Forests

This Page Has Been Updated. Updates Are Available At:
www.heinzctr.org/ecosystems

What Indicators are used to describe Forests?			Can we report trends? Are there other useful reference points?
SYSTEM DIMENSIONS			
●	Forest Area and Ownership	How much forest land is there in the United States? How much is privately owned, and how much is publicly owned?	Trends, regional comparison
●	Forest Types	How is the area occupied by major forest types changing?	Trends, regional comparison
●	Forest Management Categories	How intensively managed are U.S. forest lands?	Trends, regional comparison
◐	Forest Pattern and Fragmentation	How fragmented are U.S. forests?	Regional comparison
CHEMICAL AND PHYSICAL CONDITIONS			
●	Nitrate in Forest Streams	How much nitrate is there in forest streams?	Current data only, federal standard, cross-ecosystem comparison
◐	Carbon Storage	How much carbon is stored in U.S forests?	Trends, regional comparison
BIOLOGICAL COMPONENTS			
◐	At-Risk Native Species	What are the percentages of forest-dwelling species that are at different levels of risk of extinction?	Current data only, regional comparison
⊖	Area Covered by Non-native Plants	What percentage of the plant cover in forests is not native to the region?	No data reported
◐	Forest Age	How much of the nation's forests is young, middle-aged, or old?	Regional comparison
●	Forest Disturbance: Fire, Insects, and Disease	How many acres are affected each year by fires, insects, disease, windstorms, and ice?	Trends
⊖	Fire Frequency	Are forest fires burning much more or less frequently than in presettlement times?	No data reported
⊖	Forest Community Types with Significantly Reduced Area	How much area is occupied by forest types that have significantly declined in area since presettlement times? Are these forest types increasing or decreasing in area at present?	No data reported
HUMAN USES			
●	Timber Harvest	How much timber is harvested each year, and what is it used for?	Trends, regional comparison
●	Timber Growth and Harvest	How much timber grows each year, compared to the amount that is cut?	Trends, regional comparison
⊖	Recreation in Forests	How much recreational activity takes place in the nation's forests?	No data reported

● All Necessary Data Available ◐ Partial Data Available ⊖ Data Not Adequate for National Reporting ? Indicator Development Needed

Chapter 7: Indicators of the Condition and Use of Forests

What makes a forest a forest is, obviously, the presence of trees: the giant redwoods of the West Coast; the maples, oaks, and hickories that give New England its flaming fall foliage; the trackless wilderness of interior Alaska; even the Pine Barrens of New Jersey—all these fit into the picture conjured up by the word "forest." But forests also include the coastal live oak woodlands of California, the cypress swamps and savannahs of the South, and the pinyon–juniper woodlands of the arid Southwest. Highly managed timberlands are also forests. Many of these "forest" types overlap with, or even occupy the same space as, other ecosystem types (wetlands, grasslands and shrublands, farmlands, urban and suburban areas). These varied forest lands provide Americans with timber and other wood products, but they also offer the opportunity for solitude, hunting, hiking, birdwatching, and camping.

What can we say about the conditions and use of U.S. forests?

Fifteen indicators describe the condition and use of forests in the United States. Partial or complete data are available for eleven of these fifteen indicators; data are available for a higher percentage of forest indicators than for any other ecosystem. Seven indicators have a data record that is long enough to judge trends, and for one there is a regulatory standard for comparison. For four indicators, data are not adequate for national reporting. Nine of the eleven indicators for which data are available are presented by region, allowing comparison of conditions in different regions.

After the following brief summaries of the findings and data availability for each indicator, the remainder of this chapter consists of the indicators themselves. Each indicator page offers a graphic representation of the available data, defines the indicator and explains why it is important, and describes either the available data or the gaps in those data.

System Dimensions

Three of the four indicators of forest system dimensions track forest acreage, each in a different way. These are total forest acreage, including the split between public and private ownership; the acreage of about 20 major forest types, each of which provides habitat for a different mix of plants and animals; and the percentage of forest under various management regimes, from planted timberland to national parks and wilderness areas, where timber harvesting is prohibited. Both the type of forest and the degree to which the forest is broken into smaller patches and intermingled with nonforest areas are important for many forest species, so the fourth indicator reports the percentage of forest surrounded by small, medium, and large expanses of more-or-less complete forest cover.

- **How much forest land is there in the United States? How much is privately owned, and how much is publicly owned?** Forests cover 747 million acres, or about a third of the land area of the United States, down from about 1 billion acres at the time of European settlement. The area of forest is divided about evenly between East and West, but most historic conversion of forest to other uses has taken place in the East. In recent decades, the overall acreage of forest has been relatively stable. In the East, more than 80% of forest lands are privately owned; in the West, about two-thirds are publicly owned.
- **How is the area occupied by major forest types changing?** Over the past several decades, the major forest types with the largest increases in acreage were oak–hickory and maple–beech–birch in the East, and fir–spruce in the West. Forest types declining in area included elm–ash–cottonwood and oak–gum–cypress in the East and hemlock–sitka spruce, ponderosa pine, and lodgepole pine in the

West. Over this period, overall forest area changed very little, so reductions in area occupied by one forest type were generally balanced by increases in area by other types.

