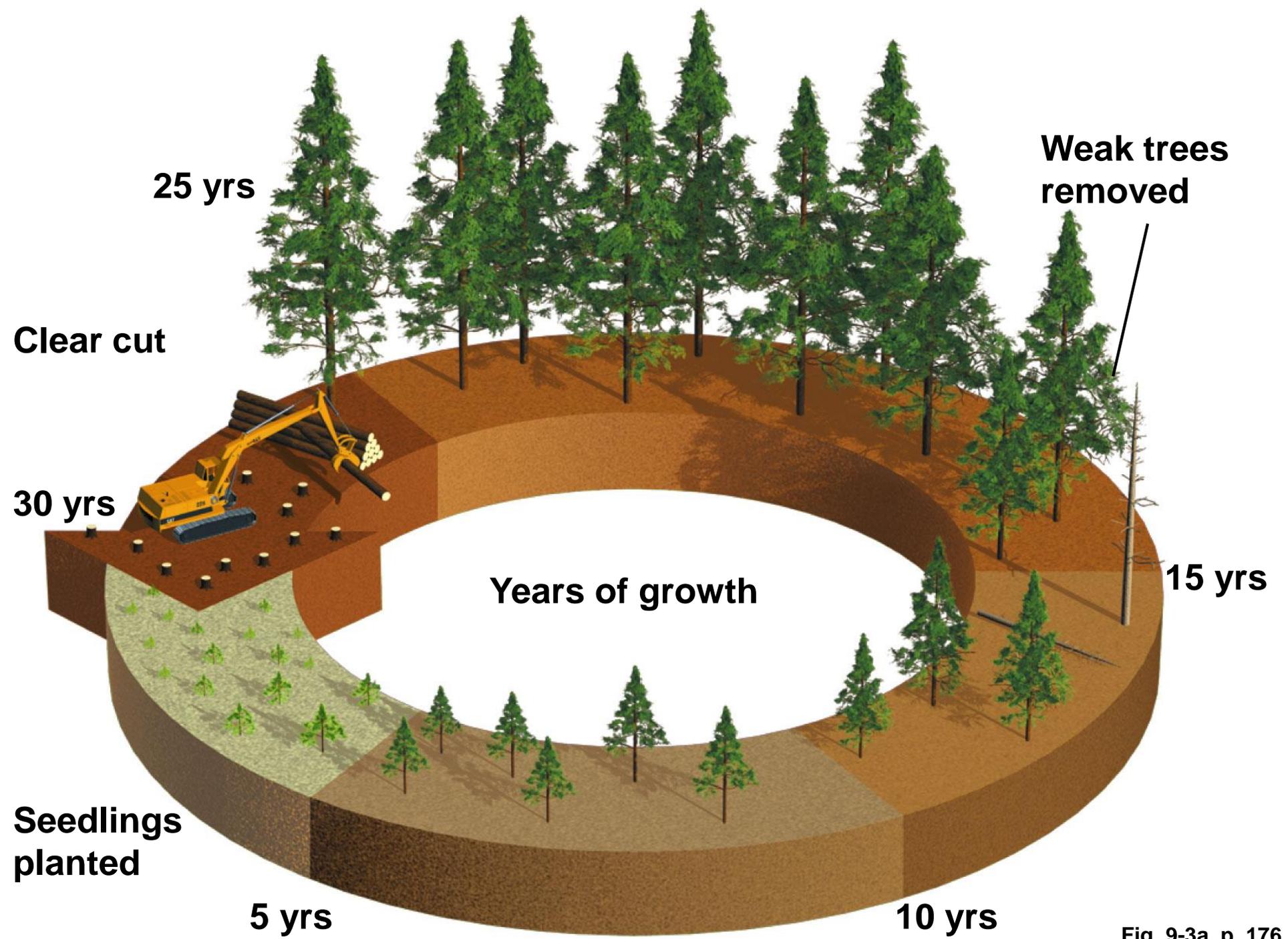


Fig. 9-3a, p. 176

Forests provide many important economic and ecological services

Natural Capital

Forests

Ecological Services

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



Economic Services

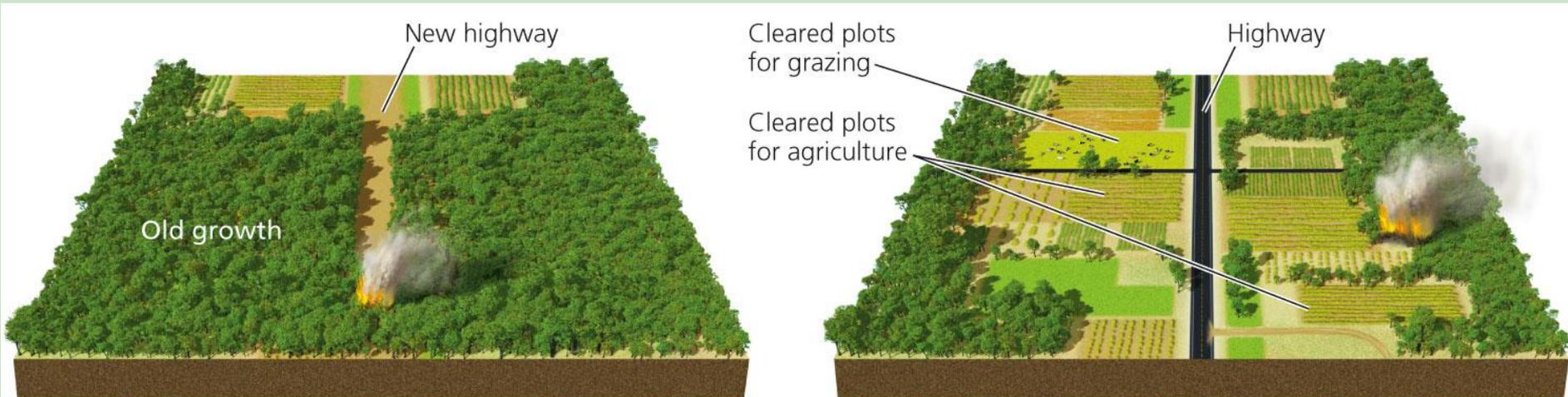
- Fuelwood
- Lumber
- Pulp to make paper
- Mining
- Livestock grazing
- Recreation
- Jobs

