

Chapter 10

Sustaining Terrestrial Biodiversity: The Ecosystem Approach



Forests Provide Valuable Natural Capital

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

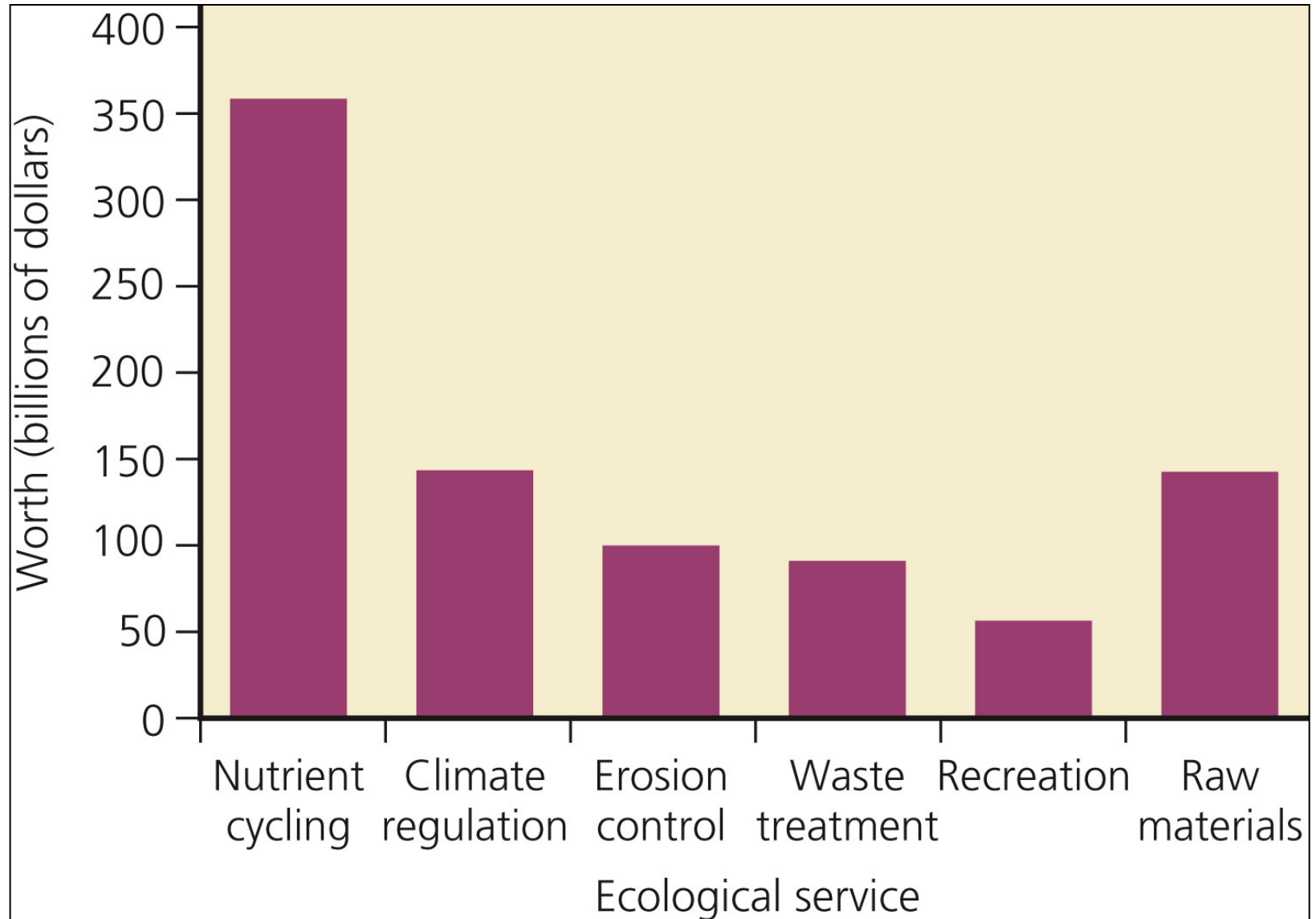
Mining

Livestock grazing

Recreation

Jobs

Estimated Annual Global Economic Values of Ecological Services Provided by Forests



Forest Ecosystems

Old-growth or primary forest (36%)

- uncut or regenerated forest that has not been seriously disturbed by human activity for several hundred years or more.
- They are biodiversity storehouses due to their varied habitat and niches for so many species.
- Five countries with largest area of old growth forests: Russia, Canada, Brazil, Indonesia, Papua New Guinea.



Second-growth forest (60%)

- Forest ecosystem resulting from secondary ecological succession
- Forests of the eastern United States decimated between 1620 and 1920;
- Grew back naturally through secondary ecological succession in the eastern states



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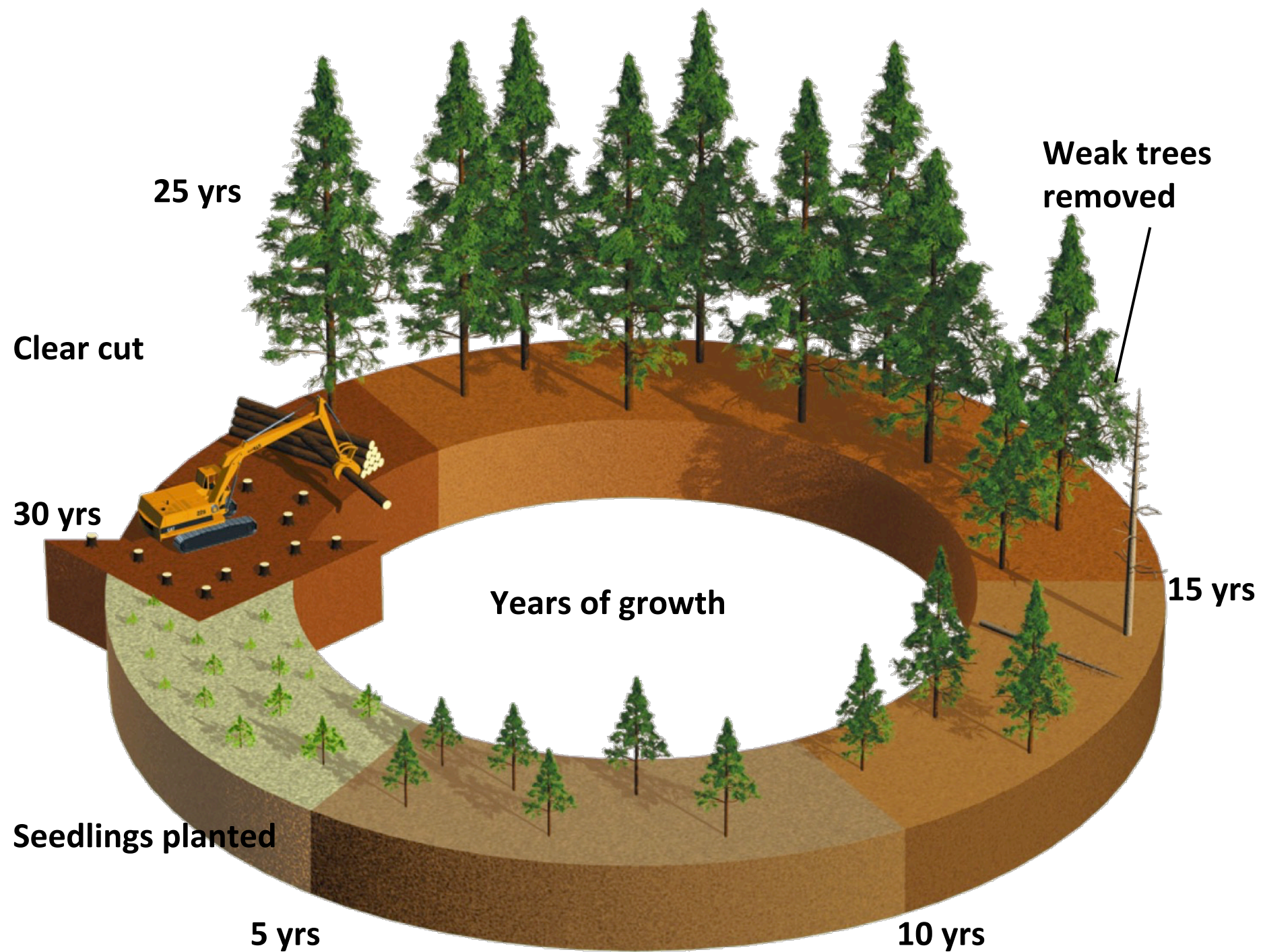
Forest Ecosystems

Tree plantation, (tree farm, commercial forest) (4%)

In a commercial forest, the aim is to get the most possible timber, fuel, pulp-wood etc. Maintained by either through planting or natural reproduction or both.

- Often managed with multiple tracts with uniformly aged trees that are harvested in intervals and then replanted. (5%)
- Biologically simplified tree plantations reduce biodiversity and deplete nutrients from soil





Implications of Clearing Forests: Environmental Degradation

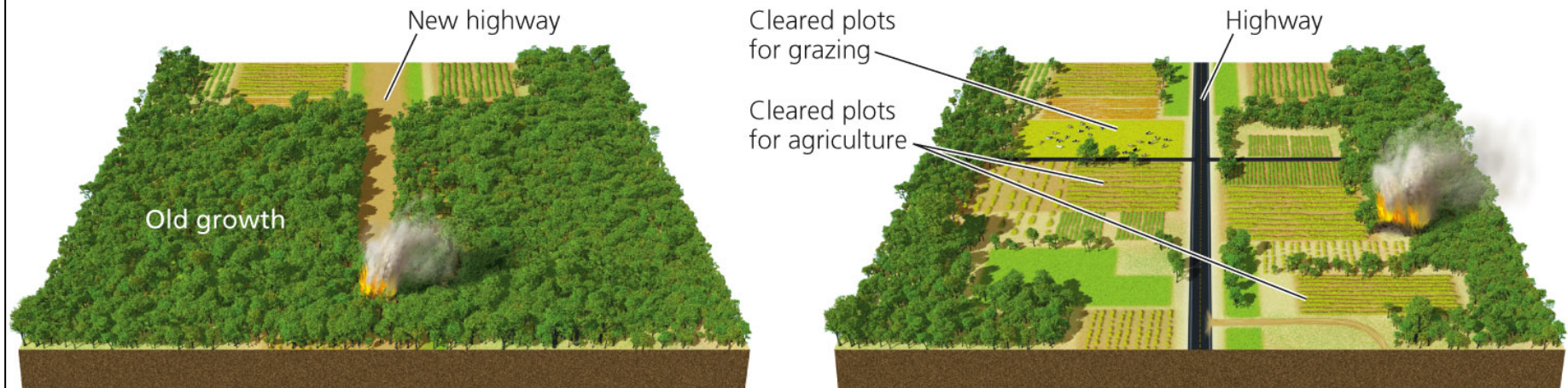
Any tree harvest technique has harmful environmental effects:

