



Sustaining Terrestrial Biodiversity: The Ecosystem Approach

Chapter Overview

Questions

- ★ How have human activities affected the earth's biodiversity?
- ★ How should forest resources be used, managed, and sustained globally and in the United States?
- ★ How serious is tropical deforestation, and how can we help sustain tropical forests?
- ★ How should rangeland resources be used, managed, and sustained?



Chapter Overview

Questions (cont'd)

- ★ What problems do parks face, and how should we manage them?
- ★ How should we establish, design, protect, and manage terrestrial nature reserves?
- ★ What is wilderness, and why is it important?
- ★ What is ecological restoration, and why is it important?
- ★ What can we do to help sustain the earth's terrestrial biodiversity?

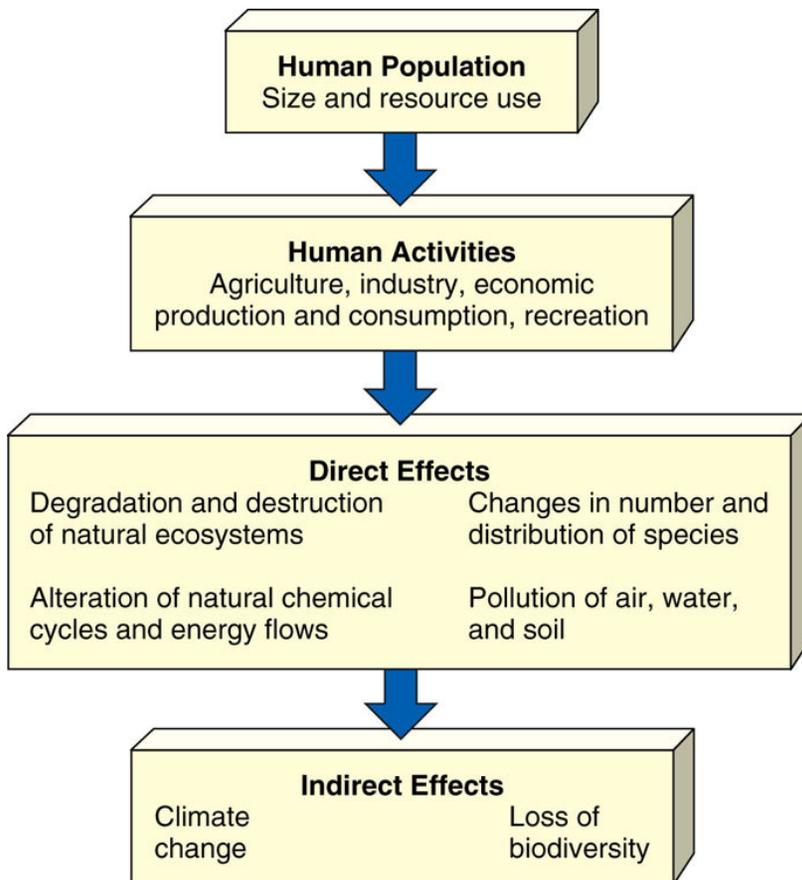


National Geographic Videos

- ★ National Geographic Channel Videos:
Man's Impact



HUMAN IMPACTS ON TERRESTRIAL BIODIVERSITY



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- ✦ We have depleted and degraded some of the earth's biodiversity and these threats are expected to increase.

Figure 10-2

MANAGING AND SUSTAINING FORESTS

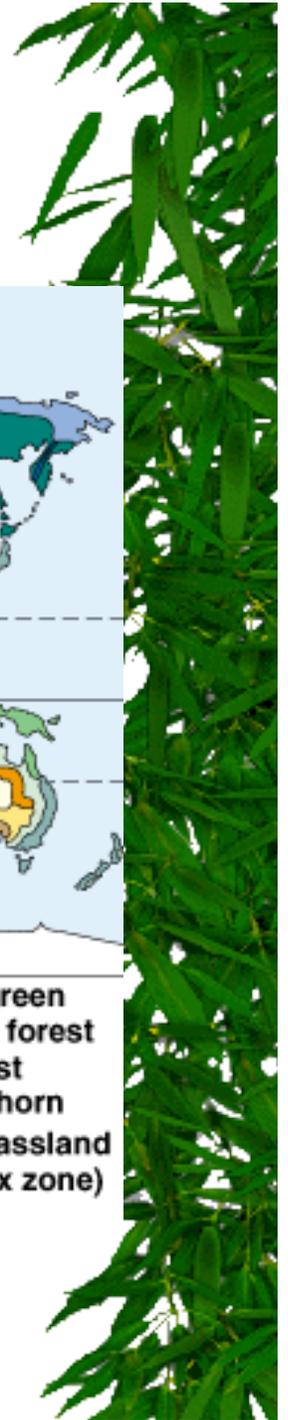
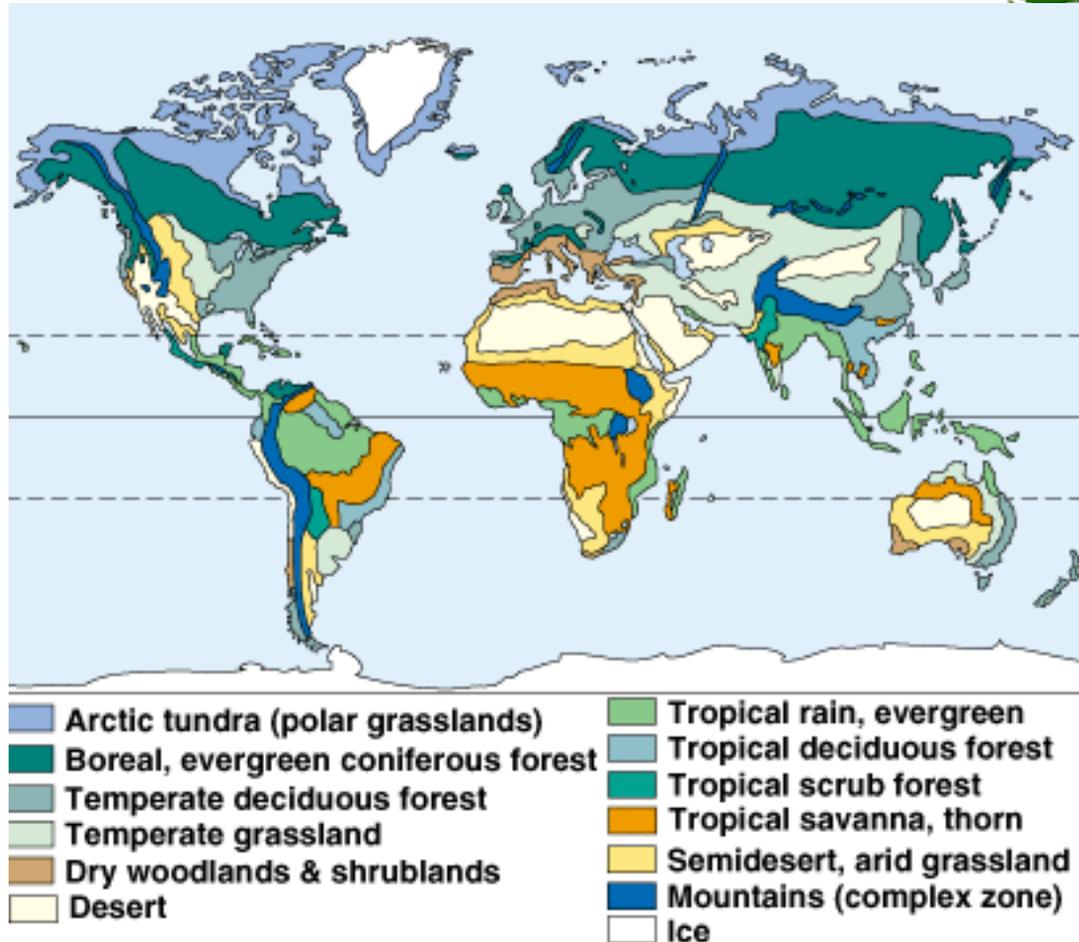