Unsustainable logging is a major threat to forest ecosystems

- The first step in harvesting trees is to build roads for access and timber removal, but they can cause the following problems:
 - Increased erosion and sediment runoff into waterways.
 - Habitat fragmentation.
 - Loss of biodiversity.
 - Forest exposure to invasion by nonnative pests, diseases, and wildlife species.

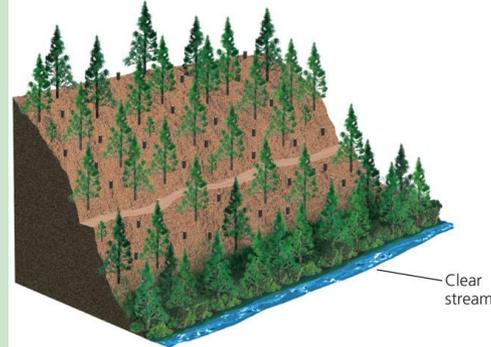
Unsustainable logging is a major threat to forest ecosystems

- Methods of harvesting trees:
 - Selective cutting.
 - Clear-cut.
 - Strip cutting.

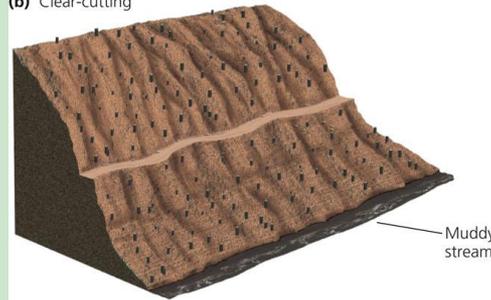


Three major tree harvesting methods

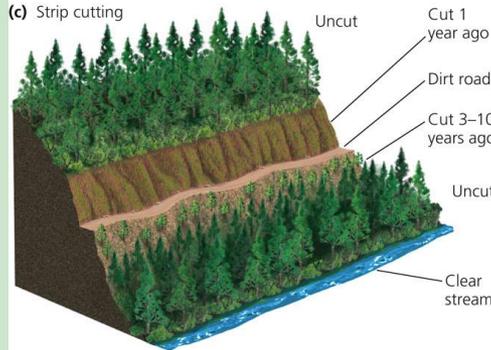
(a) Selective cutting



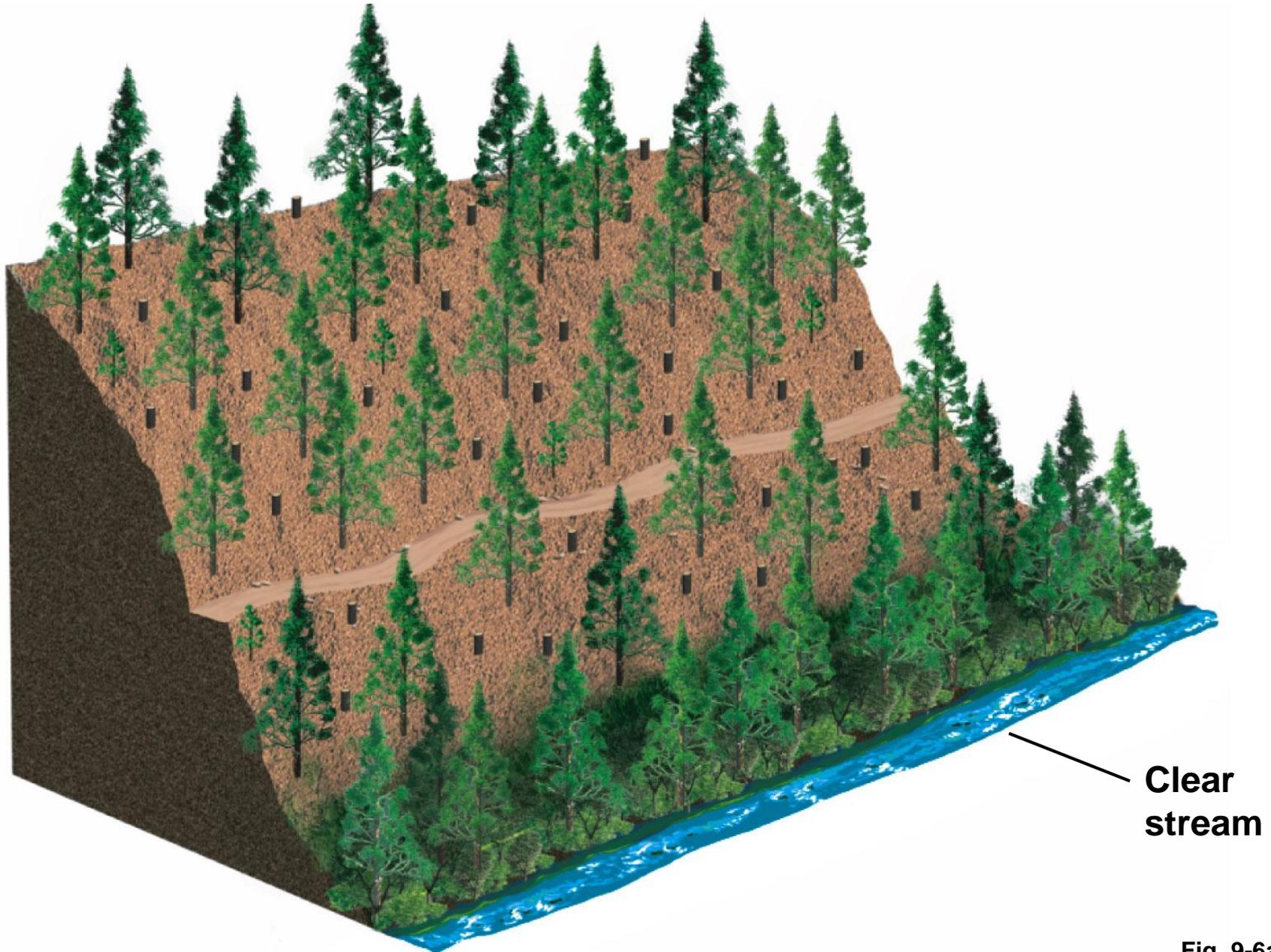
(b) Clear-cutting



(c) Strip cutting



(a) Selective cutting



**Clear
stream**

(b) Clear-cutting



Muddy stream

(c) Strip cutting

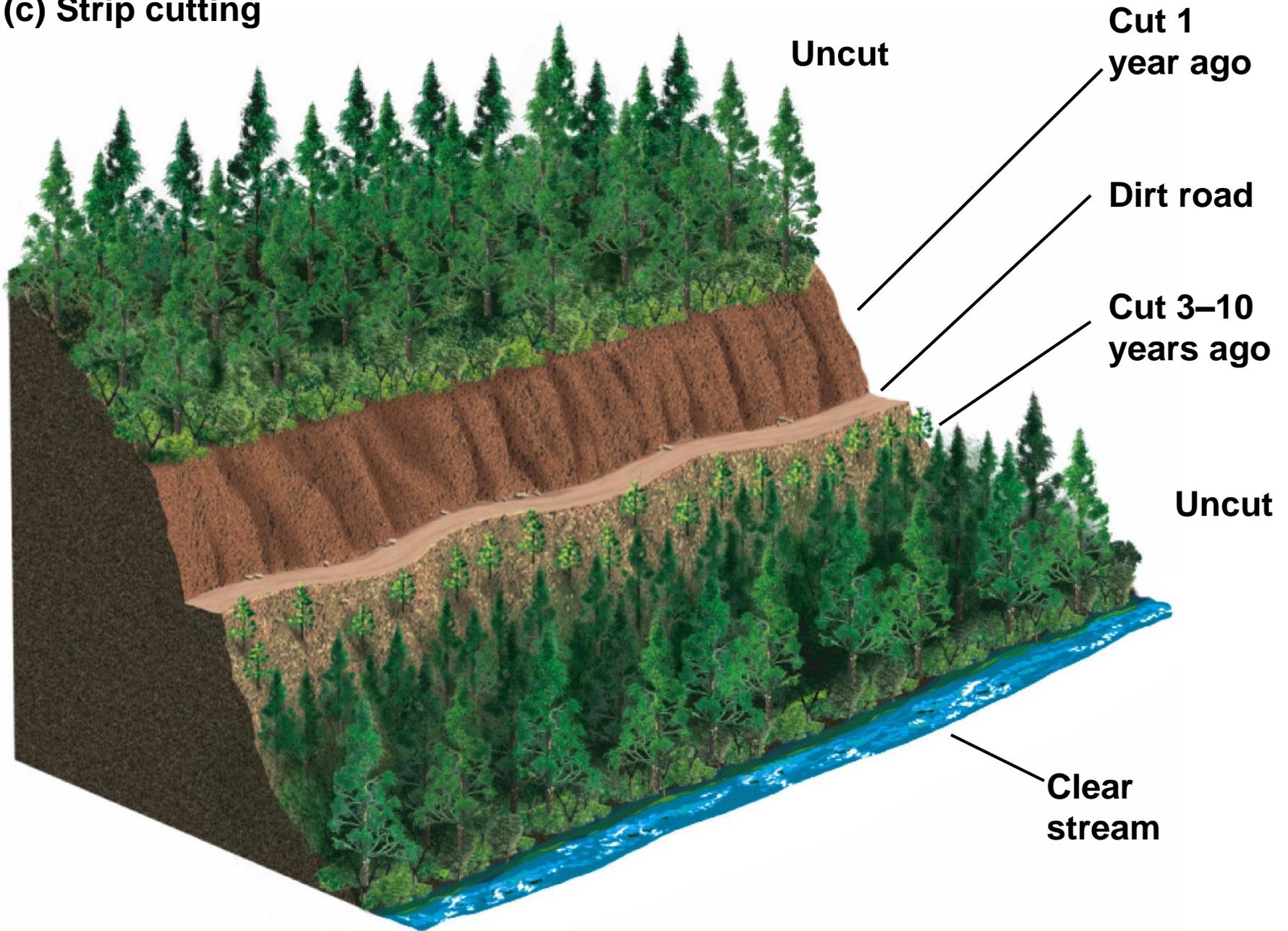


Fig. 9-6c, p. 179

Aerial view showing clear-cut logging, Washington state



Fire can threaten or benefit forest ecosystems

- Surface fires usually burn only undergrowth and leaf litter on the forest floor.
 - Kills seedlings and small trees but spares most mature trees and allows most wild animals to escape.
 - Burns away flammable ground material and may help to prevent more destructive fires.
 - Frees valuable mineral nutrients tied up in slowly decomposing litter and undergrowth.