- Increased erosion results in sediment runoff into waterways
 - nutrient loss affecting biogeochemical cycles
 - Increases turbidity of water reduces photosynthesis (primary productivity)

Building roads into previously inaccessible forests results in:

- Habitat fragmentation & Loss of biodiversity

Plus, roads and disturbance facilitate invasion by: nonnative pests/
invasive species & disease

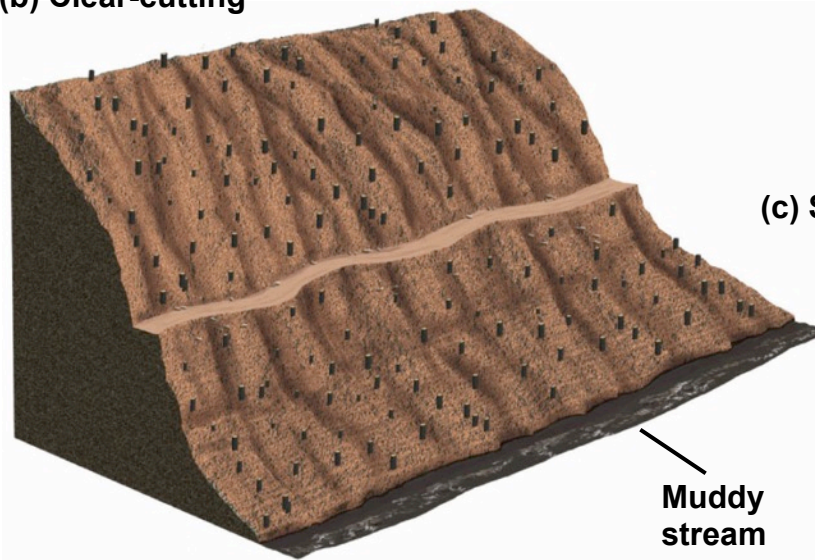


Forestry: Logging & Tree Harvesting Practices

Major Tree Harvesting Methods

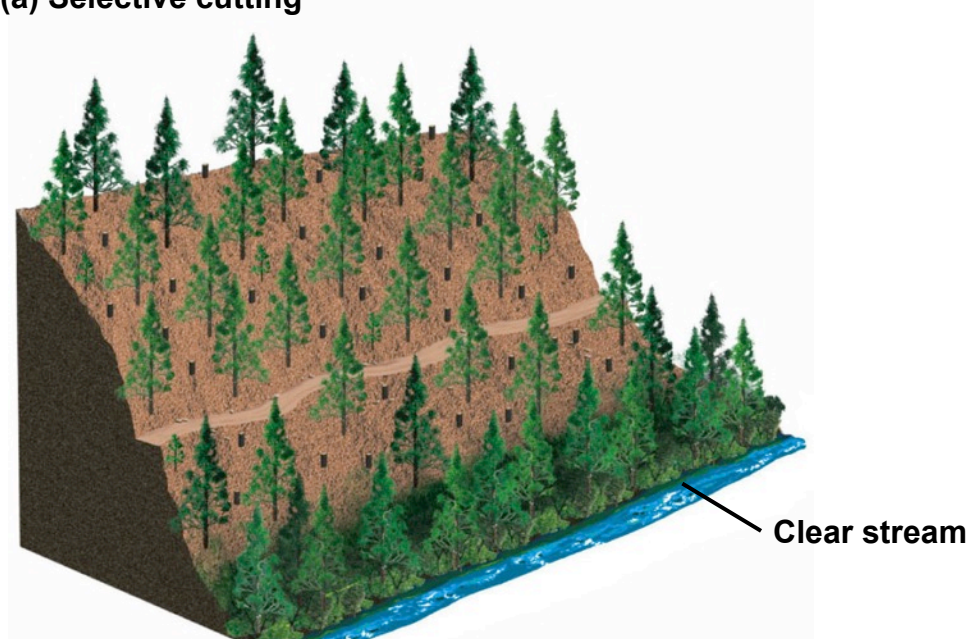
- Selective cutting
- Clear-cutting
- Strip cutting

(b) Clear-cutting

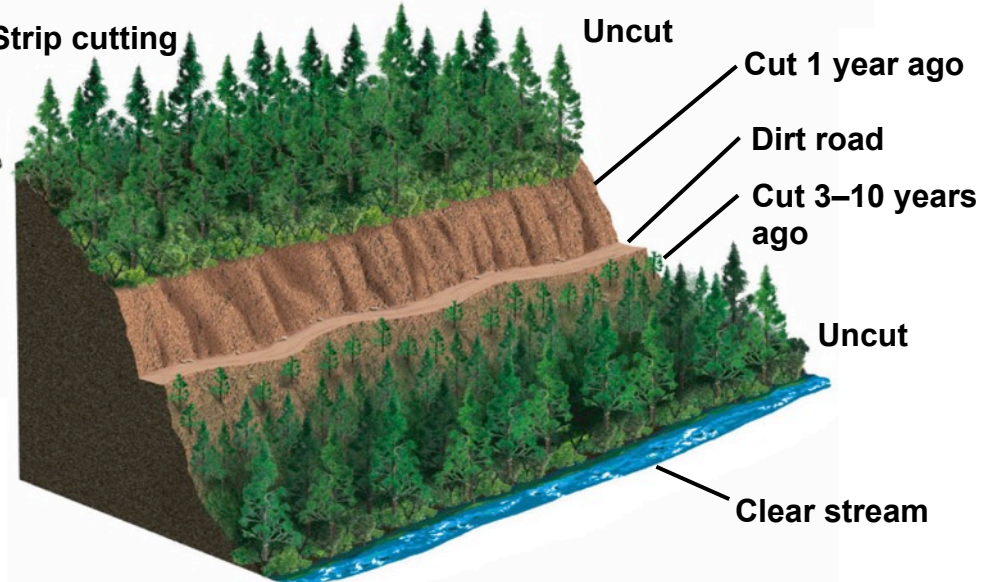


© Brooks/Cole, Cengage Learning

(a) Selective cutting



(c) Strip cutting



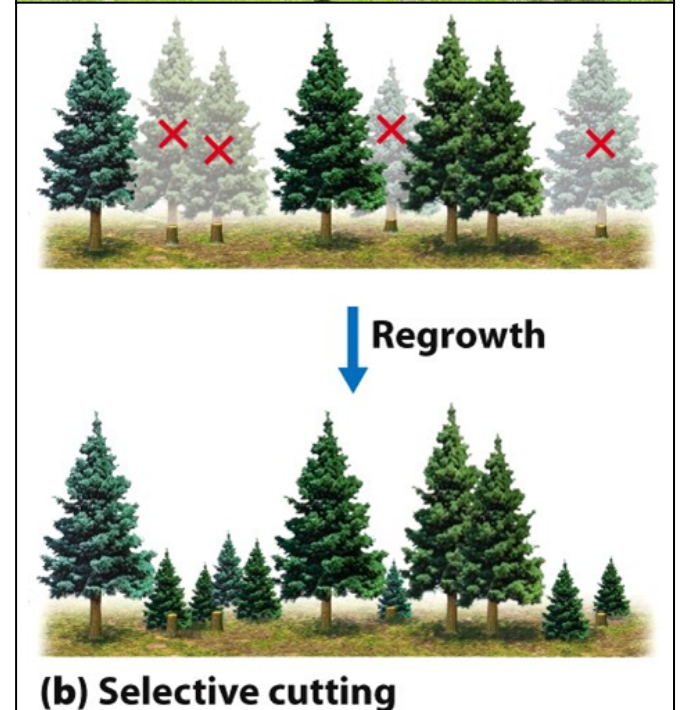
Forestry: Logging & Tree Harvesting Practices

Major Tree Harvesting Methods

Selective Cutting

Intermediate-aged or mature trees are cut singly or in groups in uneven aged forest.

- Reduces crowding, removes diseased trees, encourages new growth and provides trees of all ages for multiple use
- Soil retains water and nutrients
- Habitat remains generally intact can recover reasonable quickly
- Preserves biodiversity, to an extent; compared to clear-cutting



Forestry: Logging & Tree Harvesting Practices

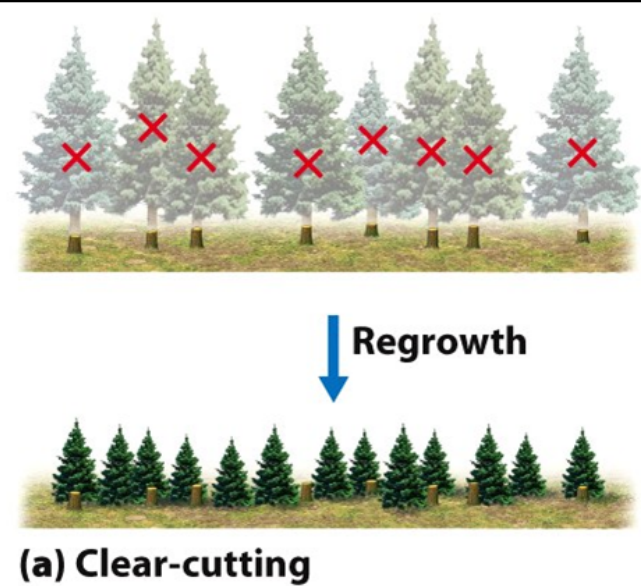
Major Tree Harvesting Methods

Clear Cutting

All trees in an area are uniformly cut down. Foresters often prefer this method because it allows for regeneration and abundance of sun-loving trees in large in even-age stands; over long period of time (min. 50 years).

However, immediate environmental implications are catastrophic:

- Habitat fragmentation; destruction/loss of habitat; & reduction in biodiversity
- Erosion resulting in loss of topsoil and nutrients inhibiting regrowth of groundcover
- Resulting in large water loss and surface run-off, water pollution (nutrient loading & turbidity)
- Opens opportunity for establishment of non-native/pests grasses



Forestry: Logging & Tree Harvesting Practices



After a century of clear-cutting, this forest, near the source of the Lewis and Clark River in Clatsop County, Oregon, is a patchwork. In each patch, most of the trees are the same age.