- ★ Forests provide a number of ecological and economic services that researchers have attempted to estimate their total monetary value.

FORESTS

• More 50% of forests are in the tropics. The rest are in temperate and boreal zones.

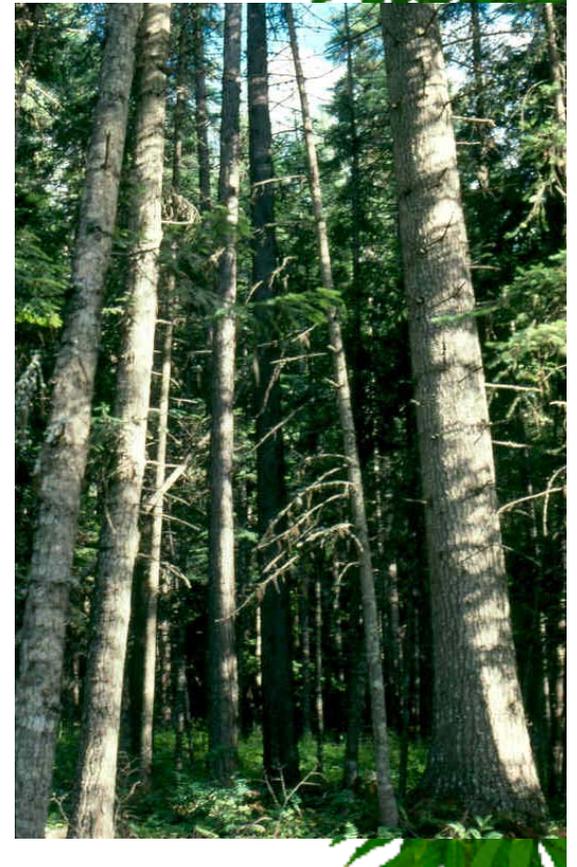
• More than 60% of all forests are in seven countries: Brazil, Russia, Canada, the U.S., China, Indonesia, and Congo.



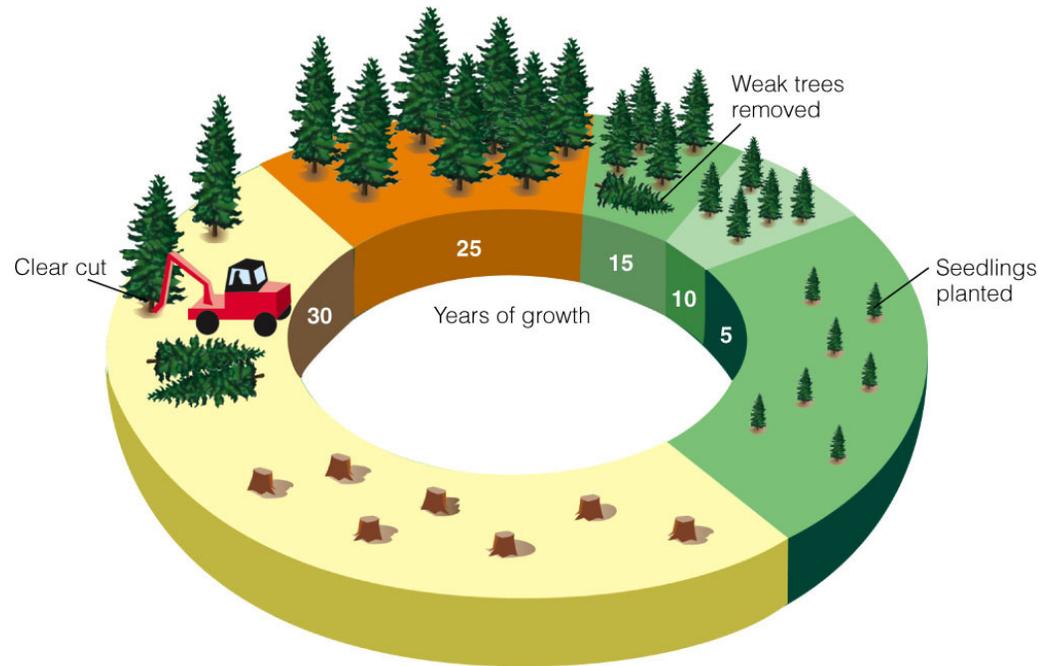
Old-Growth Forests

Old-growth forests are uncut and regenerated forests that have not been seriously disturbed for several hundred or thousands of years.

- temperate examples: forests of Douglas fir, western hemlock, giant sequoia, and coastal redwoods
- niches for species;
- **22% of the world's forests**
- Most in the world are found in the Amazon
- Most in the US are found in Alaska



Types of Forests



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- ★ **Second-growth forest:** a stand of trees resulting from natural secondary succession.
- ★ **Tree plantation:** planted stands of a particular tree species.

Figure 10-6



Second-Growth Forests

- * Stands of trees resulting from secondary ecological succession. Result from human activities (clear cutting, farming) and natural activities (fires, hurricane, volcanic eruptions).
- * **63% of the world's forests**



Tree Farms

- ★ Managed area of uniformly aged trees of one species.
- ★ Harvested by clear cutting as soon as they are commercially valuable.
- ★ **5% of world's forests.**



Management of Forests

* Even-aged

-1-2 fast growing species planted and harvested every 6-10 years

* Uneven-aged

- variety of species, different ages and sizes.
- promotes multiple uses of the forest- timber harvesting, wildlife habitat, recreation.