- **How intensively managed are U.S. forest lands?** In 1997, 11% of western forests and 3% of eastern forests were in federal wilderness areas and national parks (reserved forest), while 10% of eastern forests and 4% of western forests resulted from replanting with seedlings in anticipation of future timber harvest. Nationwide, reserved forest land has doubled since 1953, to 14 million acres; during the same period, planted timberland increased tenfold, also to 14 million acres. Most forest lands in the United States—including those used for timber production—are neither national parks or wilderness areas nor planted forests.
- **How fragmented are U.S. forests?** One way to report on forest fragmentation pattern is to describe the degree to which any forested point is surrounded by land that is mostly forested (at least 90% forest cover). About two-thirds of all points in both eastern and western forests are surrounded by mostly forest cover within a radius of about 250 feet. About a quarter of all forest points have mostly forest cover within about a 2½-mile radius. Tracking this indicator over time will make it possible to distinguish between natural forest patterns and changes caused by human activity. In addition, methods available in the future may allow identification of smaller features (for example, forest roads and small clearings with houses) than can readily be mapped using the current satellite data that this indicator relies upon.

Chemical and Physical Conditions

Two indicators describe the chemical and physical condition of forests. We track nitrate in forest streams because elevated concentrations of this nutrient can be a sign of plants under stress or of increased inputs from sources such as atmospheric deposition and conversion of forest to other land use. We track carbon storage because carbon is the major building block of forest systems and because increased carbon storage in forests can offset emissions of carbon dioxide from burning fossil fuels.

- **How much nitrate is there in forest streams?** Almost all forest streams had nitrate concentrations below 1 part per million; more than half had concentrations below 0.1 part per million. The federal drinking water standard is 10 parts per million. No trend data are available, but streams in forested regions have the lowest nitrogen concentrations, farmland streams the highest.
- **How much carbon is stored in U.S. forests?** Increased carbon storage by forests and other ecosystems can offset emissions of carbon dioxide from the burning of fossil fuels, of concern because of climate change. The amount of carbon stored in trees on timberlands (a USDA Forest Service designation for areas with trees that grow fast enough to support timber harvests and on which harvest is not prohibited by law) has gone up steadily in the East and remained stable in the West. Data are not adequate for national reporting on carbon stored in roots, forest floor litter, and soil.

Biological Components

Six indicators describe the biological condition of the forests. One tracks the fraction of native forest species according to their relative risk of extinction. A related measure tracks changes in forest plant communities—specific plant groupings—whose area has declined by at least 70% since presettlement times. Because forests of different age structures provide different goods, services, and values, a third measure tallies the age distribution of forest trees. The remaining three indicators focus on several key forest disturbances. The first focuses on non-native plants, which can be ecologically disruptive; the second tracks acres of forest affected by fire, insects, and disease; and the third indicator will focus on fire frequency, a key determinant of forest composition, once adequate data become available.

- **What are the percentages of forest-dwelling species that are at different levels of risk of extinction?** About 9% of 1,700 native animal species that depend on forests are considered critically imperiled or imperiled, and about 1.5% of forest species may already be extinct. When "vulnerable" species are

counted, a total of 20% of forest species are considered to be at risk. Interpretation of these data will be greatly enhanced when it is possible to present information on population trends for these species.

- **What percentage of the plant cover in forests is not native to the region?** Non-native plants can crowd out native plants and may provide poorer quality habitat for wildlife. Data are not adequate for national reporting on the amount of non-native cover in forests.
- **How much of the nation's forests is young, middle-aged, or old?** Data are currently available only for timberlands, a USDA Forest Service designation for areas with trees that grow fast enough to support timber harvests and on which harvest is not prohibited by law. Sixty-five percent of eastern timberlands are less than 60 years old, and 90% are less than 100 years old. About 35% of western timberlands are more than 100 years old. No trend data are available. Forest age is affected by historical and management factors, as well as by the difference in life spans of different species.
- **How many acres are affected each year by fires, insects, and tree disease?** Since 1980, between 2 million and 7 million acres were burned by wildfire per year, down from a high of 52 million acres in 1930 (note that these figures include some grassland and shrubland fire acreage). Insect damage decreased overall from 1979 to1999, but there are dramatic year-to-year variations (over these two decades, damage ranged from 8 million acres to 46 million acres).
- **Are forest fires burning much more or less frequently than in presettlement times?** The frequency with which forests burn is an important factor in shaping the composition of the forest. Data are not adequate for national reporting on this indicator.
- **How much area is occupied by forest types that have declined in area significantly since presettlement times?** Are these forest types increasing or decreasing in area now? Many forest community types now occupy a small fraction of their former area. Data are not adequate for national reporting on this indicator.

Human Use

Two of the indicators of human use of forests focus on timber: the first tracks timber harvest and the products into which it is made (for example, sawlogs or pulpwood). The second reports whether each year's harvest is greater or less than that year's growth. A third measure focuses on recreational use of forests.