Clear-cutting near Eugene, Oregon



Clear-cutting near Eureka, CA

Clear-Cutting Forests: Trade-Offs

Advantages

Higher timber yields

Maximum profits in shortest time

Can reforest with fast-growing trees

Good for tree species needing full or moderate sunlight



Disadvantages

Reduces biodiversity

Destroys and fragments wildlife habitats

Increases water pollution, flooding, and erosion on steep slopes

Eliminates most recreational value

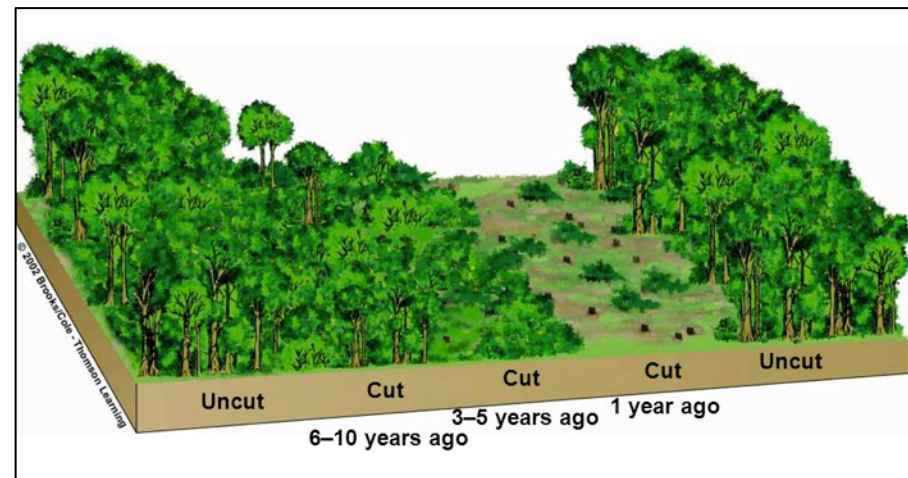
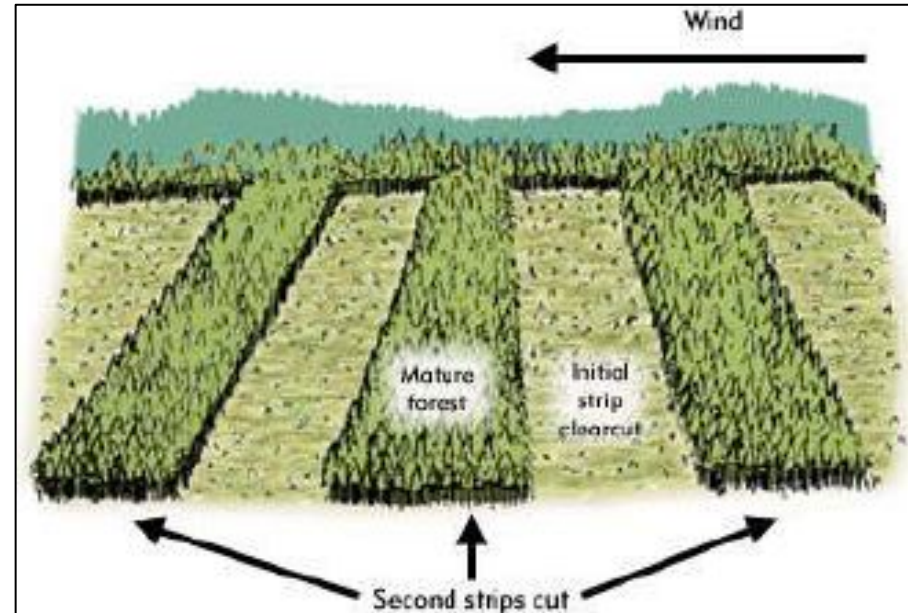


Forestry: Logging & Tree Harvesting Practices

Major Tree Harvesting Methods

Strip Cutting

- Usually done along contour of slope
- Reduces erosion, water loss, and nutrient loss.
- Fragments but does not destroy habitat.
- Secondary succession occurs naturally as reseeding is facilitated by seed dispersal from intact forest strips

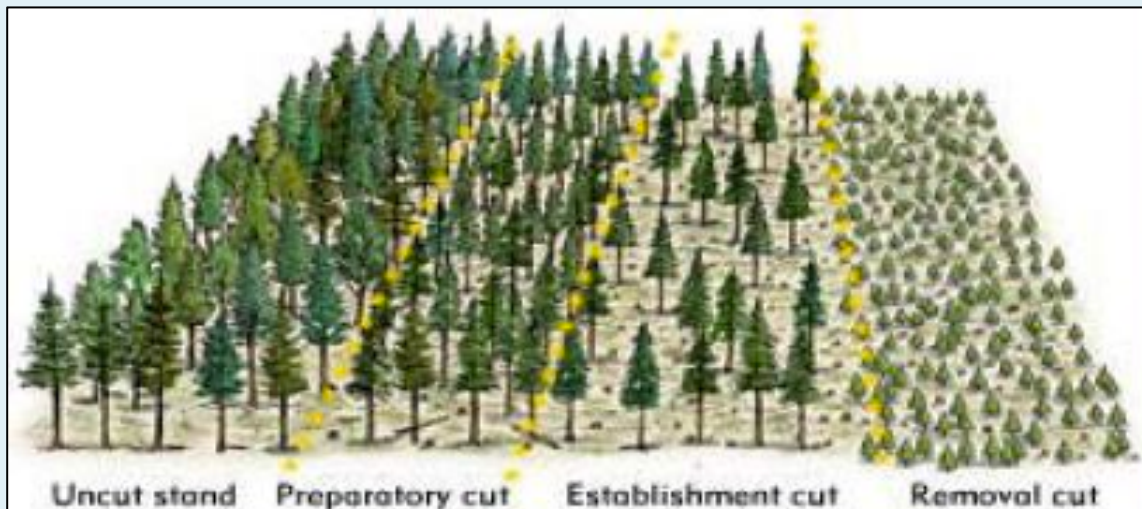


Forestry: Logging & Tree Harvesting Practices

Major Tree Harvesting Methods

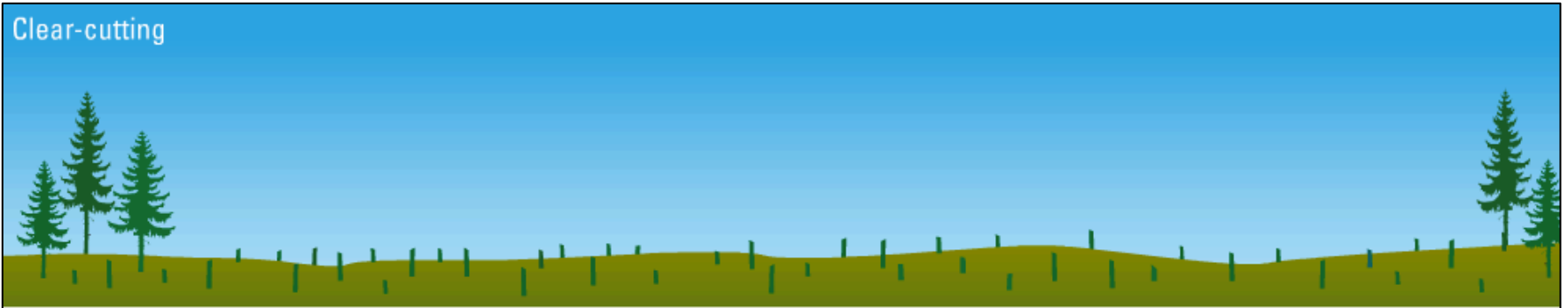
Shelterwood Cutting

- Trees are removed gradually in two or more cuttings.
- Trees that are growing vigorously are retained to provide shelter, seed, and protection of site against deterioration.
- Facilitates establishment of a new generation of seedlings without planting
- Soil left intact *little danger of invasion of the area by weeds and grasses*



Forestry: Logging & Tree Harvesting Practices

Clear-cutting



Shelterwood logging



Selective cutting



Forest Ecosystems: Fire, Insects, & Climate Change

Surface fire

Burns understory and leaf litter; most mature trees and animals survive. Can have ecological benefits-reduce fuel, release nutrients, control pests, maintains habitat.

Crown fires

Hot fires start on ground and eventually burn whole trees and leap from treetop to treetop. Much litter has accumulated (small trees & dead branches; fuel ladders), destroy most everything in path (including wildlife, insects and soil microorganisms) and increases erosion.



Forest Ecosystems: Fire, Insects, & Climate Change

Suppression

For most of the 20th century complete fire suppression was practice; putting out fires immediately and as quickly as possible.

This led to an accumulation of large quantities of biomass on the forest floor which built up until large fires became inevitable.

The Smokey Bear Educational Campaign

- Supported Total Suppression
- Turned out to facilitate fire prone conditions



**Remember—Only YOU can
PREVENT FOREST FIRES!**



Improve the Management of Forest Fires

Prescribed Burning

- A fire deliberately set under controlled conditions in order to reduce the accumulation of dead biomass on the forest floor.
- Ecological benefits: liberates nutrients tied up in dead biomass; provides opening for early successional species + browsing and foraging vegetation for wildlife.

Improve the Management of Forest Fires

- Prescribed fires
- Allow fires on public lands to burn
- Protect structures in fire-prone areas
- Thin forests in fire-prone areas



Healthy Forests Initiative

Healthy Forests Restoration Act of 2003 (P.L. 108-148),

Goals of the law:

- Thin overstocked stands;
- Clear away vegetation and trees to create shaded fuel breaks;
- Provide funding and guidance to reduce or eliminate hazardous fuels in National Forests;
- Research new methods to halt destructive insects.

Controversy

- Opponents claimed it allowed loggers to unnecessarily cut medium to large diameter trees *under the false pretense of forest thinning*, while neglecting the greater issue of ladder fuels and possibly leaving debris that would add to extremely volatile ground fuels (such as brush and small trees; cut branches known as slash).
- Opponents claimed it used environmentally friendly terminology as "cover" for a give-away to business interests.

Forest Ecosystems: Fire, Insects, & Climate Change

Introduction of Foreign Diseases and Insects Accidental & Deliberate
Pathogens and Insects cause ecological and economic damage

Integrated Pest Management: Combined pesticide use with other strategies such as:

- Ban wood transfer to control spread
- Prevention
- Remove infected trees
- Genetic engineering



Introduction of foreign diseases and insects Accidental & Deliberate

Emerald Ash Borer

Adults feed on ash foliage- little damage. Larvae feed on the inner bark disrupting the tree's ability to transport water and nutrients.