Harvesting Timber

- ★ Goal should be to remove timber with minimal damage to ecosystem.
- ★ Building roads (for logging trucks), exposes forests to: soil erosion, invasive species, habitat fragmentation, disease, etc.
- ★ Types of harvesting → next slide(s)

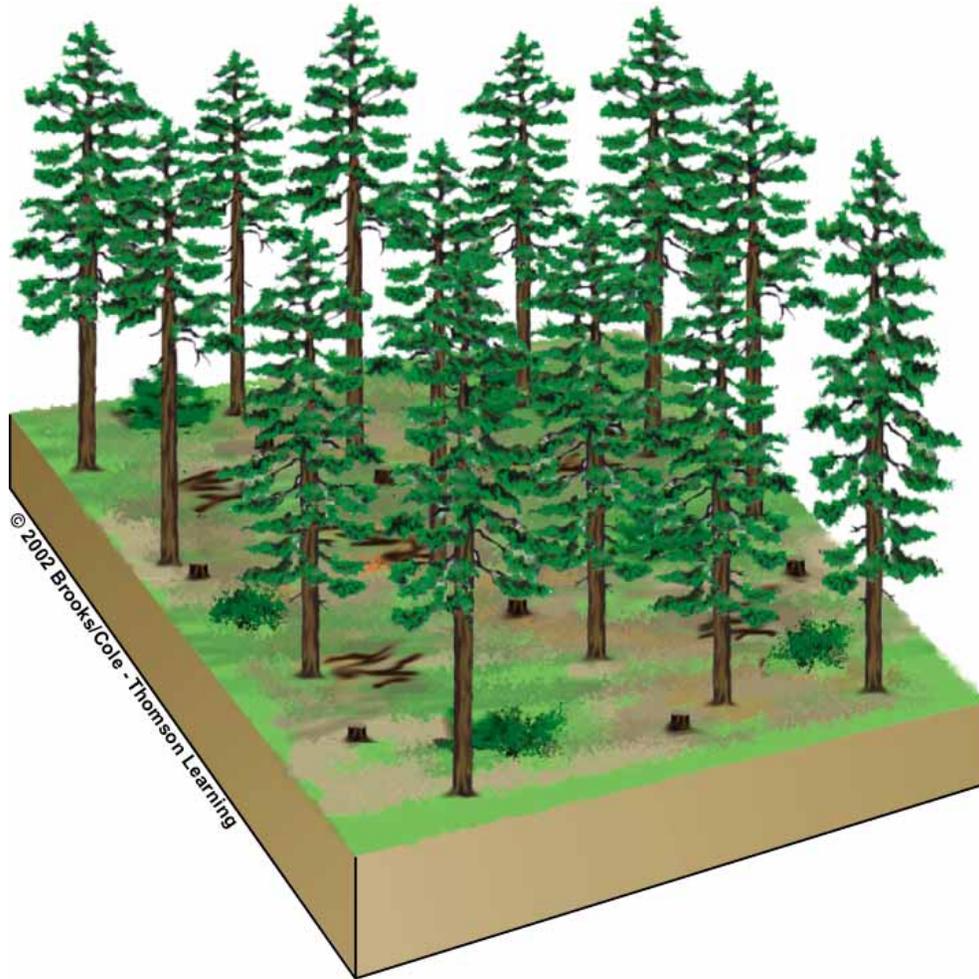


Selective Cutting

- ★ Intermediate-aged or mature trees in an uneven-aged forest are cut singly or in small groups.
 - Reduces overcrowding
 - Encourages growth of younger trees
 - Allow natural regeneration from surrounding trees
 - Protects site from soil erosion
 - Allows forest to be used for multiple purposes



1. Selective cutting

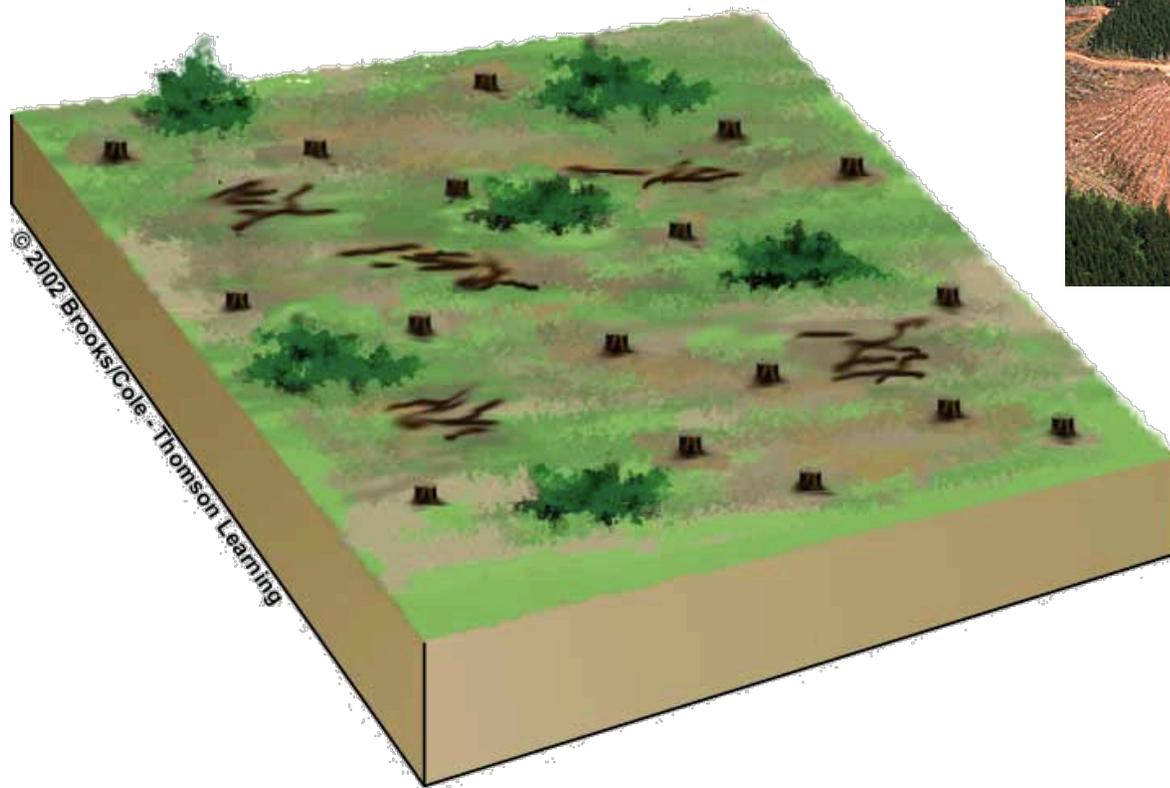


Clear-Cutting

- ★ Removes all trees from an area in a single cutting.
 - Leaves moderate to large forest openings
 - Eliminates most recreational value for several decades,
 - Reduces biodiversity, disrupts ecosystem processes, and destroys and fragments some wildlife habitats
 - Leads to severe soil erosion, sediment water pollution and flooding when done on steep slopes