- **How much timber is harvested each year, and what is it used for?** Nationally, timber harvest grew by 40% from 1952 to 1996. There was slow, steady growth through 1976, followed by a sharp increase from 1976 to 1986, and a subsequent decline. Pulpwood and sawlogs account for more than half of all harvest; other uses include fuelwood and veneer logs.
- **How much timber grows each year, compared to the amount that is cut?** Growth exceeds harvest on both public and private timberlands in the East and West; this has been true for most of the past 50 years. In 1997, growth was higher than it was in the 1950s on all categories of land, although growth on eastern forest lands (both public and private) was lower than it was at its peak in the 1970s. Nationally, almost 90% of harvest occurs on private lands.
- **How much recreational activity takes place in the nation's forests?** People use forest lands for hunting, fishing, hiking, skiing, and many other recreational activities. Data are not adequate for national reporting on this indicator.

What do we mean by "forests"?

Many of the data reported here are based on the USDA Forest Service definition of forest: any lands at least 10% covered by trees of any size, at least one acre in extent. This includes both heavily treed areas and areas where trees are intermingled with other cover, such as the chaparral and pinyon–juniper areas of the Southwest. This definition includes both naturally regenerating forests and areas planted for future harvest (plantations or "tree farms")—that is, areas that may not have mature trees now, but that will in the future, are classified as forest.

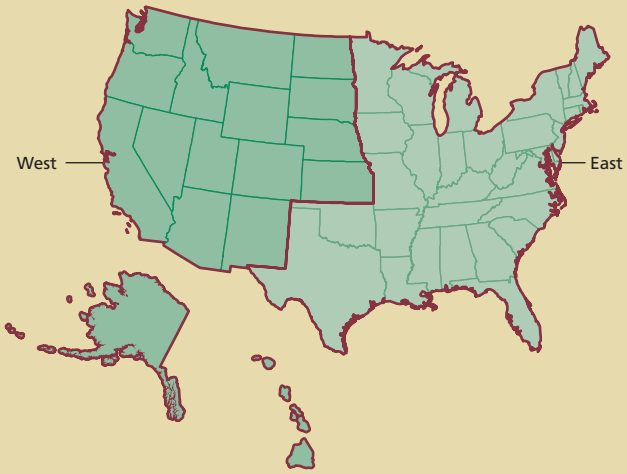
This definition overlaps to some degree with the definition of "grasslands and shrublands" in this report, largely because some areas share characteristics of both forests and grasslands and shrublands. For example, the Forest Service classifies pinyon–juniper and chaparral as forest; in this report, these lands are considered "grasslands and shrublands" as well.

Other approaches to defining and delineating forests, which did not meet our needs, include restricting the definition to "closed canopy" areas—this would eliminate consideration of woodland areas with less complete tree cover, such as chaparral and pinyon–juniper—and excluding areas that are stocked with nursery seedlings for later harvest.

Forest Service estimates reported here are part of an extensive monitoring program that provides information on many aspects of forest extent, use, and condition, and the program's breadth of coverage, historical trends, and internal consistency are quite useful. However, since this program does not produce comparable information about other ecosystem types (grasslands and shrublands, farmlands, etc.), the data cannot be used for reporting on ecosystem extent and change nationwide.

One method that does produce consistent nationwide estimates of ecosystem extent uses satellite remote sensing information (see Map 4.2, p. 40). For forests, the remote sensing method produces estimates that are about 55 million acres (9%) lower than the Forest Service estimates reported in this chapter. Differences between the methods include the scale of measurement (the satellite data include areas as small as about 100 feet on a side, or just over one-fifth of an acre) and the fact that the Forest Service approach considers as forest any areas that *will* become or return to forest cover—including areas on which timber harvest has occurred and that are either replanted or are being reseeded naturally, even if they are currently covered with grass, shrubs, or other nonwoody vegetation.

Map 7.1. Eastern and Western Regions, Used for the Majority of Indicators in this Chapter



Map 7.2. Regional Boundaries for the At-Risk Species Indicator, p. 124

A Note about Regions

The eastern and western regions used to present data on eight of the indicators in this chapter (Map 7.1) are aggregates of the USDA Forest Service regional structure and mirror the distribution of forest lands in the United States, which is interrupted by the major expanse of farmland and grassland and shrubland that occupies the Midwest and the Great Plains. This approach was selected to enable the report to focus on very broad regional trends. Data from Alaska, when available, are included in the western region.

One indicator (At-Risk Species) is presented on the basis of seven regions (see Map 7.2), consistent with the data presented in other at-risk species indicators (pp. 52, 144, and 168).

Forest Area and Ownership

What Is This Indicator, and Why Is It Important? This indicator reports how much forest land there is in the United States and who owns it.

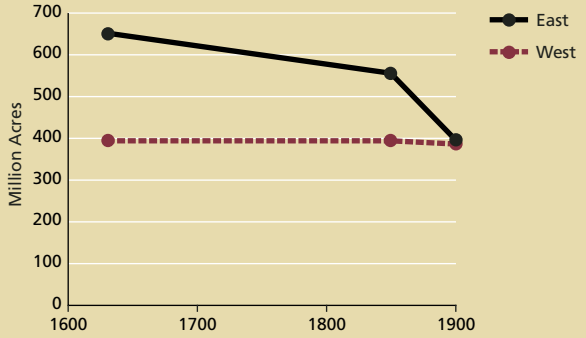
Knowing how much land is forested and who owns that land is vital to making informed decisions about forests. Gains and losses in forest area directly affect the public's continued enjoyment of the goods and services that forests provide—recreation, lumber, watershed protection, and many other things. Public and private owners often have very different goals and assumptions, differences that are reflected in management priorities and practices.