Fire can threaten or benefit forest ecosystems

- Releases seeds from the cones of lodgepole pines.
- Stimulates the germination of certain tree seeds (e.g. giant sequoia and jack pine).
- Helps to control tree diseases and insects.
- Crown fires are extremely hot fires that leap from treetops, burning whole trees.
 - Can destroy most vegetation, kill wildlife, increase soil erosion, and burn or damage human structures in their paths.

Surface fires and crown fires



Almost half of the world's forests have been cut down

- Deforestation is the temporary or permanent removal of large expanses of forest for agriculture, settlements, or other uses.
- **Human activities have reduced the earth's original forest cover by about 46%**, with most of this loss occurring in the last 60 years.
- If current deforestation rates continue, about **40% of the world's remaining intact forests will have been logged or converted to other uses within two decades**, if not sooner.

Harmful effects of deforestation

Natural Capital Degradation

Deforestation

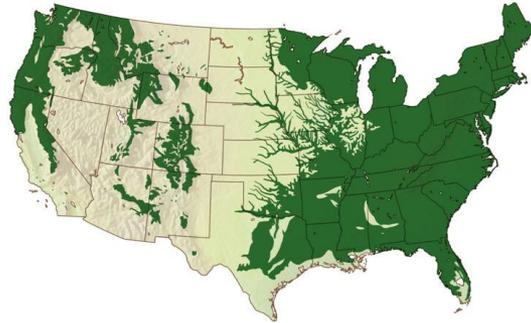
- Decreased soil fertility from erosion
- Runoff of eroded soil into aquatic systems
- Premature extinction of species with specialized niches
- Loss of habitat for native species and migratory species such as birds and butterflies
- Regional climate change from extensive clearing