4. Clear Cutting



Trade-Offs

Clear-Cutting Forests

Advantages

Disadvantages

Higher timber yields

Maximum profits in shortest time

Can reforest with fast-growing trees

Short time to establish new stand of trees

Needs less skill and planning

Good for tree species needing full or moderate sunlight



Reduces biodiversity

Disrupts ecosystem processes

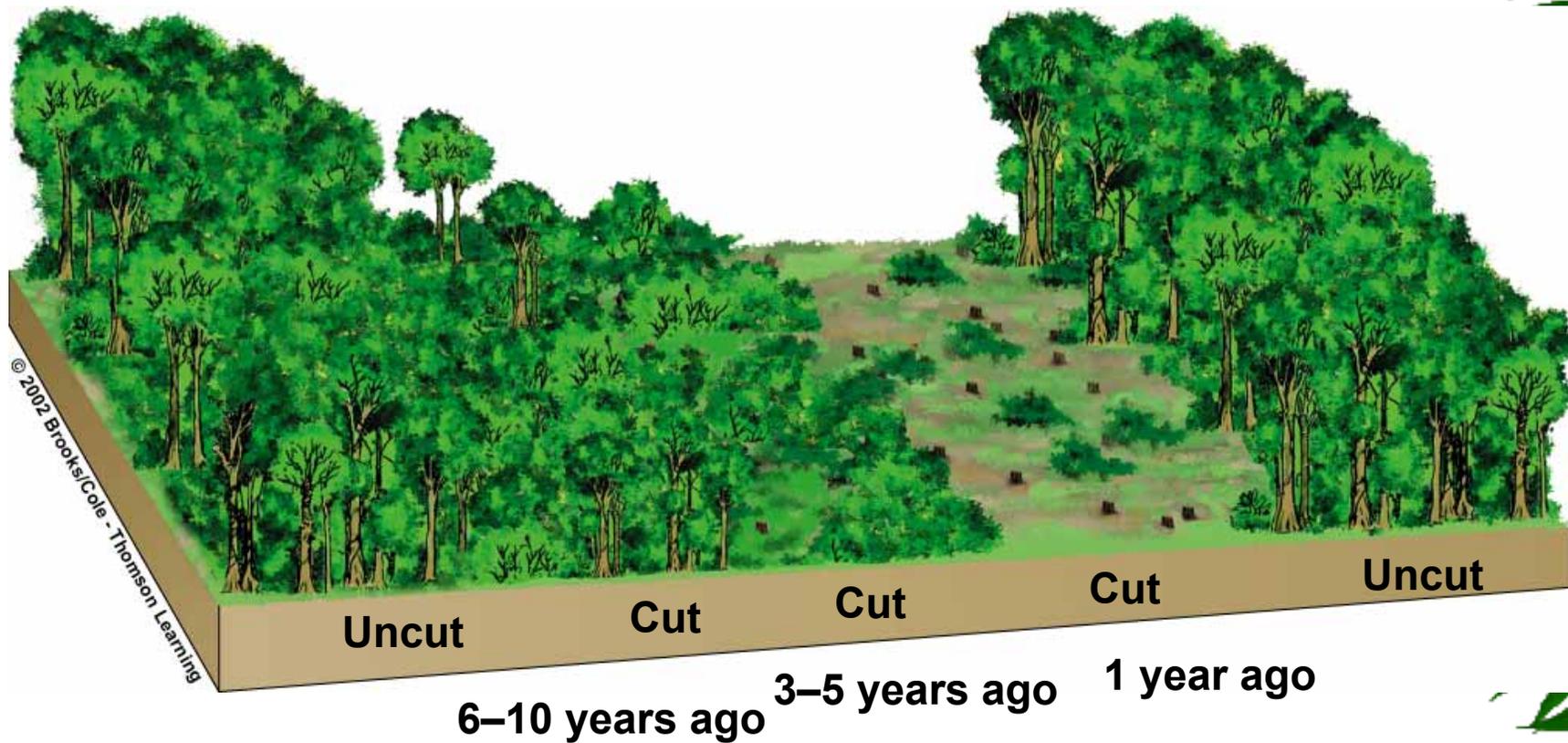
Destroys and fragments wildlife habitats

Leaves large openings

Increases water pollution, flooding, and erosion on steep slopes

Eliminates most recreational value

5. Strip Cutting



Strip Cutting



Strip cutting to regenerate exposure-prone tree species. (<http://cfs.nrcan.gc.ca/news/650>)



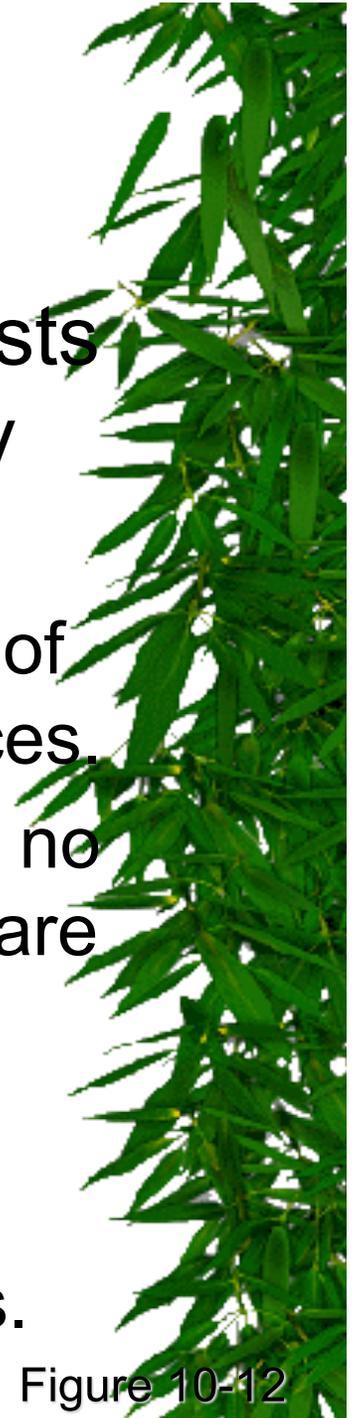
Solutions

Solutions

Sustainable Forestry

- Identify and protect forest areas high in biodiversity
- Grow more timber on long rotations
- Rely more on selective cutting and strip cutting
- Stop clear-cutting on steep slopes
- Cease logging of old-growth forests
- Prohibit fragmentation of remaining large blocks of forest
- Sharply reduce road building into uncut forest areas
- Leave most standing dead trees and fallen timber for wildlife habitat and nutrient recycling
- Certify timber grown by sustainable methods
- Include ecological services of forests in estimating their economic value
- Plant tree plantations on deforested and degraded land
- Shift government subsidies from harvesting trees to planting trees

- ★ We can use forests more sustainably by emphasizing:
 - Economic value of ecological services.
 - Harvesting trees no faster than they are replenished.
 - Protecting old-growth and vulnerable areas.