- Probably arrived in the United States on solid wood packing material originating in its native Asia.
- EAB is responsible for the death of tens of millions of ash trees in 30 states, and has become a concern for Colorado communities since its initial 2013 detection in Boulder, as 15 percent or more of all urban and community trees in the state are ash.

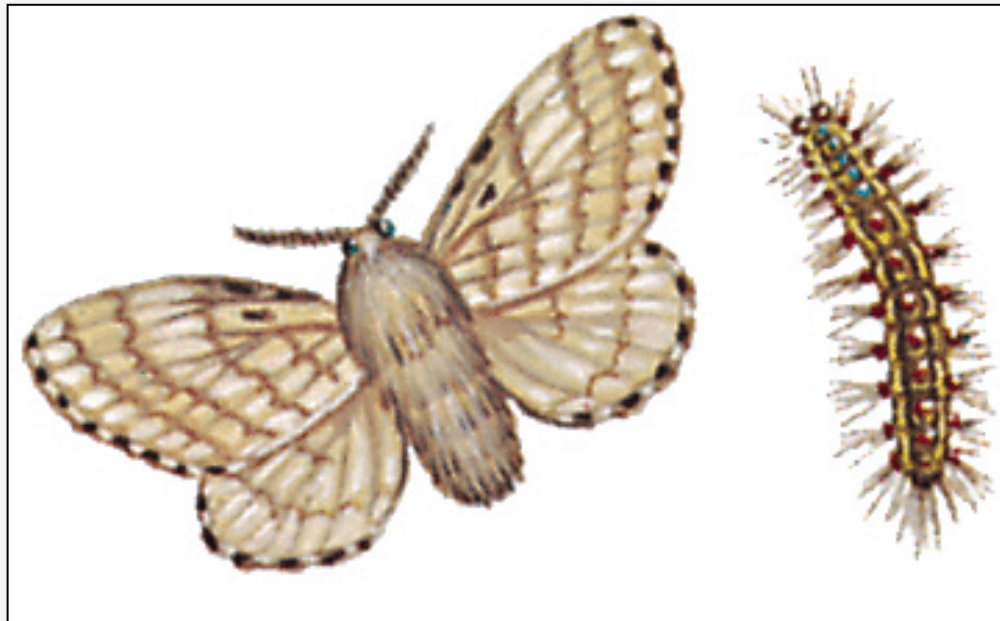


Forest Ecosystems: Fire, Insects, & Climate Change

Introduction of foreign diseases and insects Accidental & Deliberate

Gypsy Moth

Defoliator primarily of hardwood trees, especially oak. Feeds on the foliage of numerous N. American plants and trees; most common hosts are oak and aspen; highest concentrations in the southern Appalachian mountains., the Ozark mountains, and in the northern lake states.

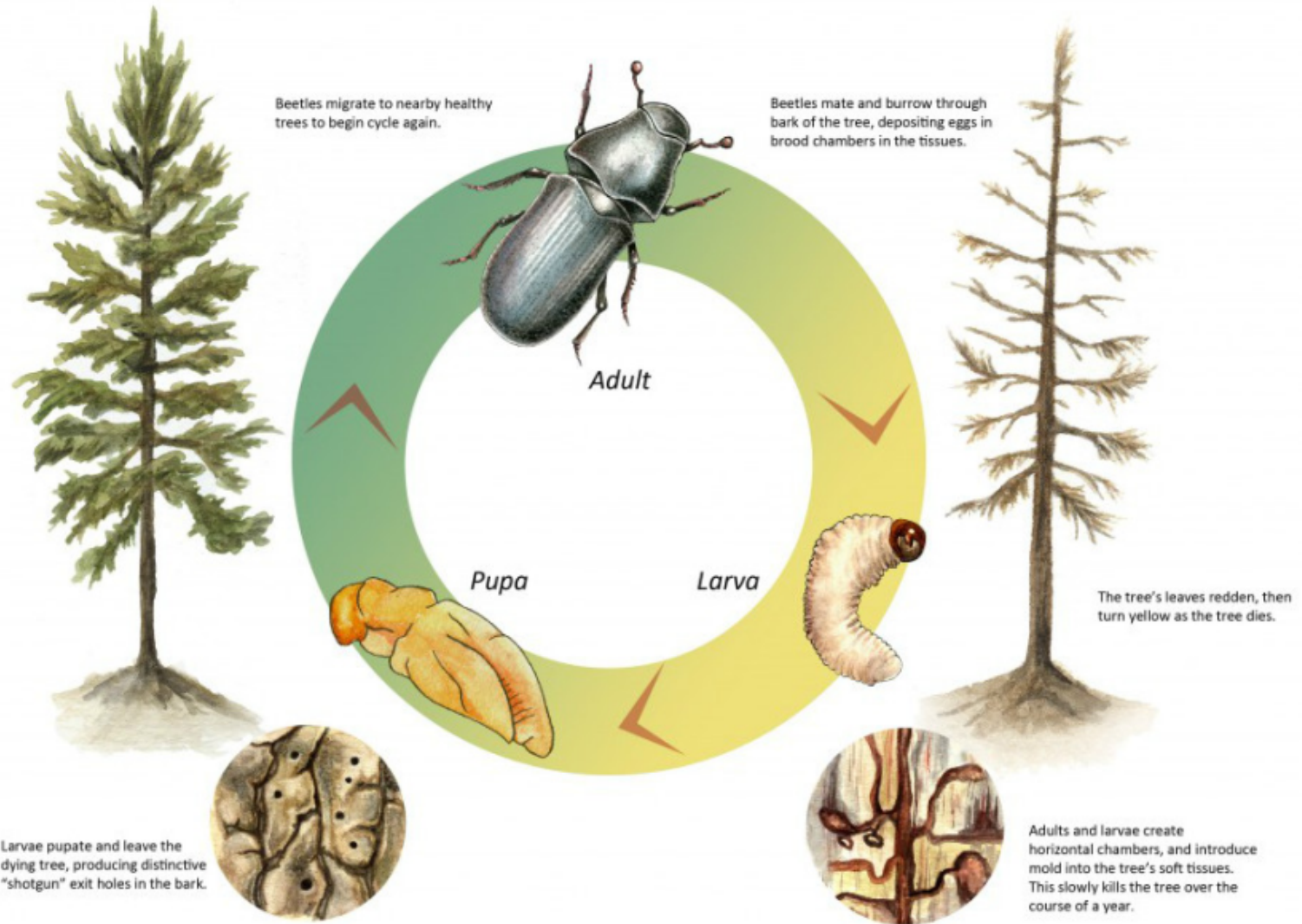


Forest Ecosystems: Fire, Insects, & Climate Change



Forest Ecosystems: Fire, Insects, & Climate Change

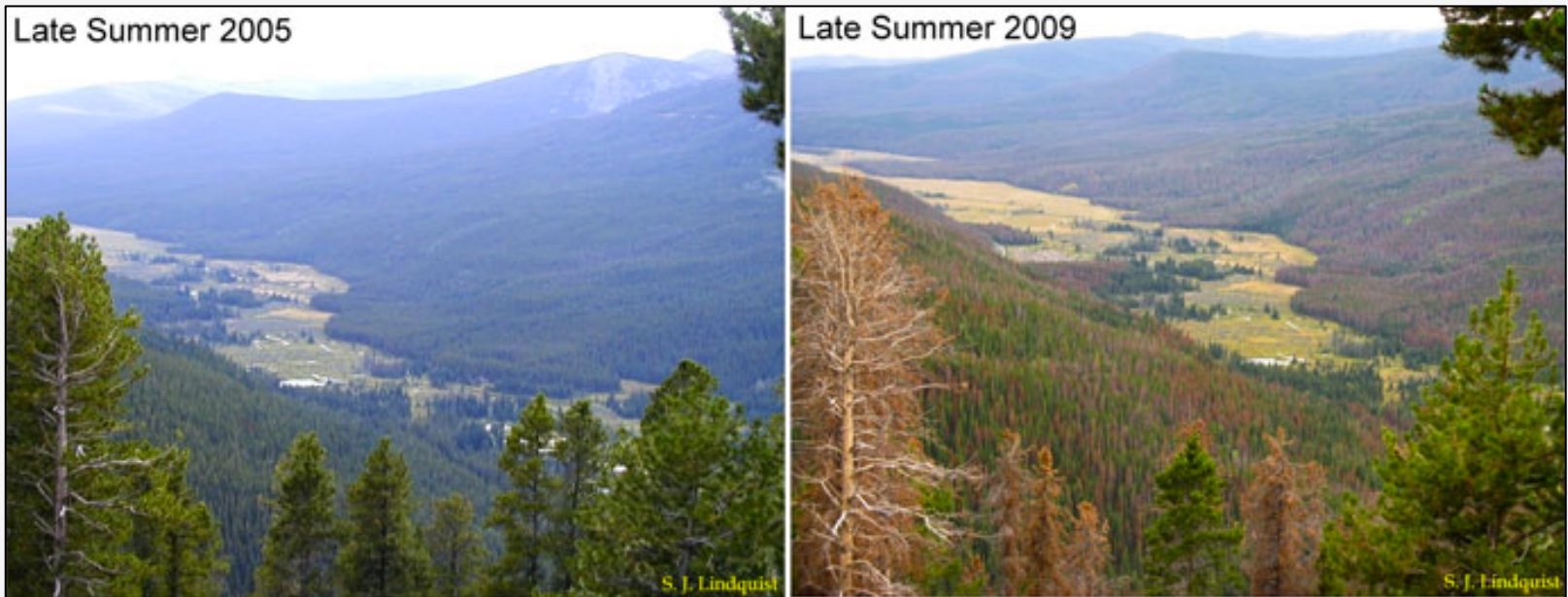
Life Cycle of Mountain Pine Beetle, *Dendroctonus ponderosae*



Forest Ecosystems: Fire, Insects, & Climate Change

Mountain Pine Beetle

Hard winters with cold temperatures can kill beetle eggs and larvae wintering under a tree's outer bark. Related to general climate warming, average winter temperatures in the Rocky Mountains have been higher than normal over the past ten years. Trees have also been weakened by a prolonged period of low precipitation. The combination of milder temperatures and low precipitation has aided a vast outbreak of beetles.