- Release of CO₂ into atmosphere
- Acceleration of flooding

CASE STUDY: Many Cleared Forests in the United States Have Grown Back

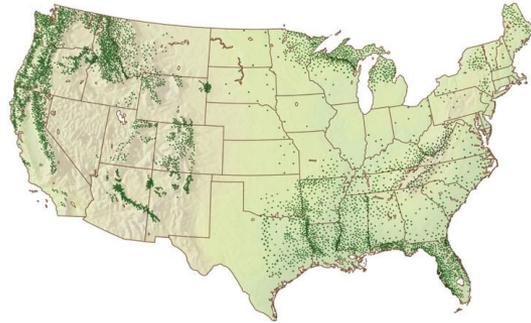
- Forests that cover about **30% of the U.S. land area provide habitats** for more than **80% of the country's wildlife species** and **supply about two-thirds of the nation's surface water**.
- Today, forests in the U.S. cover more area than they did in 1920, primarily due to secondary succession.
- Every year, more wood is grown in the U.S. than is cut and the total area planted with trees increases.
- Protected forests make up about 40%.
- Since the mid-1960s, an increasing area of the nation's remaining old-growth and fairly diverse second-growth forests has been cut down and replaced with biologically simplified tree plantations.

Forest cover in the U.S.

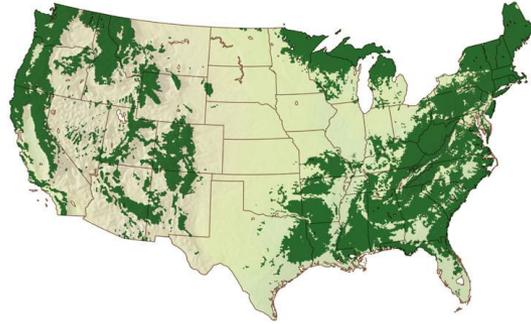
(a) 1620



(b) 1920



(c) 2000



Tropical forests are disappearing rapidly

- Tropical forests cover about 6% of the earth's land area.
- At least half of the world's known species of terrestrial plants and animals live in tropical forests.
- Brazil has more than 30% of the world's remaining tropical rain forest in its vast Amazon basin.
- At the current rate of global deforestation, 50% of the world's remaining old-growth tropical forests will be gone or severely degraded by the end of this century.