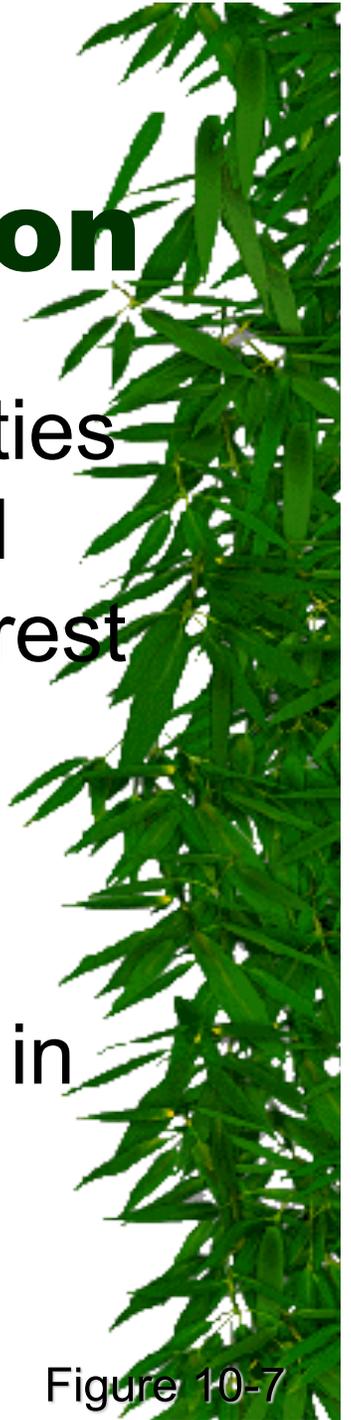
Global Outlook: Extent of Deforestation

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

- ★ Human activities have reduced the earth's forest cover by as much as half.
- ★ Losses are concentrated in developing countries.



Deforestation

- ★ Temporary or permanent removal of forest for agricultural purposes or other uses.
- ★ Research has shown it takes 200 years for new forests to accumulate the same amount of carbon that old growth forests had.
- ★ If current rate of deforestation continues- world's remaining forests will be gone in 10-20 years.
- ★ Good news- some re-growth is occurring in North America and Europe



Case Study: Deforestation and the Fuelwood Crisis

- ★ Almost half the people in the developing world face a shortage of fuelwood and charcoal.
 - In Haiti, 98% of country is deforested.
 - MIT scientist has found a way to make charcoal from spent sugarcane.



Natural Capital Degradation

Deforestation

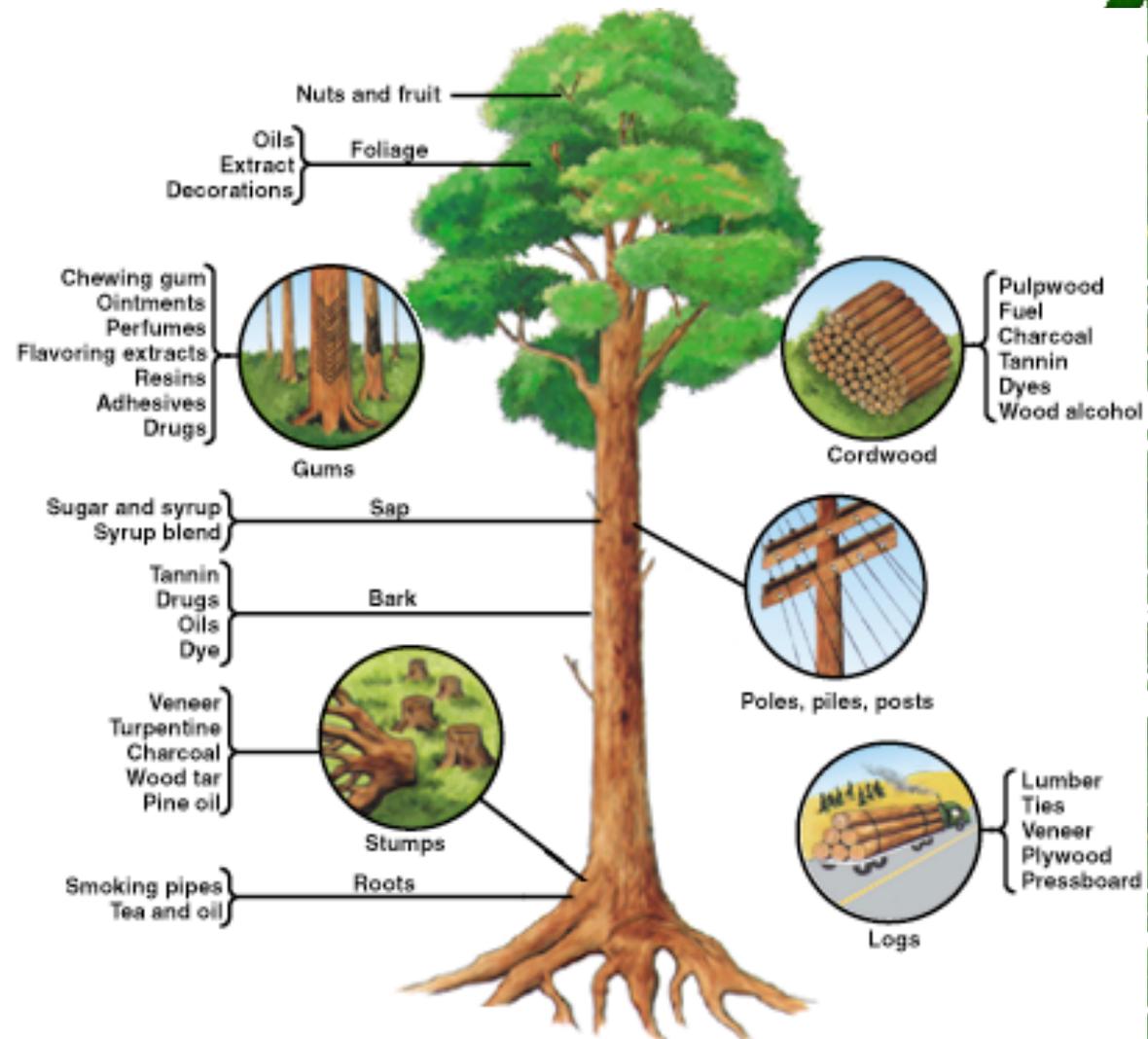
- **Decreased soil fertility from erosion**
- **Runoff of eroded soil into aquatic systems**
- **Premature extinction of species with specialized niches**
- **Loss of habitat for migratory species such as birds and butterflies**
- **Regional climate change from extensive clearing**
- **Releases CO₂ into atmosphere from burning and tree decay**
- **Accelerates flooding**



Economic Importance of Forests

Some of the many useful products obtained from trees.

Forests produce more than \$300 billion in economic products each year.