Similar Views from Farview Curve

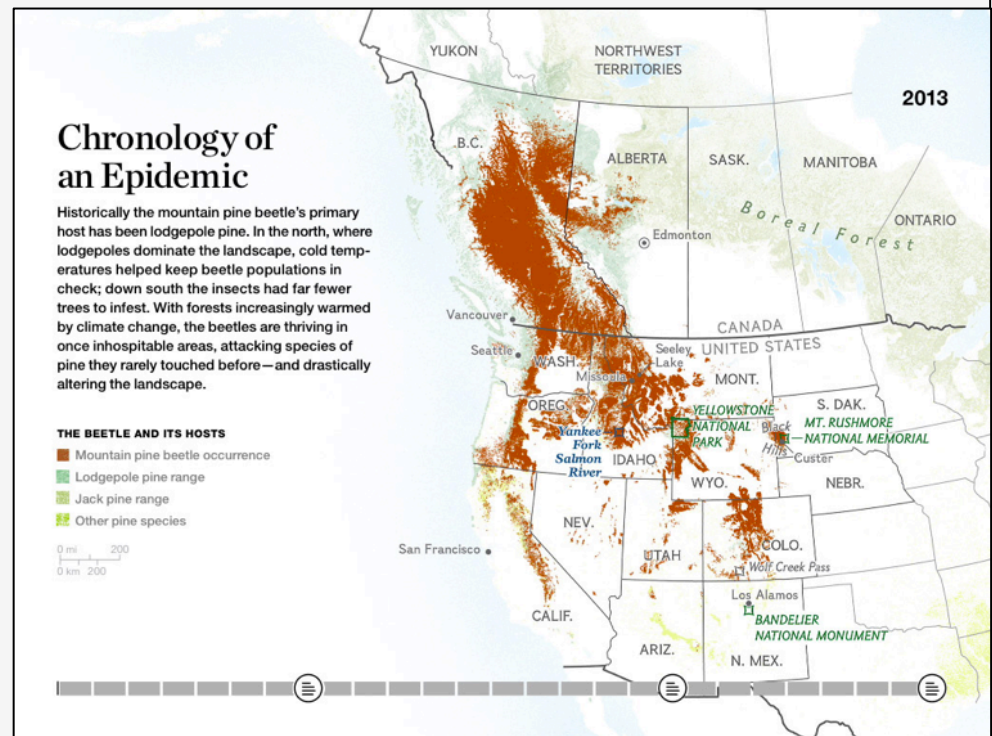
Forest Ecosystems: Fire, Insects, & Climate Change

Mountain Pine Beetle

Bark beetles are native insects that have shaped the forests of North America for thousands of years. Several species of bark beetles are presently killing lodgepole pine, ponderosa pine, limber pine, Engelmann spruce, subalpine fir and Colorado blue spruce. Rocky Mountain National Park is just one relatively small area where trees are dying from the beetle epidemic. Because the task is enormous, the park's priorities for mitigation of the effects of beetles are focused on removing hazard trees and hazard fuels tied to the protection of life and property.



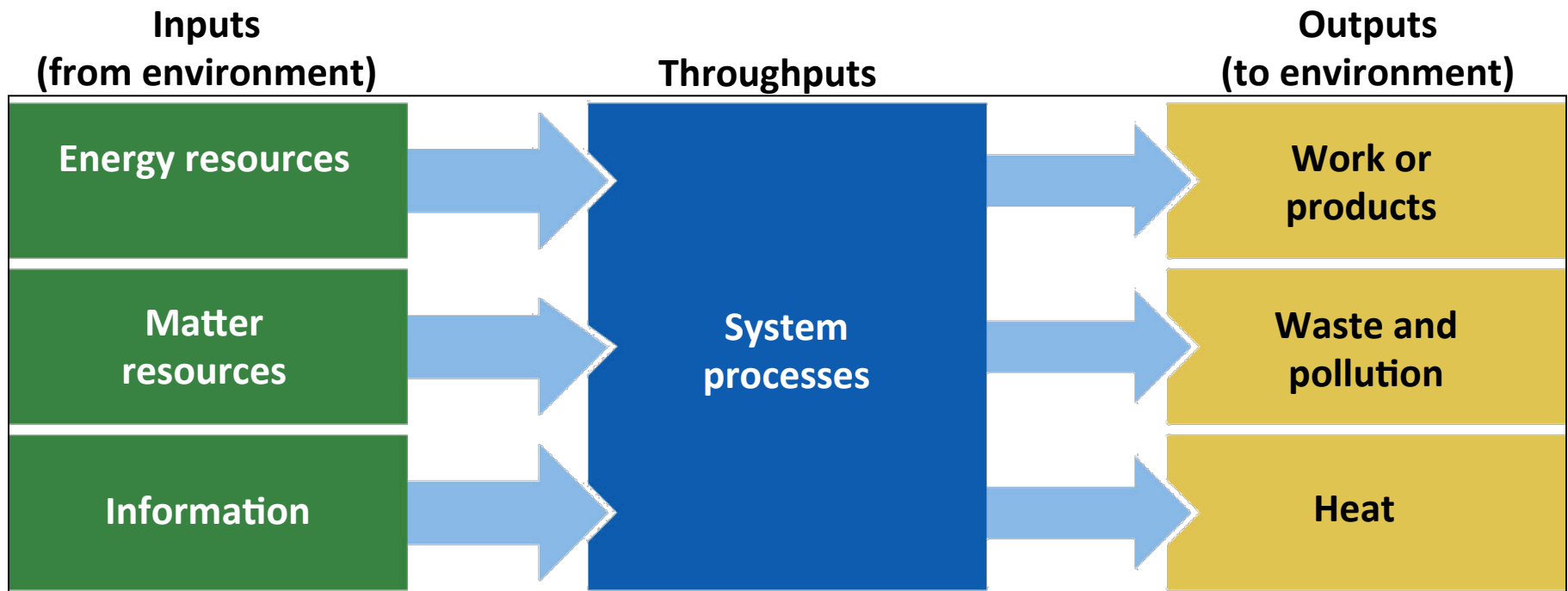
Annual carbaryl spraying has been effective in protecting high value trees in the RMNP.



Fundamentals of Environmental Science

Systems Have Inputs, Flows, and Outputs

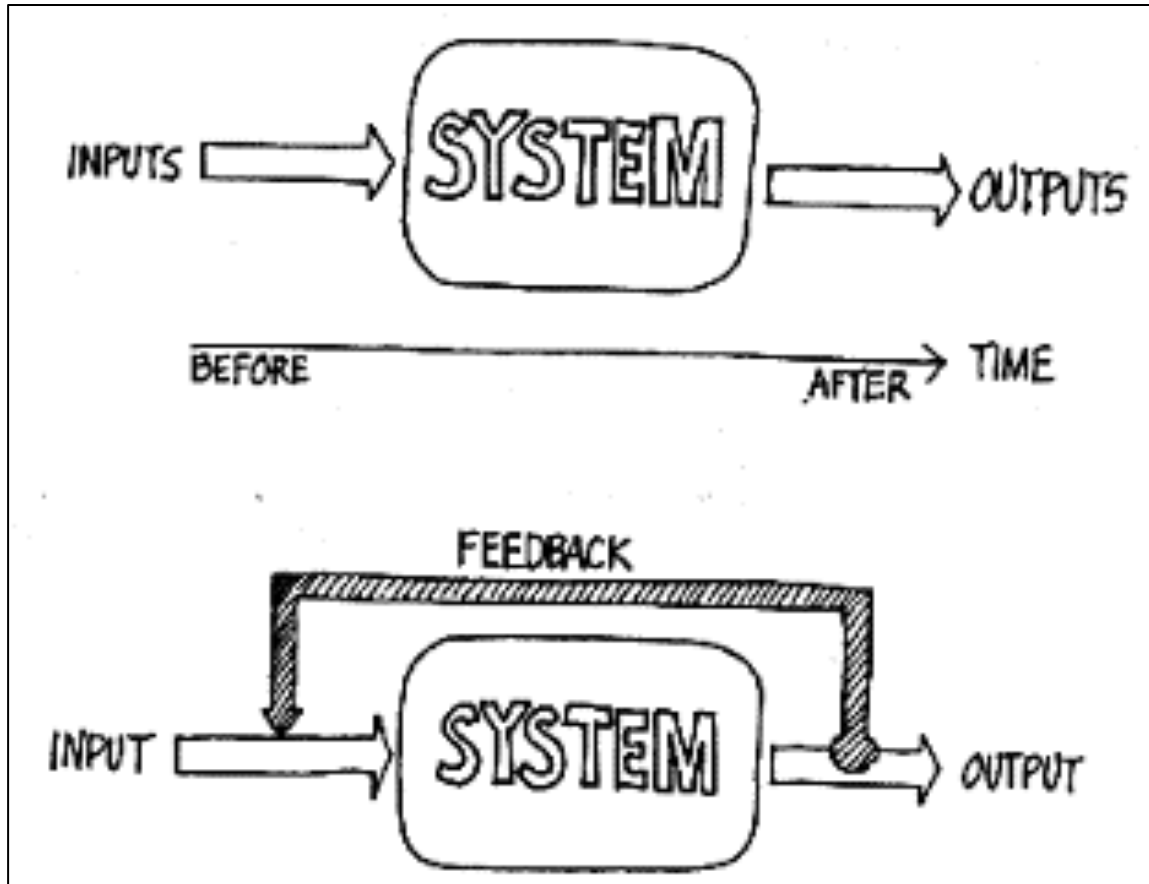
- **System**
 - Set of components that interact in a regular way
- **Inputs** from the environment
- **Flows, throughputs** of matter and energy
- **Outputs** to the environment