Major underlying and direct causes of the destruction and degradation of tropical forests

Natural Capital Degradation

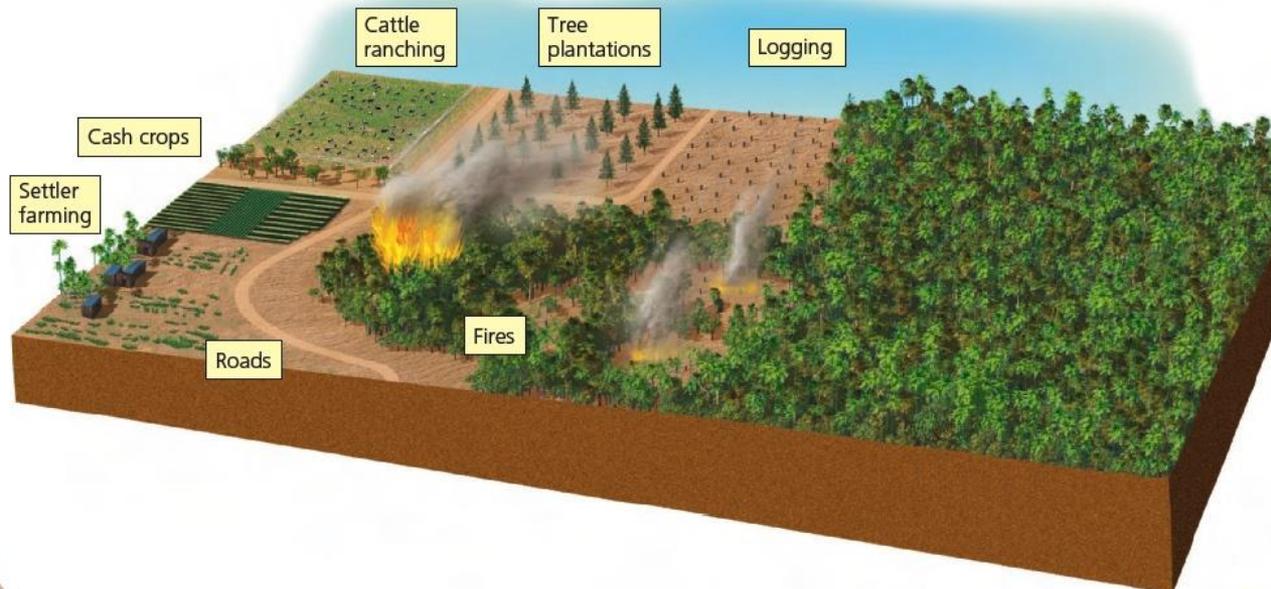
Major Causes of the Destruction and Degradation of Tropical Forests

Underlying Causes

- Not valuing ecological services
- Crop and timber exports
- Government policies
- Poverty
- Population growth

Direct Causes

- Roads
- Fires
- Settler farming
- Cash crops
- Cattle ranching
- Logging
- Tree plantations



Section 9-2

HOW SHOULD WE MANAGE AND SUSTAIN FORESTS?

Ways to grow and harvest trees more sustainably

Solutions

More Sustainable Forestry

- Identify and protect forest areas high in biodiversity
- Rely more on selective cutting and strip cutting
- Stop clear-cutting on steep slopes
- Stop logging in old-growth forests
- Sharply reduce road building in uncut forest areas
- Leave most standing dead trees and fallen timber for wildlife habitat and nutrient cycling
- Put tree plantations only on deforested and degraded land
- Certify timber grown by sustainable methods
- Include ecological services of forests in estimates of their economic value

We can improve the management of forest fires

- In the United States, the Smokey Bear educational campaign has:
 - prevented countless forest fires, saved many lives and prevented billions of dollars in loss of trees, wildlife, and human structures.
 - convinced the public that all forest fires are bad and should be prevented or put out.
- Trying to prevent all forest fires can make matters worse by increasing the likelihood of destructive crown fires due to the accumulation of highly flammable underbrush and smaller trees in some forests.

We can improve the management of forest fires

- Strategies for reducing fire-related harm:
 - Prescribed burns are small, contained surface fires to remove flammable small trees and underbrush in the highest-risk forest areas.
 - Allow some fires on public lands to burn, thereby removing flammable underbrush and smaller trees, as long as the fires do not threaten human structures and life. Protect houses/buildings in fire-prone areas by thinning a zone of about 60 meters (200 feet) around them and eliminating the use of flammable building materials such as wooden shingles.
 - Thin fire-prone areas by clearing small fire-prone trees and underbrush under careful environmental controls.

We can reduce the demand for harvested trees

- Reduce inefficient use of construction materials, excess packaging, overuse of junk mail, inadequate paper recycling, and failure to reuse or find substitutes for wooden shipping containers.
- Paper can be made from fiber that does not come from trees.

Ways to reduce tropical deforestation

- Consumers can reduce the demand for products that are supplied through illegal and unsustainable logging in tropical forests.
 - For building projects, use recycled waste lumber or wood alternatives, such as recycled plastic building materials and bamboo.
 - Reduce the use of throwaway paper products and replace them with reusable plates, cups, and cloth napkins and handkerchiefs.
- Individuals can plant trees.

Ways to protect tropical forests and use them more sustainably

Solutions

Sustaining Tropical Forests

Prevention

Protect the most diverse and endangered areas

Educate settlers about sustainable agriculture and forestry

Subsidize only sustainable forest use

Protect forests through debt-for-nature swaps and conservation concessions

Certify sustainably grown timber

Reduce poverty

Slow population growth



Restoration

Encourage regrowth through secondary succession

Rehabilitate degraded areas

Concentrate farming and ranching in already-cleared areas

Section 9-3

HOW SHOULD WE MANAGE AND SUSTAIN GRASSLANDS?