Ecological Importance of Forests

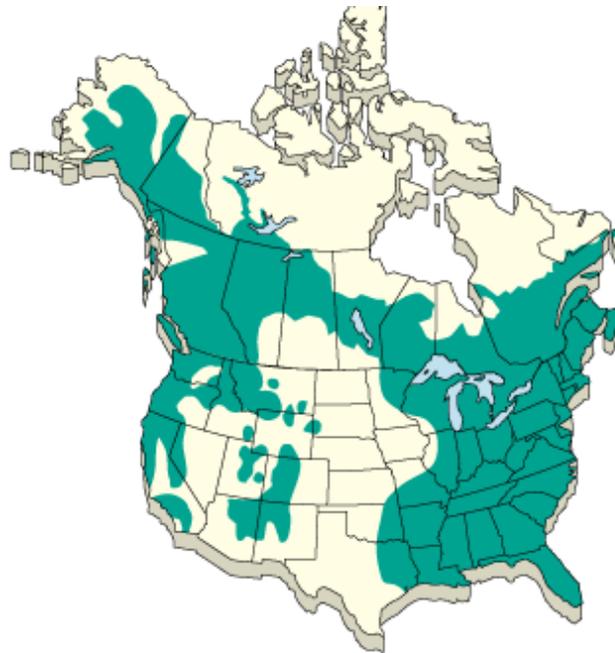
Forests play a various important ecological roles:

- **regulate the flow of water**
slow runoff, provide continual recharge of groundwater and streams, reduce soil erosion and stream sediments
- **influence climate**
increase local precipitation and lower local temperatures
- **vital to carbon cycle**
take up 90% of carbon fixed by terrestrial ecosystems
- **provide wildlife habitat**
- according to one calculation, a typical tree provides \$196,250 worth of ecological benefits in its lifetime
oxygen, air purification, soil fertility and erosion control, water recycling and humidity control, wildlife habitat

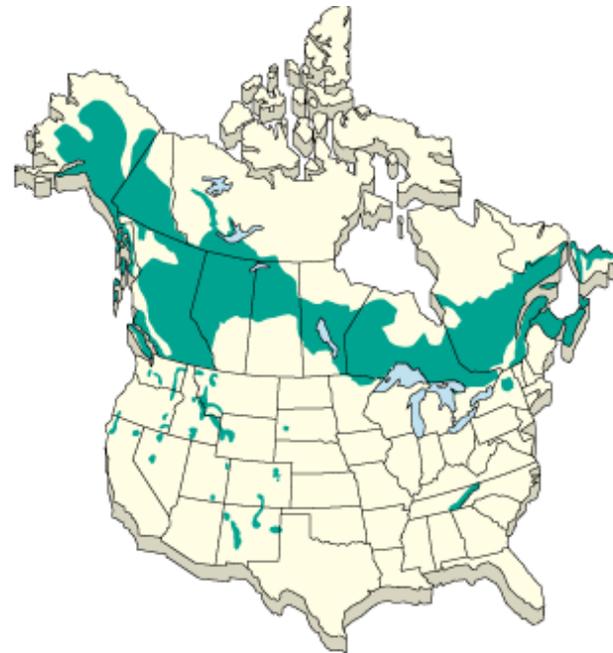


Temperate Deforestation

Since 1600 most of the **old-growth forests** in the lower 48 states have been cleared. **Second-growth forests** grow as the result of secondary succession after forests are cut.



Virgin forests, circa 1600



Virgin forests, 1993



Status of U.S. Temperate Forests

Today U.S. forests generally bigger and often healthier than in 1900.

- due to reversion of marginal farmlands to forests, planting of tree farms, more efficient use of wood products, recycling, and substitutes for wood products;
- since 1950 total volume of timber increased 50%;
- 85–95% of U.S. old–growth forests cleared;
- most remaining old–growth forests are in fragmented areas of the northwest.



Types and Effects of Forest Fires



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- ★ Depending on their intensity, fires can benefit or harm forests.
 - Burn away flammable ground material.
 - Release valuable mineral nutrients.

Figure 10-13

Solutions: Controversy Over Fire Management

- ★ To reduce fire damage:
 - Set controlled surface fires.
 - Allow fires to burn on public lands if they don't threaten life and property.
 - Clear small areas around property subject to fire.



Solutions: Controversy Over Fire Management

- ★ In 2003, U.S. Congress passed the *Healthy Forest Restoration Act*:
 - Allows timber companies to cut medium and large trees in 71% of the national forests.
 - In return, must clear away smaller, more fire-prone trees and underbrush.
 - Some forest scientists believe this could increase severe fires by removing fire resistant trees and leaving highly flammable slash.



Controversy over Logging in U.S. National Forests



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★ There has been an ongoing debate over whether U.S. national forests should be primarily for:

- Timber.
- Ecological services.
- Recreation.
- Mix of these uses.

Figure 10-14

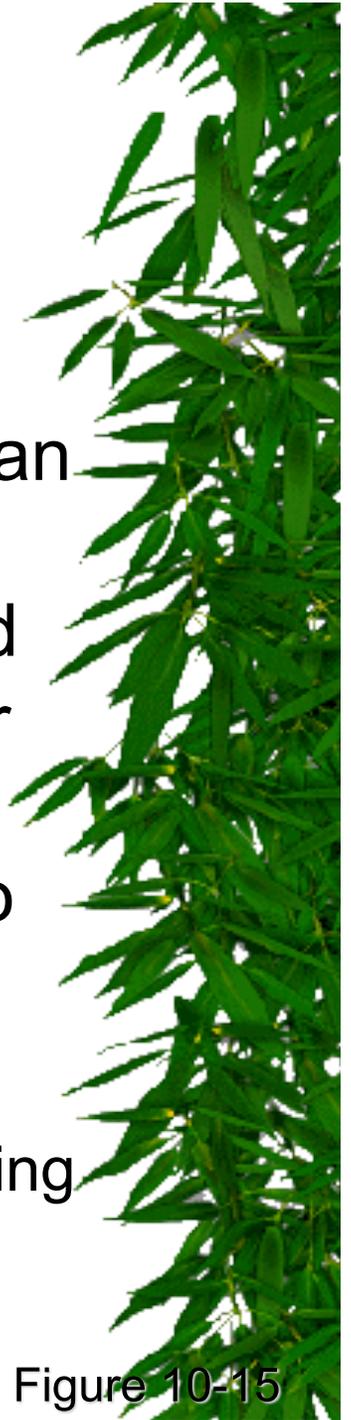
Solutions: Reducing Demand for Harvest Trees



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- ★ Tree harvesting can be reduced by wasting less wood and making paper and charcoal fuel from fibers that do not come from trees.
 - Kenaf is a promising plant for paper production.