Fundamentals of Environmental Science

Systems Respond to Change through Feedback Loops

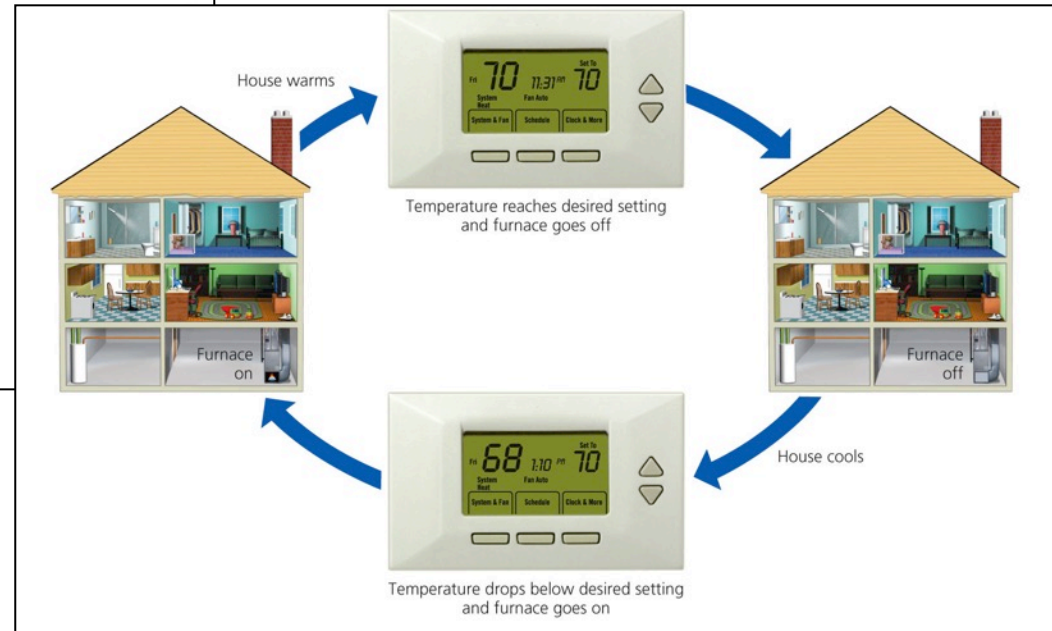
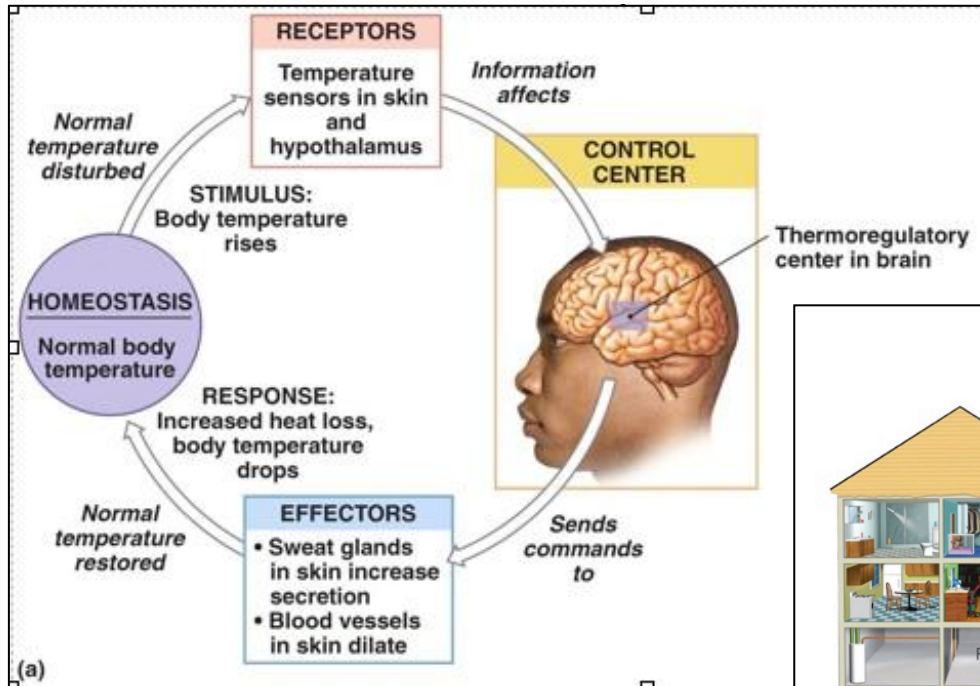
- **Feedback Loop:** results of a process feed back into the system to change the rate of that process.



Fundamentals of Environmental Science

Systems Respond to Change through Feedback Loops

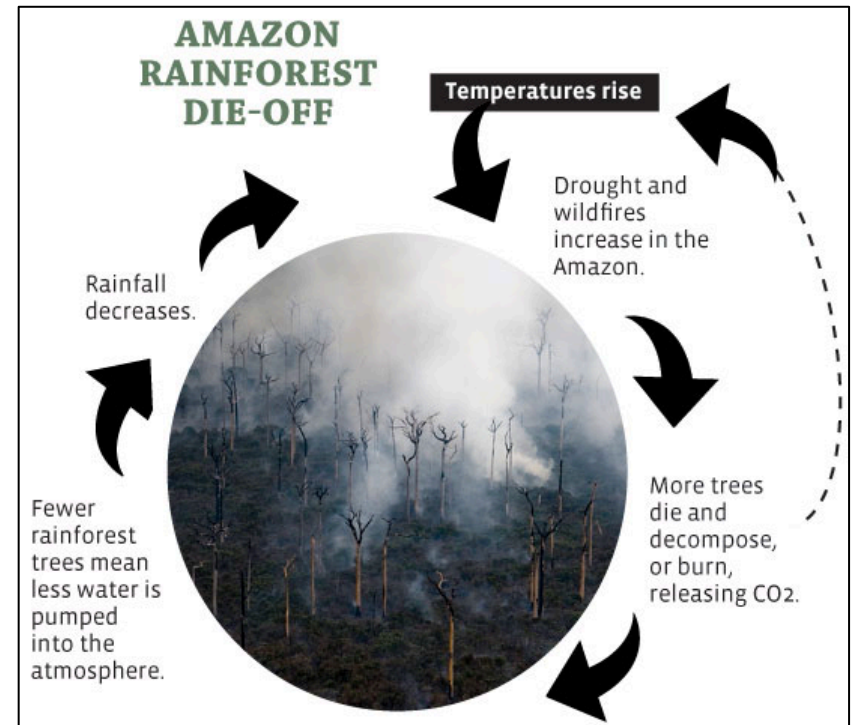
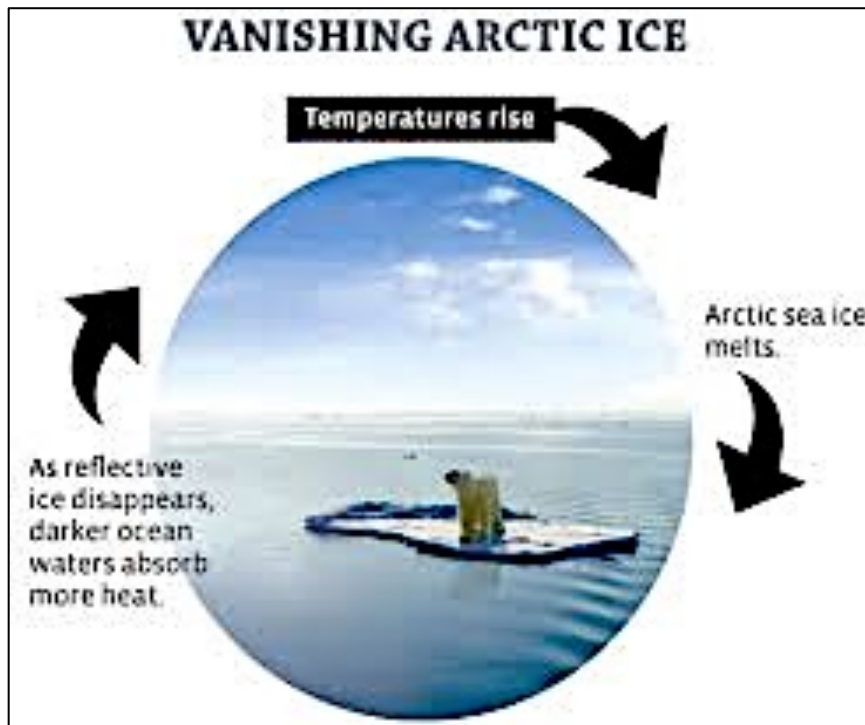
- **Negative Feedback Loop:** a system responds to a change by returning to its original state or decreasing the rate at which change



Fundamentals of Environmental Science

Systems Respond to Change through Feedback Loops

- **Positive Feedback Loop** : Causes the system to change further in same direction; amplifies a change



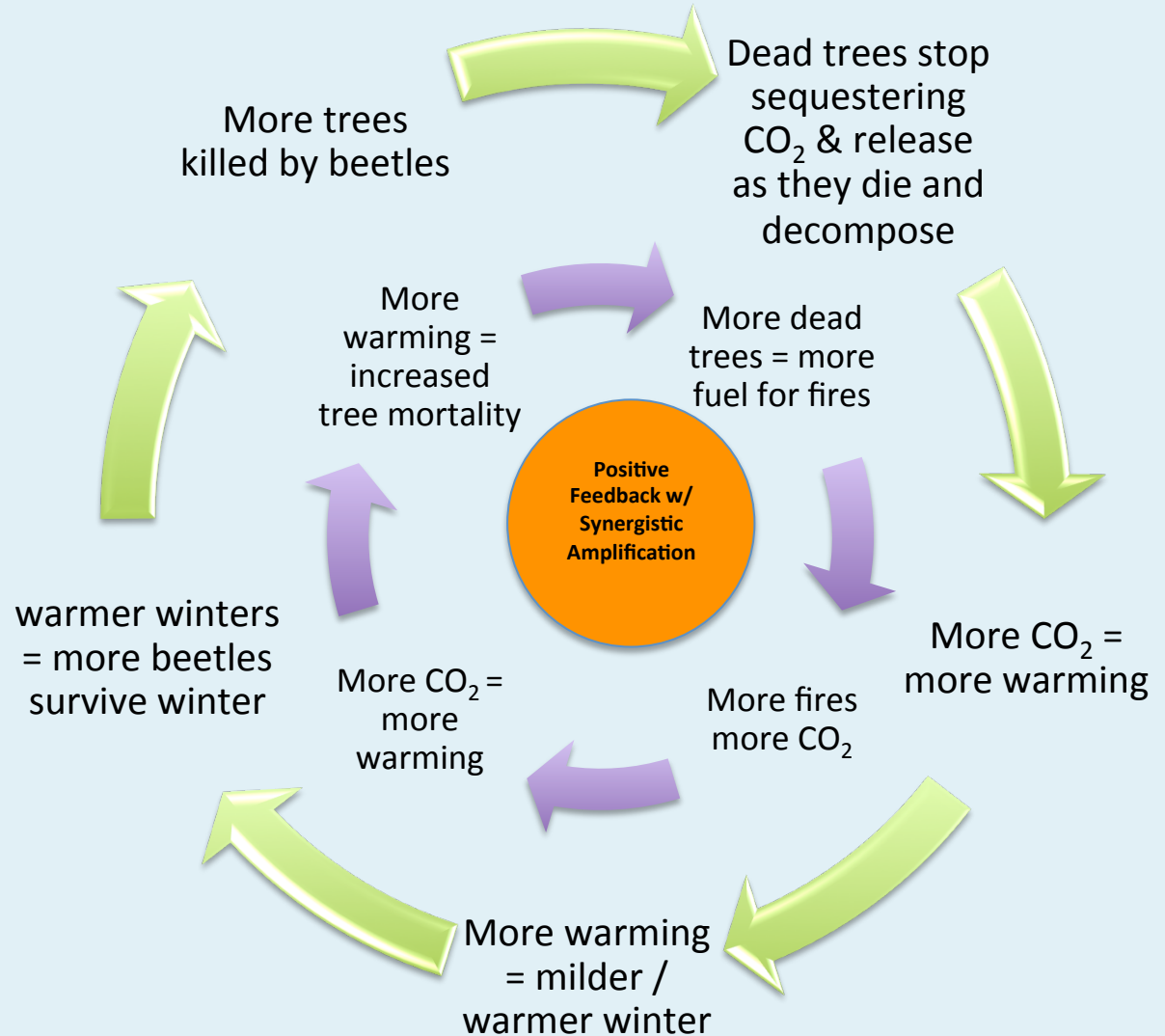
Forest Ecosystems: Fire, Insects, & Climate Change