Some rangelands are overgrazed

- Grasslands provide many important ecological services, **including soil formation, erosion control, nutrient cycling, storage of atmospheric carbon dioxide in biomass, and maintenance of biodiversity.**
- Rangelands are unfenced grasslands in temperate and tropical climates that supply forage, or vegetation, for grazing (grass-eating) and browsing (shrub-eating) animals.

Some rangelands are overgrazed

- Livestock also graze in pastures, which are managed grasslands or enclosed meadows usually planted with domesticated grasses or other forage.
- **Overgrazing occurs when too many animals graze for too long and exceed the carrying capacity of a rangeland area.**
- Limited data from surveys in various countries indicate that overgrazing by livestock has caused a loss in productivity in as much as 20% of the world's rangeland.

Left of fence: overgrazed land
Right: lightly grazed land



We can manage rangelands more sustainably

- **Control the number of grazing animals and the duration of their grazing in a given area** so the carrying capacity of the area is not exceeded.
 - **Rotational grazing**: confine cattle to one area via portable fencing for a short time (1–2 days) and then moved.
 - Provide **supplemental feed** at selected sites and strategically locate water holes and tanks and salt blocks to reduce overgrazing.
 - **Suppress the growth of unwanted invader plants** by use of herbicides, mechanical removal, or controlled burning or use controlled, short-term trampling by large numbers of livestock.

Restoration via secondary ecological succession



Section 9-4

HOW SHOULD WE MANAGE AND SUSTAIN PARKS AND NATURE RESERVES?

National parks face many environmental threats

- More than 1,100 major national parks are located in more than 120 countries.
- Most too small to sustain many large animal species.
- Many parks suffer from invasions by nonnative species that compete with and reduce the populations of native species.
- Some parks are so popular that large numbers of visitors are degrading the natural features that make them attractive.
- Parks in less-developed countries have the greatest biodiversity of all parks, but only about 1% of these parklands are protected.

CASE STUDY: Stresses on U.S. Public Parks

- The U.S. national park system, established in 1912, includes **58 major national parks**, along with 335 monuments and historic sites. States, counties, and cities also operate public parks.
- **Popularity is one of the biggest problems.** Noisy and polluting vehicles degrade the aesthetic experience for many visitors, destroy or damage fragile vegetation, and disturb wildlife.
- Many suffer damage from the migration or deliberate introduction of nonnative species.
- Native species—some of them threatened or endangered—are killed or removed illegally.

Nature reserves occupy only a small part of the earth's land

- As of 2010, less than 13% of the earth's land area was strictly or partially protected in nature reserves, parks, wildlife refuges, wilderness, and other areas.
- No more than 5% of the earth's land is strictly protected from potentially harmful human activities.
- Conservation biologists call for full protection of at least 20% of the earth's land area in a global system of biodiversity.
- Developers and resource extractors oppose protection and contend that these areas might contain valuable resources that would add to current economic growth.

Nature reserves occupy only a small part of the earth's land

- Ecologists and conservation biologists view protected areas as islands of biodiversity and natural capital that help to sustain all life and economies and serve as centers of evolution.
- The buffer zone concept strictly protects an inner core of a reserve and establishes buffer zones in which local people can extract resources sustainably without harming the inner core.
- By 2010, the United Nations had used this principle to create a global network of 553 biosphere reserves in 109 countries.

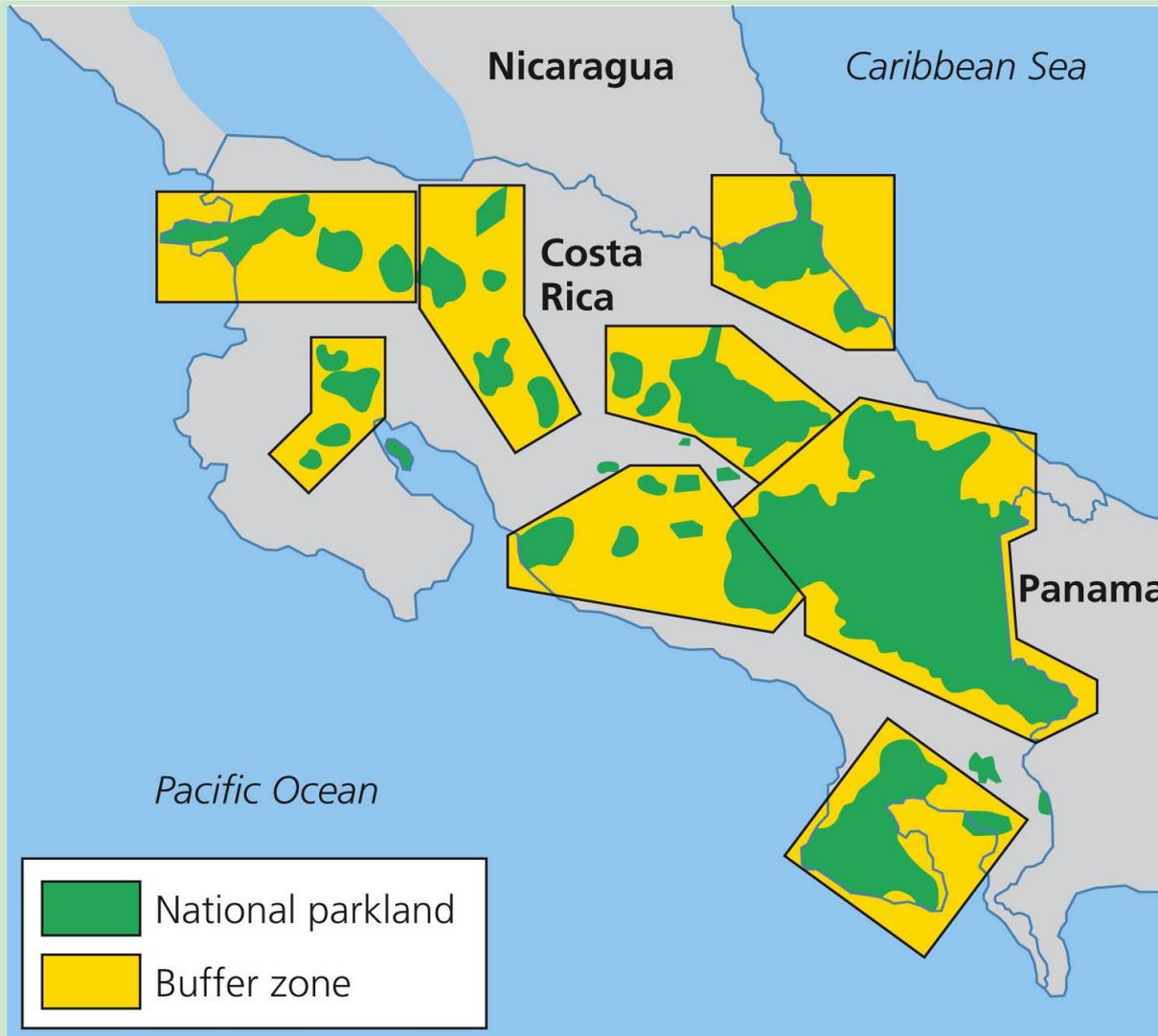
CASE STUDY: Costa Rica—A Global Conservation Leader