Figure 10-15



Tropical Deforestation

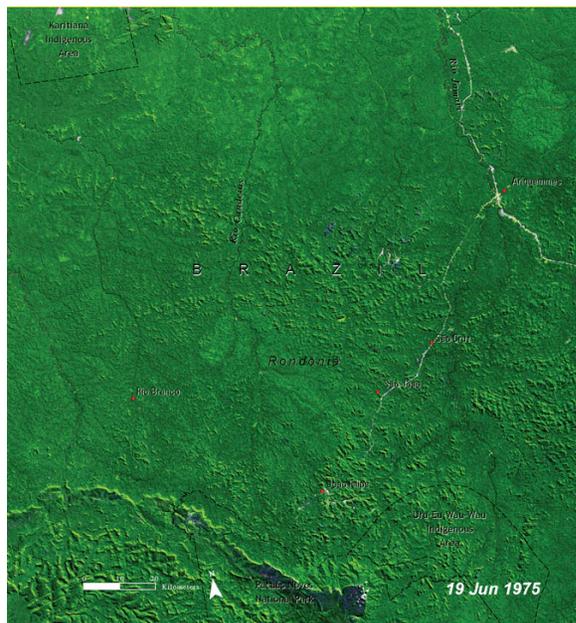
Tropical forests cover about 6% of Earth's land area and contain grow...

- Four countries contain more than half of tropical forest: Brazil, Indonesia, Democratic Republic of the Congo, and Peru;
- High biodiversity: tropical forests contain 50–90% of Earth's terrestrial species;
- Economic products: half annual harvest of hardwoods, food (coffee, tea, spices, nuts, chocolate, fruits...), medicines, latex rubber, resins, dyes, essential oils;
- Home and source of resources for indigenous peoples.



Tropical Deforestation

Building roads into previously inaccessible areas leads to forest fragmentation, destruction, and degradation.



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Why Should We Care about the Loss of Tropical Forests?



Rauwolfia
Rauwolfia serpentina,
Southeast Asia
Tranquilizer, high
blood pressure
medication



Foxglove
Digitalis purpurea,
Europe
Digitalis for heart failure



Pacific yew
Taxus brevifolia,
Pacific Northwest
Ovarian cancer



Cinchona
Cinchona ledgeriana,
South America
Quinine for malaria treatment



Rosy periwinkle
Catharanthus roseus,
Madagascar
Hodgkin's disease,
lymphocytic leukemia



Neem tree
Azadirachta indica,
India
Treatment of many
diseases, insecticide,
spermicide

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- ★ About 2,100 of the 3,000 plants identified by the National Cancer Institute as sources of cancer-fighting chemicals come from tropical forests.

Figure 10-18

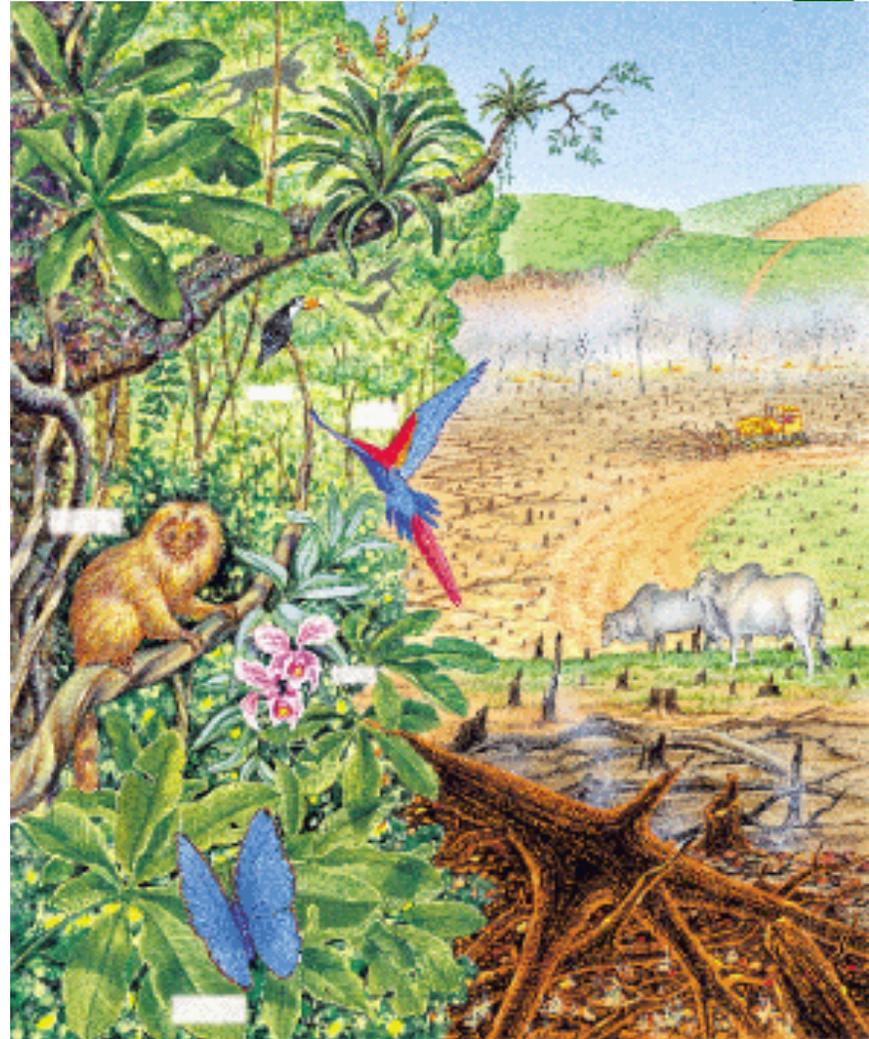
Causes of Tropical Deforestation

Primary Causes:

- population growth;
- poverty;
- exploitive government policies;
- exports to developed countries;
- failure to include ecological services in evaluation of forest resources.

Secondary Causes:

- roads, logging, mining;
- unsustainable peasant farming;
- cash crops, tree plantations;
- cattle ranching
- flooding from dams
- oil drilling
- fuelwood



Managing Forests

Some ways to improve federal forest management in the United States:

- institute policy that makes sustaining biodiversity a high priority;
- full-cost accounting of ecological services provided by forests;
- prohibit logging of at least half of remaining old-growth forests;
- reduce or ban timber harvest from National Forests and fund lands from recreational user fees;
- reduce building of new roads in national forests;
- require that timber be sold at costs that include road building, site preparation, and site regeneration;
- do not use money from timber sales to supplement the Forest Service budget;
- eliminate loopholes in current ban on exporting timber from public lands;
- provide increased aid and job retraining for displaced workers.