Global Warming

- Rising temperatures
- Trees more susceptible to diseases and pests
- Drier forests: more fires
- More greenhouse gases

Positive Feedback Loop

-Synergy
-Amplification

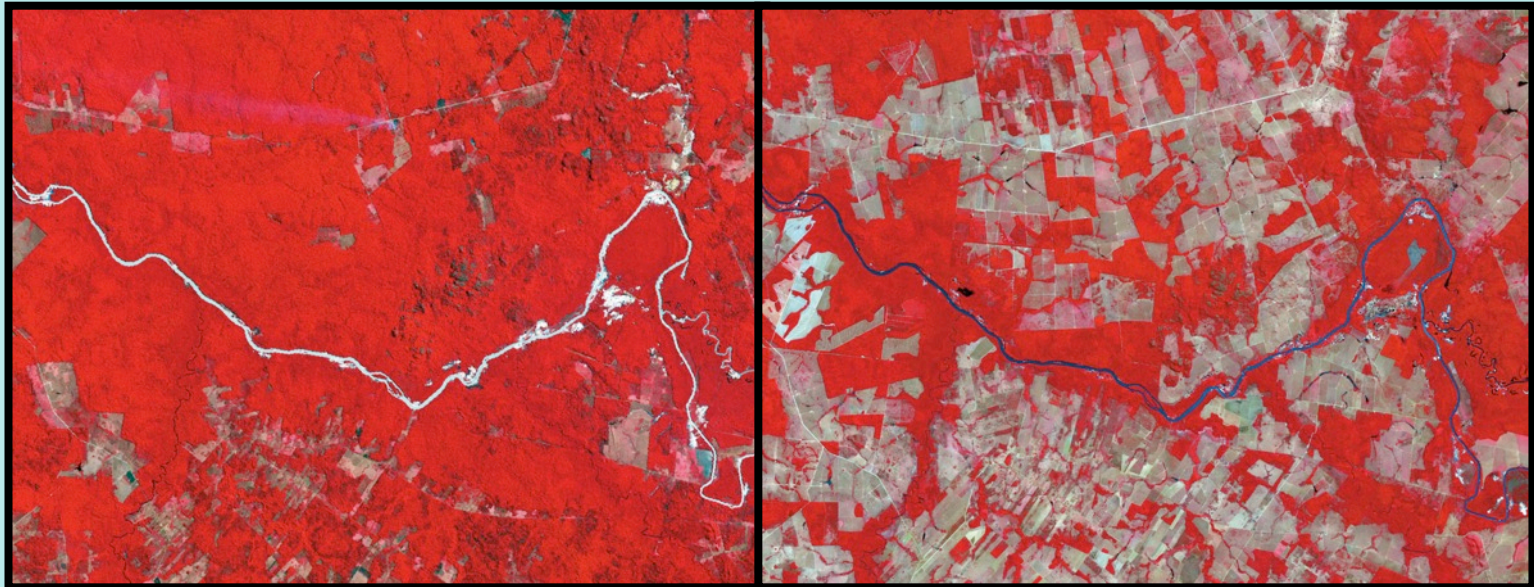


Deforestation

Deforestation

We have cut down almost half of the world's forests.

- Tropical forests
 - Especially in Latin America, Indonesia, and Africa
- Boreal forests
 - Especially in Alaska, Canada, Scandinavia, and Russia

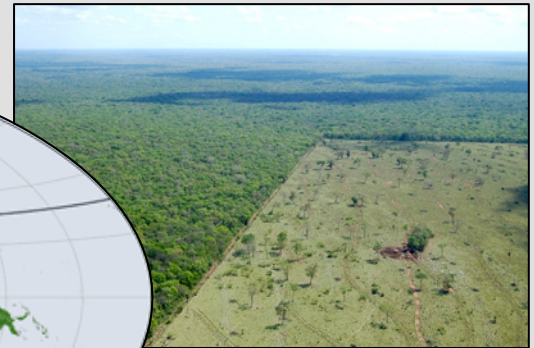
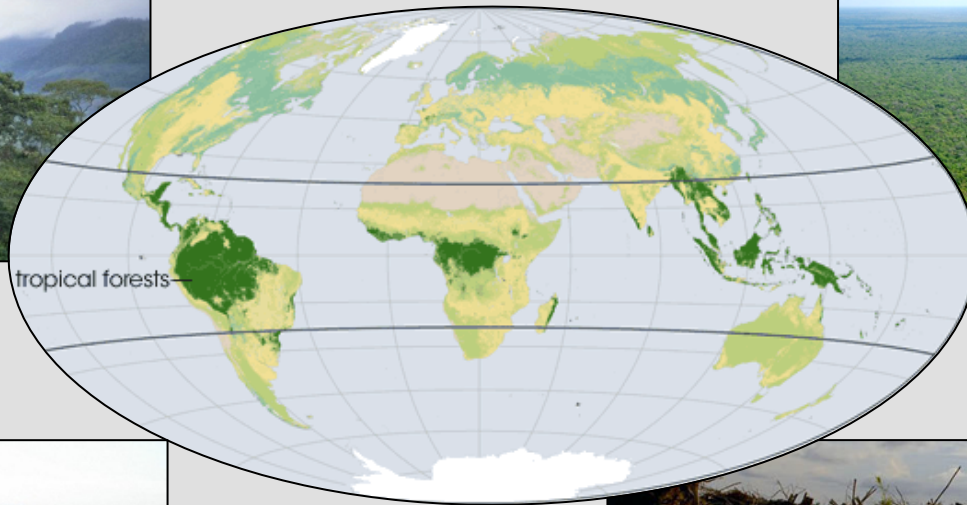


Mato Graoso, Brazil 1992-2006

Deforestation

Tropical Forests are Disappearing Rapidly

- Majority of loss since 1950
- Africa, Southeast Asia, South America
- Role of deforestation in species extinction



Deforestation

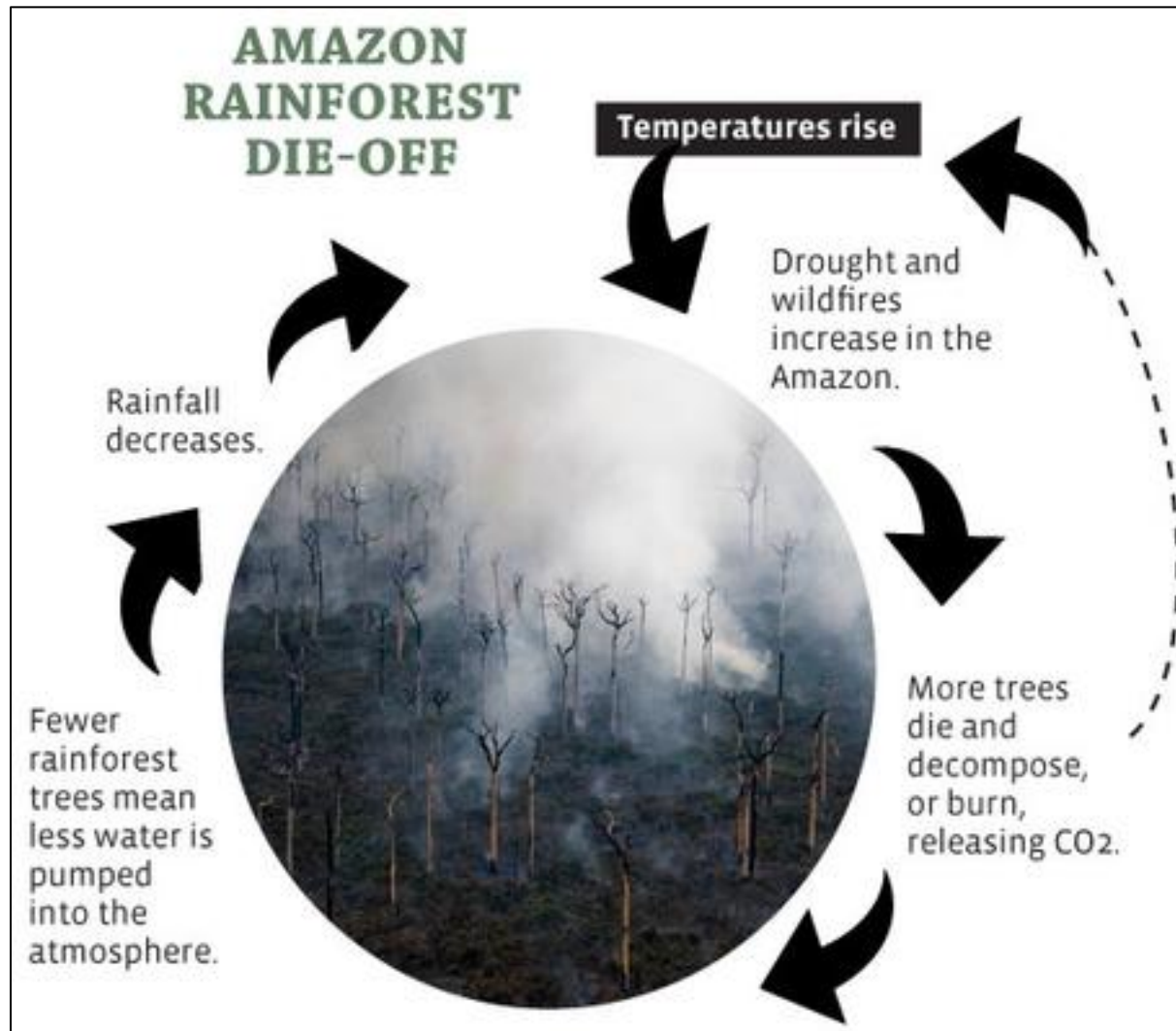
Causes of Tropical Deforestation are Varied and Complex

- Population growth
- Poverty of subsistence farmers
- Ranching (cattle – beef)
- Agriculture (cash crops)
 - *Plantation farms: palm oil, sugar cane, soy beans (cattle feed)*
- Lumber (wood)
- Begins with building of roads
- Many forests burned
- Large dam construction
- Fuel wood



→ Can tilt tropical forest to tropical savanna

Deforestation



Deforestation: Beef Cattle and Soy Beans

Beef cattle

Of the major deforestation drivers, beef has by far the largest impact. Converting forest to pasture for beef cattle, largely in Latin America, is responsible for destroying 2.71 million hectares of tropical forest each year—an area about the size of the state of Massachusetts.