What Do the Data Show? Forests today cover about 747 million acres, or about a third of the total land area of the United States, down from about 1 billion acres at the time of European settlement. Most forest clearing occurred in the East, ending by 1900. In recent decades, the amount of forest land has been nearly stable, with an increase of about 1%, or 8 million acres, from 1987 to 1997.

There are striking regional differences in patterns of ownership: in the East, more than 80% of forest land is privately owned, while in the West, about two-thirds is publicly owned. Forest industry ownership accounts for about 13% of eastern forest land and 4% of western forest land; a wide variety of individuals and corporations own the rest.

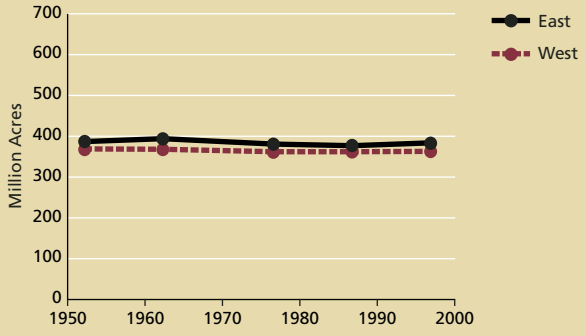
The technical note for this indicator is on page 239.

Forest Area: Historic Trends



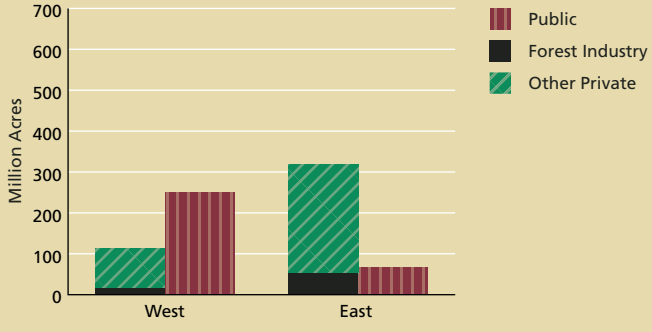
Data Source: USDA Forest Service. Coverage: all 50 states.

Forest Area: Recent Trends



Data Source: USDA Forest Service. Coverage: all 50 states.

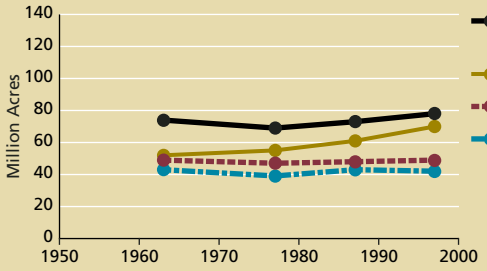
Forest Ownership (1997)



Data Source: USDA Forest Service. Coverage: all 50 states.

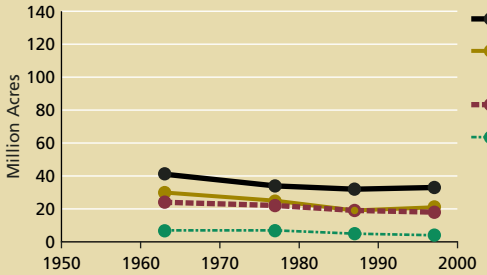
Forest Types

Western Forest Cover Types Increasing in Area



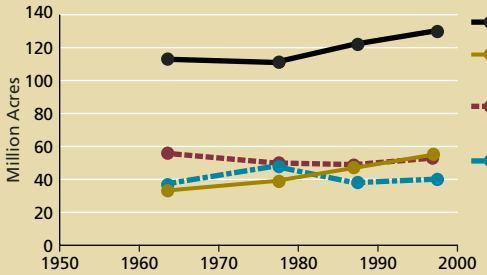
Data Source: USDA Forest Service. Coverage: all 50 states.

Western Forest Cover Types Decreasing in Area



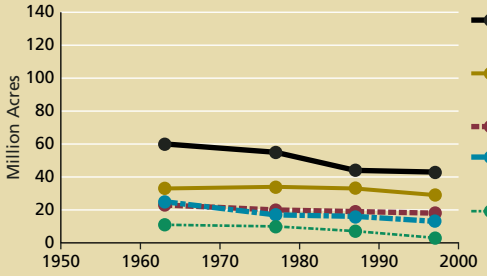
Data Source: USDA Forest Service. Coverage: all 50 states.

Eastern Forest Cover Types Increasing in Area



Data Source: USDA Forest Service. Coverage: all 50 states.

Eastern Forest Cover Types Decreasing in Area



Data Source: USDA Forest Service. Coverage: all 50 states.