- Tropical forests once completely covered Costa Rica, but between 1963 and 1983 much of the country's forests were cleared to graze cattle.
- Costa Rica is a superpower of biodiversity, with an estimated 500,000 plant and animal species.
- Costa Rica now has a system of nature reserves and national parks that, by 2010, included about a quarter of its land.
- Costa Rica now devotes a larger proportion of its land to biodiversity conservation than does any other country

CASE STUDY: Costa Rica—A Global Conservation Leader

- The country's largest source of income is its \$1-billion-a-year tourism industry, almost two-thirds of which involves ecotourism.
- To reduce deforestation, the government has cut subsidies for converting forest to rangeland.
- The government pays landowners to maintain or restore tree cover.
- Between 2007 and 2008, the government planted nearly 14 million trees.
- Went from having one of the world's highest deforestation rates to having one of the lowest.

Costa Rica's eight *megareserves*



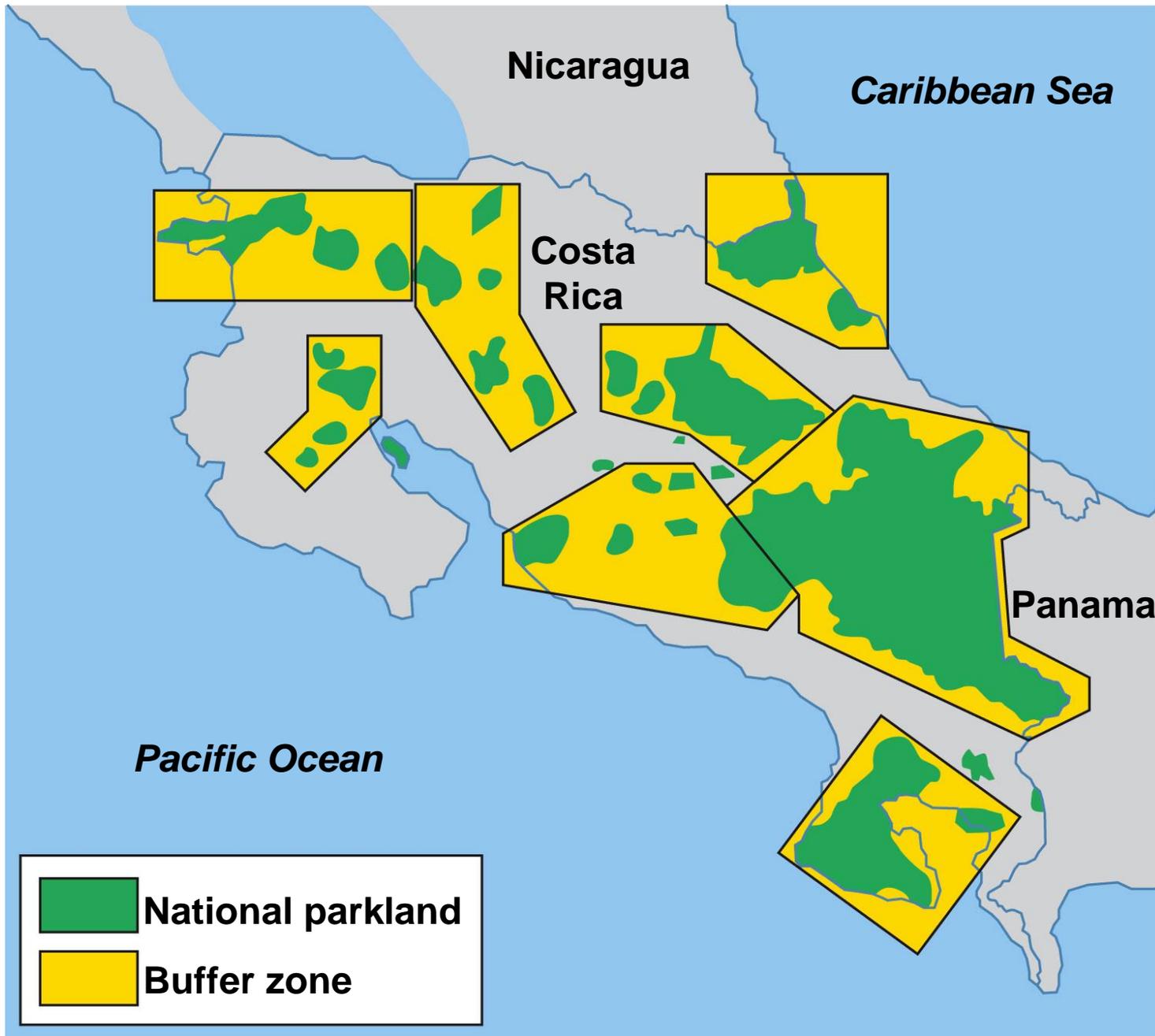


Fig. 9-20, p. 191

Protecting wilderness is an important way to preserve biodiversity

- One way to protect undeveloped lands is to set them aside as wilderness, land officially designated as an area where natural communities have not been seriously disturbed by humans and where human activities are limited by law.
- Some critics oppose protecting large areas for their scenic and recreational value for a relatively small number of people.
- Conservation biologists support protecting wilderness in order to preserve biodiversity and as centers for evolution.

CASE STUDY: Controversy over Wilderness Protection in the United States

- Conservationists have been trying to save wild areas from development since 1900.
- The Wilderness Act (1964) allowed the government to protect undeveloped tracts of public land from development as part of the National Wilderness Preservation System.
- Only about 2% of the land area of the lower 48 states is protected, most of it in the West.

Section 9-5

WHAT IS THE ECOSYSTEM APPROACH TO SUSTAINING BIODIVERSITY?

Here are four ways to protect ecosystems

- Most biologists and wildlife conservationists believe that the best way to keep from hastening the extinction of wild species through human activities is the ecosystems approach, which protects threatened habitats and ecosystem services.

Here are four ways to protect ecosystems

- Four-point plan of the ecosystems approach:
 - Map the world's terrestrial and aquatic ecosystems and create an inventory of the species contained in each of them and the ecosystem services they provide.
 - Locate and protect the most endangered ecosystems and species, with emphasis on protecting plant biodiversity and ecosystem services.
 - Seek to restore as many degraded ecosystems as possible.

Protecting global biodiversity hotspots is an urgent priority

- Some biodiversity scientists urge adoption of an emergency action strategy to identify and quickly protect biodiversity hotspots, areas especially rich in plant species that are found nowhere else and are in great danger of extinction .