Deforestation: Beef Cattle and Soy Beans

Soybeans

Growing global demand for meat and dairy products has contributed to the doubling of soybean production in the last 20 years. Soy is primarily used to feed pork, poultry, and dairy cows, though significant amounts are also used to produce vegetable oil and biodiesel. Large soybean fields in the tropics, particularly in Latin America, are often planted on newly deforested land—or they may expand onto former pastureland, pushing cattle to the forest frontier. Every year around 480,000 hectares is deforested for soy in major soy-producing tropical countries.



Deforestation: Beef Cattle and Soy Beans



MARKETS

INT

2014

SOY AND CONSUMERS

How soy and animal products affect vital ecosystems

PRISTINE NATURAL WONDERS SUCH AS
THE AMAZON, CERRADO, ATLANTIC FOREST,
GRAN CHACO AND CHIQUITANO FOREST

EXPANDING SOY PRODUCTION

SHIPPED ALL OVER THE WORLD

CONSUMERS BUY THESE
ANIMAL PRODUCTS

HOME OF RICH BIODIVERSITY
AND IMPORTANT SPECIES,
PROVIDER OF FOOD AND SHELTER
FOR LOCAL COMMUNITIES

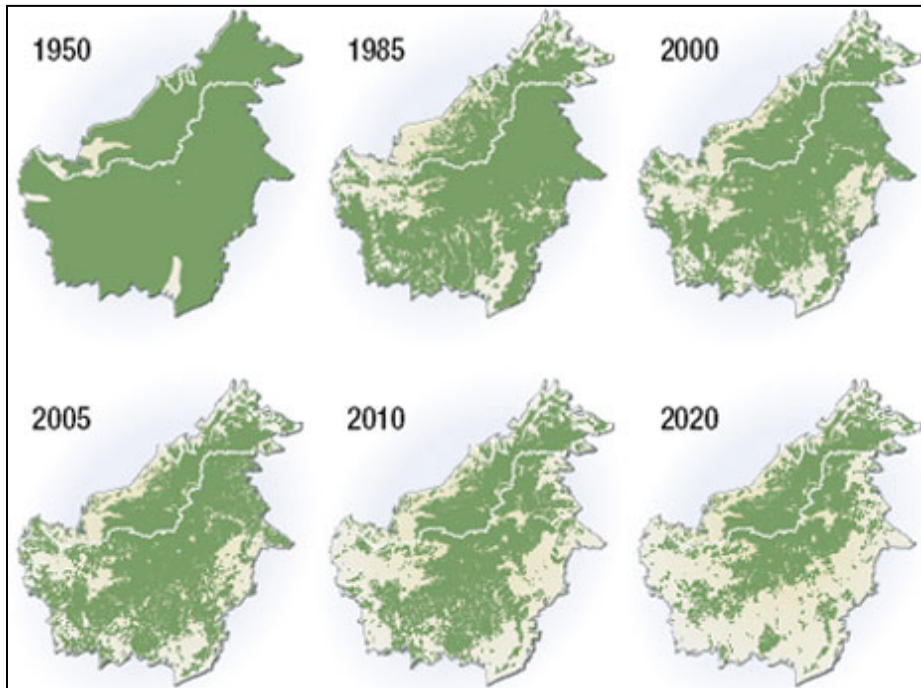
DESTRUCTION AND DEFORESTATION

FED TO THE
ANIMALS USED FOR
MEAT, EGGS AND DAIRY

IT'S NOT TOO LATE TO TAKE ACTION. SUPPORT
COMPANIES THAT BUY RESPONSIBLE SOY NOW.

See the results of the WWF Soy Report Card 2014 at wwf.panda.org/soyreportcard/2014

Deforestation: Palm Oil Production



Deforestation: Palm Oil Production

Effects of Producing Palm Oil

90% of Sumatra's orangutan population has disappeared since 1900.

Sumatra's orangutans now face extinction.

How To Spot Palm Oil in Products

- **Palm oil is found in everything from food and household products, food and cosmetics. It is also being used as an biofuel.**
- **It is thought that one in ten products found on our supermarket shelves today contain palm oil.**

These products list palm oil under a variety of different names including: Vegetable oil, Sodium Lauryl Sulphates, Sodium Dodecyl Sulphate, Palmate, Palm Oil Kernal, Palmitate, Stearic Acid, Glyceryl Stearate, Elaeis Guineensis, Steareth-2, Steareth-20, Hydrated palm glycerides, Cety palmitate & ocyl palmitate (anything ending with palmitate)



Deforestation: The Global Fuelwood Crisis

One half of world wood harvest is for fuel for cooking and heating

Haiti: ecological disaster →

Deforestation in Tanzania threatens the future of forests →

Average citizens of the DRC are reliant on fuelwood as are many citizens across Africa. →

Possible solutions

- Establish small plantations of fast-growing fuelwood trees and shrubs
- Burn wood more efficiently
- Solar or wind-generated electricity
- Burn garden waste



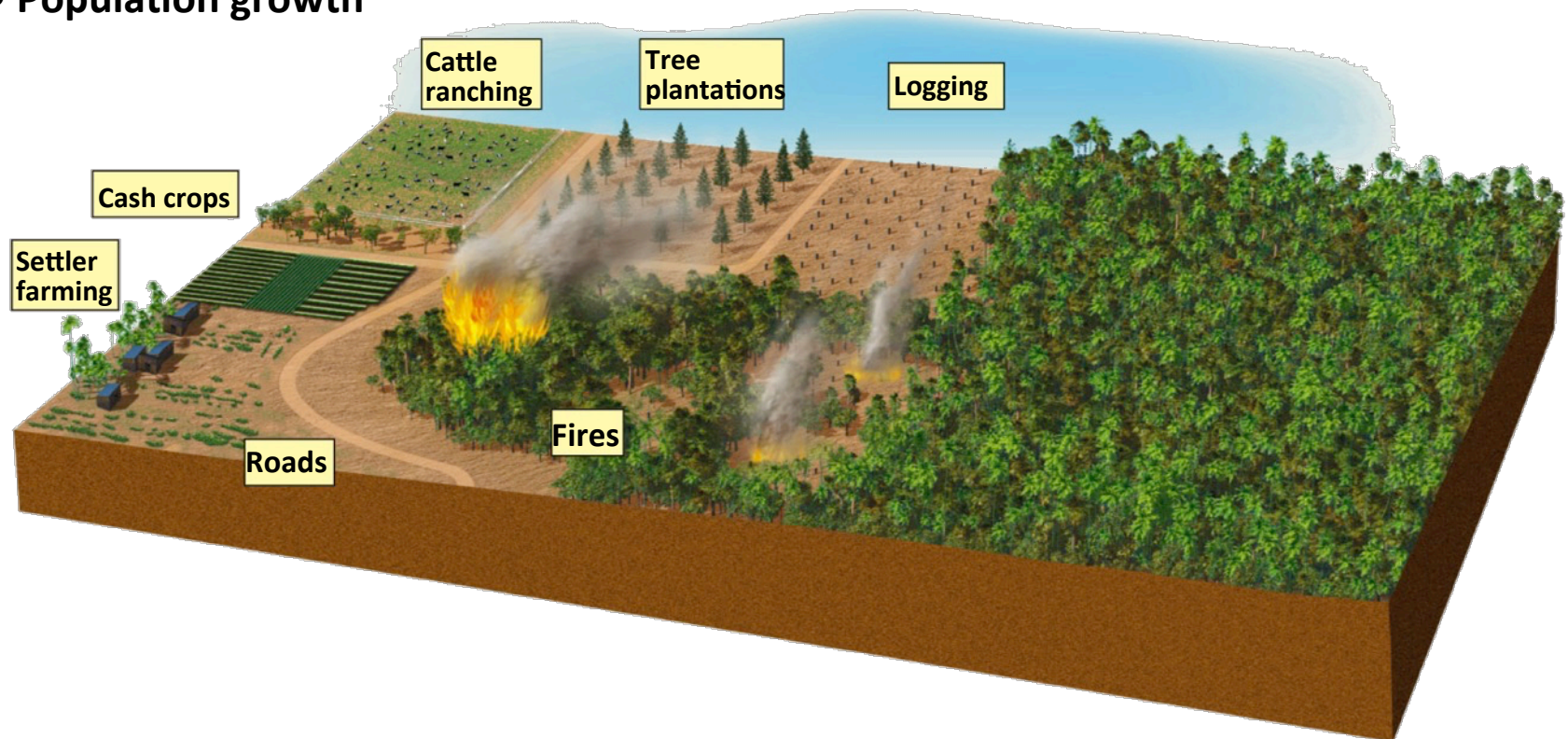
Major Causes of the Destruction and Degradation of Tropical Forests

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



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

Certifying Sustainably Grown Timber

Collins Pine

- Owns and manages protective timberland

Forest Stewardship Council

- Nonprofit
- Developed list of environmentally sound practices
- Certifies timber and products
- 2009: 5% of world's forest have certified to FSC standards
- Also certifies manufacturers of wood products

Governments and Individuals Can Act to Reduce Tropical Deforestation

- Reduce fuelwood demand
- Practice small-scale sustainable agriculture and forestry in tropical forest
- Government protection
- Debt-for-nature swaps/conservation concessions
- Plant trees
- Buy certified lumber and wood products

Sustaining Tropical Forests

Prevention

Protect the most diverse and endangered areas

Educate settlers about sustainable agriculture and forestry

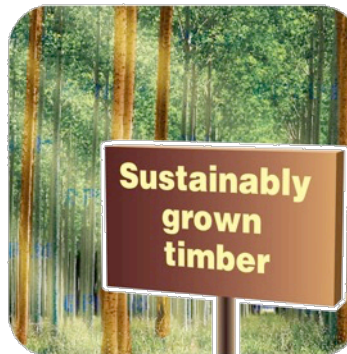
Subsidize only sustainable forest use

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