What Is This Indicator, and Why Is It Important? This indicator reports the acreage of a variety of forest "cover types." Cover types describe the dominant species of trees found in the forests (e.g., oak–hickory forests are dominated by oaks and hickories, but include other kinds of trees as well).

Forest type may change as a result of direct human intervention (fire suppression, planting and harvesting, development, and grazing) or because of natural succession. Changes in climate may also affect the range of different forest types.

Different plants and animals live in different types of forests. In addition, the types of forest available influence the way people use them for recreation and other purposes.

What Do the Data Show? From 1963 to 1997, oak–hickory and maple–beech–birch in the East and fir–spruce in the West increased the most (by 18 million, 22 million, and 18 million acres, respectively).

In the East, longleaf–slash pine and lowland hardwoods (elm–ash–cottonwood and oak–gum–cypress) had the largest decreases in acreage (12 million and 17 million acres, respectively). In the West, hemlock–sitka spruce, ponderosa pine, and lodgepole pine decreased the most (by 9 million, 8 million, and 6 million acres, respectively).

In both regions, "nonstocked" land (land where trees have been cut but that has not yet regrown as forest) has declined steadily.

It is important to note that total forest area changed very little over this period. In general, the increases or reductions described here represent shifts from one forest type to another.

The technical note for this indicator is on page 240.

Forest Management Categories

What Is This Indicator, and Why Is It Important? This indicator reports the percentage of forest area in several different management categories. These range from "reserved lands" (forests in national parks, wilderness areas, and other similar areas) to forests under intensive management involving replanting after harvest. Other forest lands are subject to a wide variety of both management practices and restrictions on use.

How a forest is managed influences the goods and services that it provides. Heavily managed areas produce fiber and other wood products, while the value of reserved areas may lie in the solitude they offer, the rare plants and animals they shelter, or the watersheds they protect.

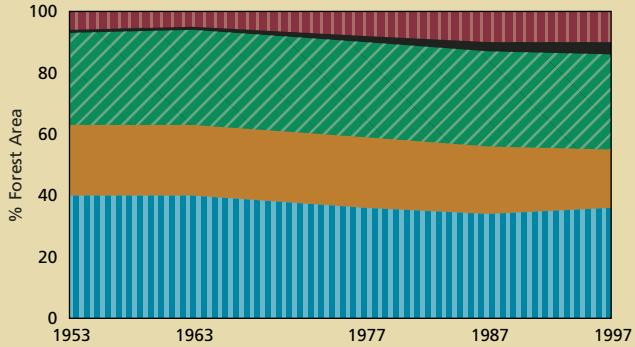
What Do the Data Show? In 1997, 10% of eastern forests and 4% of western forests were in intensively managed plantations (planted timberlands). Eleven percent of western forests and 3% of eastern forests were in reserved forest lands (federally designated wilderness areas or national parks). (Data are not currently available to support national reporting on reserved lands in private or other public ownership.) Nationwide (East plus West), reserved forest land doubled between 1953 and 1997, while planted timberland increased tenfold.

Other forest lands receive less-intensive management activity, which may include periodic timber harvest. Nineteen percent of forests in the West grow too slowly to support timber harvest under current economic conditions; these forests are identified as "other natural or semi-natural forest lands" in the graph above.

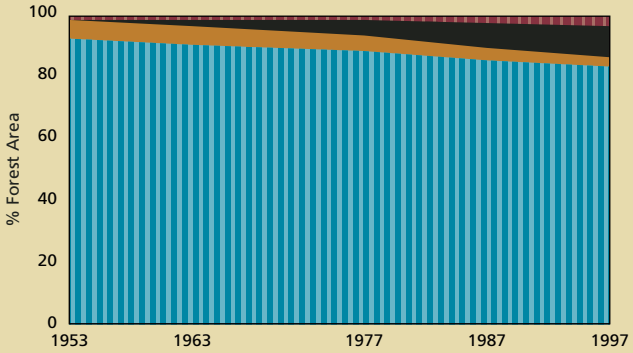
The technical note for this indicator is on page 240.

Management Categories

Management Categories, West



Management Categories, East



Reserved forest land: land where timber harvesting is prohibited by statute. Data shown for this category currently include only national parks and federally designated wilderness areas. Future reports will track reserved forests in private and other public ownership.

Planted timberland: planted with nursery seedlings and intended for repeated harvest.

Interior Alaska: distinguished here because—regardless of its legal or management status, it is practically "off-limits" at this time because of its remoteness; so is similar to "reserved forest land".

Other natural/semi-natural forest land: forest that grows too slowly or too sparsely to support timber harvest under current economic conditions and is neither in national parks or wilderness areas, nor managed by planting seedlings from a nursery.