Strategies For Managing Forests

Some ways to decrease tropical deforestation:

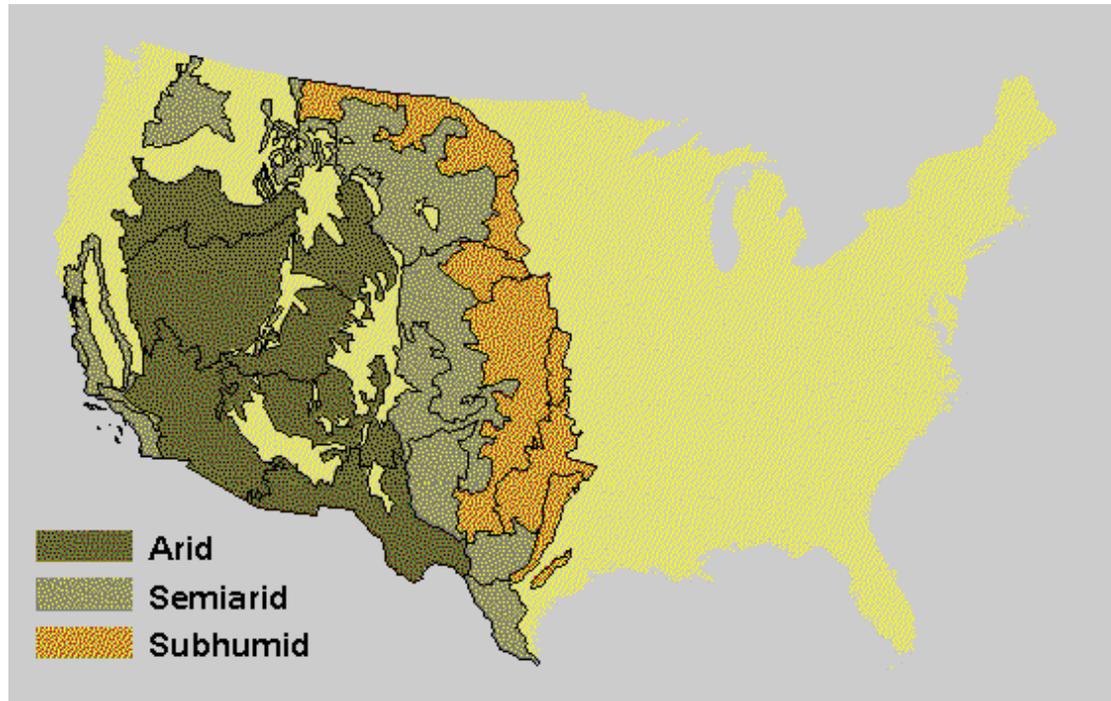
- **ecotourism**: promoting tourism that benefits from the aesthetic, education, and recreational opportunities provided by intact forest;
- **debt-for-nature swaps**: forgiving foreign debt in exchange for preserving forest;
- **extractive reserves**: sustainable harvest of forest products such as nuts, fruits, herbs, spices, oils, medicines, and latex-rubber;
- **decreasing the fuelwood crisis**: planting fast-growing fuelwood trees and shrubs, burning wood more efficiently, and switching to other fuels.



MANAGING AND SUSTAINING GRASSLANDS

- ★ Almost half of the world's livestock graze on natural grasslands (rangelands) and managed grasslands (pastures).
- ★ We can sustain rangeland productivity by controlling the number and distribution of livestock and by restoring degraded rangeland.





Rangelands in NV



CA annual rangeland



How should rangelands be managed?

- ★ Rangelands: grasslands that supply food for grazing animals
 - Found in temperate and tropical climates
- ★ Have a deep, complex system of roots
 - Help anchor the plants
 - Plants grow from roots, not tips, so can be grazed without killing the plant
- ★ Moderate levels of grazing are healthy for the plants
 - Removes mature vegetation and stimulates growth



MANAGING AND SUSTAINING GRASSLANDS



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- ★ Overgrazing (left) occurs when too many animals graze for too long and exceed carrying capacity of a grassland area.

Figure 10-21

What are the effects of overgrazing?

- * Occurs when too many animals exceed carrying capacity of rangeland
- * Effects:
 - Lowers NPP of vegetation
 - Reduces grass cover
 - Causes desertification when combined with prolonged drought
 - Exposes soil to erosion
 - Causes soil compaction
 - Enhances invasion of woody shrubs (mesquite and prickly pear cactus)
 - Limits livestock production



How can rangelands be managed more sustainably?

- * Control number and distribution of livestock
 - Difficult, because livestock concentration of riparian zones
 - Has damaged about 80% of stream and riparian ecosystems in US
 - Can fence off riparian zones and place supplemental feed, salt blocks and water holes strategically
- * Restore degraded rangeland
 - Replant barren areas with native grass seeds
 - * Very expensive



MANAGING AND SUSTAINING GRASSLANDS



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- ★ Example of restored area along the San Pedro River in Arizona after 10 years of banning grazing and off-road vehicles.

Figure 10-22

NATIONAL PARKS

- ★ Countries have established more than 1,100 national parks, but most are threatened by human activities.
 - Local people invade park for wood, cropland, and other natural resources.
 - Loggers, miners, and wildlife poachers also deplete natural resources.
 - Many are too small to sustain large-animal species.
 - Many suffer from invasive species.



Solutions

National Parks

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

★ Suggestions for sustaining and expanding the national park system in the U.S.



Figure 10-24

NATURE RESERVES

- ★ Ecologists call for protecting more land to help sustain biodiversity, but powerful economic and political interests oppose doing this.
 - Currently 12% of earth's land area is protected.
 - Only 5% is strictly protected from harmful human activities.
 - Conservation biologists call for full protection of at least 20% of earth's land area representing multiple examples of all biomes.



NATURE RESERVES

- ★ Large and medium-sized reserves with buffer zones help protect biodiversity and can be connected by corridors.
- ★ Costa Rica has consolidated its parks and reserves into 8 megareserves designed to sustain 80% of its biodiversity.



Figure 10-10B

NATURE RESERVES

- ★ Wilderness is land legally set aside in a large enough area to prevent or minimize harm from human activities.
- ★ Only a small percentage of the land area of the United States has been protected as wilderness.



ECOLOGICAL RESTORATION

- ★ **Restoration**: trying to return to a condition as similar as possible to original state.
- ★ **Rehabilitation**: attempting to turn a degraded ecosystem back to being functional.
- ★ **Replacement**: replacing a degraded ecosystem with another type of ecosystem.
- ★ **Creating artificial ecosystems**: such as artificial wetlands for flood reduction and sewage treatment.



ECOLOGICAL RESTORATION

- ★ Five basic science-based principles for ecological restoration:
 - Identify cause.
 - Stop abuse by eliminating or sharply reducing factors.
 - Reintroduce species if necessary.
 - Protect area from further degradation.
 - Use adaptive management to monitor efforts, assess successes, and modify strategies.



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 sustainable wood and wood products.**
- **Choose wood substitutes such as bamboo furniture and recycled plastic outdoor furniture, decking, and fencing.**
- **Restore a nearby degraded forest or grassland.**
- **Landscape your yard with a diversity of plants natural to the area.**
- **Live in town because suburban sprawl reduces biodiversity.**