- These hotspots cover only a little more than 2% of the earth's land surface, they contain an estimated 50% of the world's flowering plant species and 42% of all terrestrial species.
- These hotspots are home for a large majority of the world's endangered or critically endangered species, and one-fifth of the world's population.

Biodiversity hotspots



We can rehabilitate and restore ecosystems that we have damaged

- Almost every natural place on the earth has been affected or degraded to some degree by human activities.
- We can at least partially reverse much of this harm through ecological restoration: the process of repairing damage caused by humans to the biodiversity and dynamics of natural ecosystems.
- Examples of restoration include:
 - replanting forests

We can rehabilitate and restore ecosystems that we have damaged

- restoring grasslands
- restoring coral reefs
- restoring wetlands and stream banks
- reintroducing native species
- removing invasive species
- freeing river flows by removing dams.

We can rehabilitate and restore ecosystems that we have damaged

- Four steps to speed up repair operations include the following:
 - Restoration.
 - Rehabilitation.
 - Replacement.
 - Creating artificial ecosystems.

We can rehabilitate and restore ecosystems that we have damaged

- Researchers have suggested a science-based, four-step strategy for carrying out most forms of ecological restoration and rehabilitation:
 - Identify the causes of the degradation.
 - Stop the abuse by eliminating or sharply reducing these factors.
 - If necessary, reintroduce key species to help restore natural ecological processes.
 - Protect the area from further degradation and allow secondary ecological succession to occur.

We can share areas we dominate with other species

- Reconciliation ecology is the science that focuses on inventing, establishing, and maintaining new habitats to conserve species diversity in places where people live, work, or play.
- Examples include:
 - Protecting local wildlife and ecosystems can provide economic resources for their communities by encouraging sustainable forms of ecotourism.

We can share areas we dominate with other species

- Protecting vital insect pollinators such as native butterflies and bees by reducing the use of pesticides, planting flowering plants as a source of food for pollinating insect species, and building structures which serve as hives for pollinating bees.
- Protecting bluebirds within human-dominated habitats where most of the bluebirds' nesting trees have been cut down by using nesting boxes and keeping house cats away from nesting bluebirds.

Ways you can help sustain terrestrial biodiversity

What Can You Do?

Sustaining Terrestrial Biodiversity

- Adopt a forest
- Plant trees and take care of them
- Recycle paper and buy recycled paper products
- Buy sustainably produced wood and wood products
- Choose wood substitutes such as bamboo furniture and recycled plastic outdoor furniture, decking, and fencing
- Help to restore a nearby degraded forest or grassland
- Landscape your yard with a diversity of plants that are native to your area