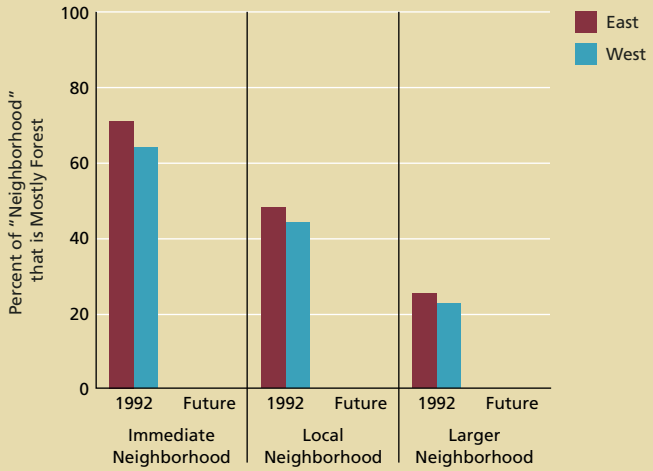
Natural/semi-natural timberland: "timberland" is any forest land that grows fast enough to support harvesting and that is not in an area, such as a national park or wilderness area, where harvesting is prohibited by statute. This term does *not* imply that harvesting is being, will be, or should be carried out. On "natural and semi-natural" lands, new trees grow from seeds from nearby trees, not from planted seedlings.

Data Source: USDA Forest Service. Coverage: all 50 states.

SYSTEM DIMENSIONS	CHEMICAL AND PHYSICAL	BIOLOGICAL COMPONENTS	HUMAN USES
Extent	Nutrients, Carbon, Oxygen	Plants and Animals	Food, Fiber, and Water
Pattern	Contaminants	Communities	Recreation and Other Services
	Physical	Ecological Productivity	

◐ Forest Pattern and Fragmentation

Forest Cover and "Neighborhood" Size



Immediate neighborhood: land within a radius of about 250 ft from each forest point

Local neighborhood: land within a radius of about 1/4 mile from each forest point

Larger neighborhood: land within a radius of about 21/2 miles from each forest point

Mostly forest: land that is at least 90% forested (less than 10% nonforest)

Data Source: Multi-Resolution Land Characterization Consortium; USDA Forest Service. Coverage: lower 48 states.

What Is This Indicator, and Why Is It Important? Imagine that it was possible to measure, for each tree in the nation's forests, whether that tree was surrounded by more-or-less complete forest cover, or whether its "neighborhood" contained a substantial amount of nonforest cover (agriculture, developed areas, recently cleared land, roads, railroads, powerline rights-of way, etc.). Some trees have only small forested neighborhoods, while others are surrounded by larger forested regions.

This indicator describes a tree's forest neighborhood according to the degree of forest cover within various distances. Thus, the "immediate neighborhood" of a particular tree is everything within about 250 feet in all directions. This "immediate neighborhood" is "mostly forest" if the land is at least 90% forested. A tree's "local neighborhood" extends about ¼ mile in all directions, and its "larger neighborhood" extends about 2½ miles. This analysis relies upon computer analyses of satellite data on millions of individual forest points. While these points (called "pixels") are not individual trees—they are squares about 100 feet on a side—they serve much the same purpose.

"Forest fragmentation" describes the degree to which forested areas are being broken into smaller patches and interspersed with nonforest areas. Research has shown that forest close to nonforest cover is often warmer and drier, more likely to be affected by wind, and more likely to be invaded by non-native species. In addition, forest animals that live near developed areas, farmlands, or roads are more likely to be affected by collisions with cars, increased hunting pressure, noise, lights, predation by cats and dogs, etc.

These effects may be felt at different distances from the nonforest edge. In addition, some species are quite sensitive to these effects, while others are less affected. Because these variations in both effect and response by species mean that there is no single distance threshold for the extent of such effects, this indicator presents a range of different neighborhood sizes.

What Do the Data Show? About two-thirds of all points in both eastern and western forests have land cover that is mostly forest—that is, 10% or less of the area is nonforest—within their immediate neighborhood (roughly 250-foot radius). About a quarter of all forest points are surrounded by larger (roughly 2½-mile radius) neighborhoods that are "mostly forest." Tracking this indicator through time is important, because it will help distinguish between natural forest patterns and changes caused by human activity.

SYSTEM DIMENSIONS	CHEMICAL AND PHYSICAL	BIOLOGICAL COMPONENTS	HUMAN USES
Extent	Nutrients, Carbon, Oxygen	Plants and Animals	Food, Fiber, and Water
Pattern	Contaminants	Communities	Recreation and Other Services
	Physical	Ecological Productivity	

◐ Forest Pattern and Fragmentation *(continued)*

Discussion This analysis does not distinguish between fragmentation caused by human activity (development, agriculture, etc.) and natural patchworks of forest and nonforest cover. Many western forests in particular are characterized by natural intermingling of forest and grasslands or shrublands.

The satellite remote sensing data presented here can generally identify forest features that are at least 10,000 feet square, or about 100 feet on a side. Thus, features that are narrower than about 100 feet—for example, some roads, powerlines, residential development within otherwise-wooded areas, or other small nonforest land uses—are missing. (Somewhat larger features may also be missed if they are split between multiple pixels.) Future analyses could include these smaller features by using satellite data that can discern smaller nonforest areas, or using ancillary information, such as mapped databases showing the location of these smaller features.

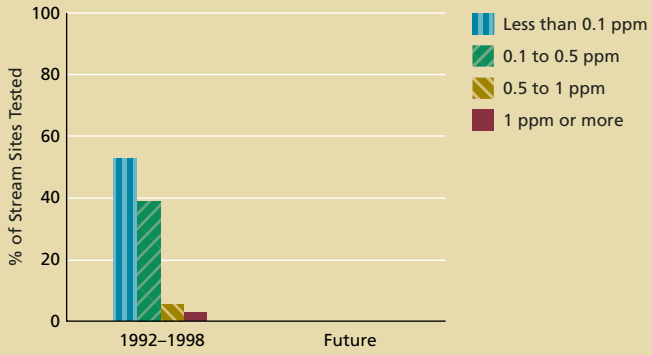
This analysis treats all nonforest land uses similarly, whether they are clumped together, spread evenly across a landscape, or strung together in a line (e.g., as a road or powerline). Different types of breaks in forest cover may affect forests in different ways—concentrations of nonforest cover may have major impacts on local habitat suitability, while linear features such as roads can serve as barriers to species movement. Future analyses might weight some nonforest areas or patterns more than others.

The "neighborhoods" used in this analysis are intended to provide a perspective on forest pattern, not to represent the habitat needs of particular species.

The technical note for this indicator is on page 240.

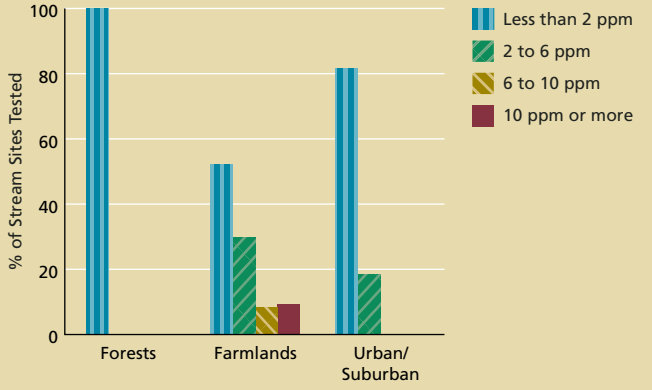
Nitrate in Streams

Nitrate in Forest Streams



Data Source: USGS National Water Quality Assessment. Coverage: lower 48 states. Each sampling area was sampled intensively for approximately 2 years during 1992–1998.

Ecosystem Comparison: Nitrate in Streams, 1992-1998



Data Source: USGS National Water Quality Assessment. Coverage: lower 48 states. Each sampling area was sampled intensively for approximately 2 years during 1992–1998.

What Is This Indicator, and Why Is It Important? This indicator reports on the concentration of nitrate in representative streams in forested areas. Specifically, the indicator reports the percentage of streams with average nitrate concentrations in one of four ranges, for streams draining watersheds that are primarily forested.

Nitrate is a naturally occurring form of nitrogen and an important plant nutrient; it is often the most abundant of the forms of nitrogen that are readily usable by plants, including algae. Increased nitrate in streams that ultimately empty into coastal waters can lead to algal blooms in those waters, which can decrease recreational and aesthetic values and help deplete oxygen needed by fish and other animals (see the national nitrogen indicator and the hypoxia indicator, pp. 46 and 71). Elevated nitrate in drinking water can also cause human health problems.

Elevated amounts of nitrate in streams are a sign that inputs from human sources have increased or that that plants in the system are under stress. Nitrogen is a critical plant nutrient, and most nitrogen, including nitrate, is used and reused by plants within an ecosystem. Thus, in undisturbed forested ecosystems, there is relatively little "leakage" into either surface runoff or groundwater, and concentrations are very low. Elevated stream nitrate might come from land clearing, the use of fertilizer in the watershed, or from rain and snowfall (in the form of acid rain).

What Do the Data Show? Almost all forest stream sites (97%) had nitrate concentrations below 1 part per million (ppm), more than three-fourths had concentrations of less than 0.5 ppm, and more than half had concentrations of less than 0.1 ppm.

Most streams in urban/suburban areas also have low average nitrate concentrations (less than 2 ppm), while farmland streams have the highest nitrate concentrations (see pp. 95 and 186). There is also a core national indicator for nitrogen (p. 46).

The federal drinking water standard for the protection of human health is 10 ppm of nitrate, which is exceeded only in agricultural areas (see p. 95).

The technical note for this indicator is on page 232.

Carbon Storage

What Is This Indicator, and Why Is It Important? This indicator reports how much carbon—an essential component of all organisms—is stored in forests, including trees, soil, and plant litter on the forest floor, and in wood products.

Carbon storage has become important in international negotiations on the management of greenhouse gas emissions, because increased carbon storage can be useful in offsetting emissions of carbon from fossil fuel burning and other sources. The amount of carbon stored in forests can change through the adoption of forest management practices that allow the incorporation of more plant materials into forest soils, changes in age structure (see Forest Age, p. 126), and increases in the extent of forested areas (see Forest Area and Ownership, p. 117).

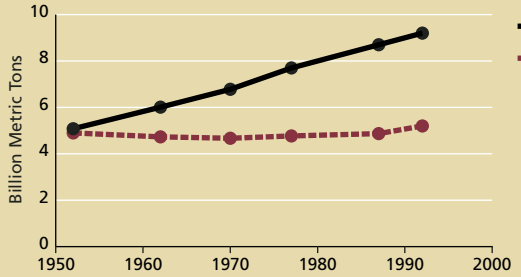
What Do the Data Show? The amount of carbon stored in trees in the East increased by 80% from1950 to 1992, despite relatively modest changes in forest area. This increase has been attributed to growth on farmlands allowed to revert to forests, maturing of second-growth forests, and to increased growth in some southeastern forests. In western forests, the addition of new carbon through forest growth was offset by harvest, resulting in little change in the overall amount stored. Note that, unlike many other forest indicators, these data do not reflect changes that occurred after 1992.

Carbon Stored in Forests

Data Not Adequate for National Reporting on

- Soils
- Forest Floors
- Wood Products
- Nontimberland Forests

Partial Indicator Data: Carbon Stored in Trees (Timberlands only)



Data Source: USDA Forest Service. Coverage: timberlands in lower 48 states.

Note: "Timberlands" is a USDA Forest Service designation for lands that grow at least 20 cubic feet of wood per acre per year, which is considered to be sufficient to support commercial harvest under current economic conditions. Lands on which harvest is prohibited by statute are not included as "timberlands."

Why Can't This Entire Indicator Be Reported at This Time? More data are needed to report on the amount of carbon stored in forest soils, in leaf litter and other decomposing matter on the ground in forests, and in forest products in use or slowly decomposing in landfills.

In addition, available data are limited to timberlands, but data collection will be more comprehensive in future.

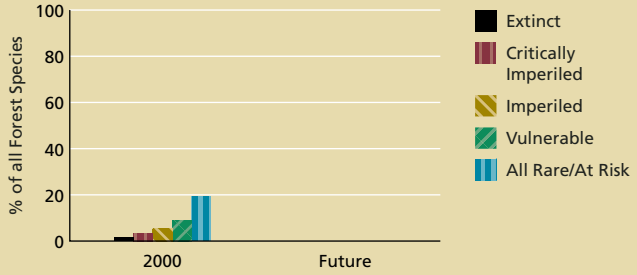
The technical note for this indicator is on page 241.

At-Risk Native Forest Species

At-Risk Species, by Risk Category

Data Not Adequate for National Reporting on
■ Forest Plants

Partial Indicator Data: Animals Only

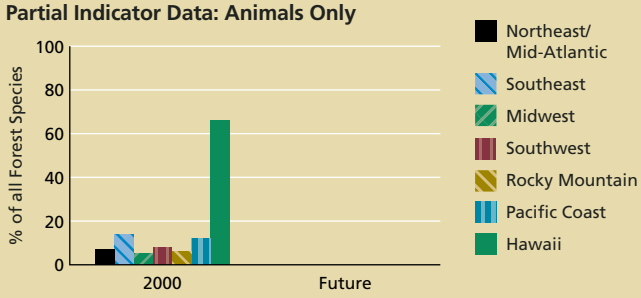


Source: NatureServe and its natural heritage member programs.
Coverage: all 50 states.

At-Risk Species, by Region

Data Not Adequate for National Reporting on
■ Forest Plants

Partial Indicator Data: Animals Only



Source: NatureServe and its natural heritage member programs.
Coverage: all 50 states.

What Is This Indicator, and Why Is It Important? This indicator reports on the relative risk of extinction of native forest species. The risk categories are based on such factors as the number and condition of individuals and populations, the area occupied by the species, population trends, and known threats. Degrees of risk reported here range from very high ("critically imperiled" species are often found in five or fewer places or have experienced very steep declines) to moderate ("vulnerable" species are often found in fewer than 80 places or have recently experienced widespread declines). In all cases, a wide variety of factors contribute to the overall ratings. "Forest species" live in forests during at least part of their life and depend on forest habitats for survival.

Species are valued for a variety of reasons: they provide products, including food, fiber, and, more recently, genetic materials; they are key elements of ecosystems, which themselves provide valuable goods and services; and many people value them for their intrinsic worth or beauty.

What Do the Data Show? About 3.5% of native forest animal species are critically imperiled, about 5% are imperiled, and 1.5% are or may be extinct. When vulnerable species (9%) are counted, a total of about 20% of forest animals are considered to be "at risk." Hawaii has a much larger percentage of at-risk forest species than any other region.

Interpreting these figures is complicated, however, because some species are naturally rare. Thus, the rankings are influenced by differences among regions and species groups in the number of naturally rare species, as well as by different types and levels of human activities that can cause species declines. Interpretation of these data will be greatly enhanced when information on population trends for these at-risk species becomes available.

Why Can't This Entire Indicator Be Reported? This indicator reports on mammals, birds, reptiles, amphibians, grasshoppers, and butterflies. Data on other groups have not been included either because too little is known to assign risk categories or, as with most plants, because determinations of which species are associated with forests, grasslands, or other habitats have not been completed.

See also the national at-risk species indicator (p. 52) and the indicators for at-risk coastal, freshwater, and grassland and shrubland species (pp. 75, 144, and 168), as well as the indicators for species in farmlands (p. 103) and urban and suburban areas (p. 191).

The technical note for this indicator is on page 214.

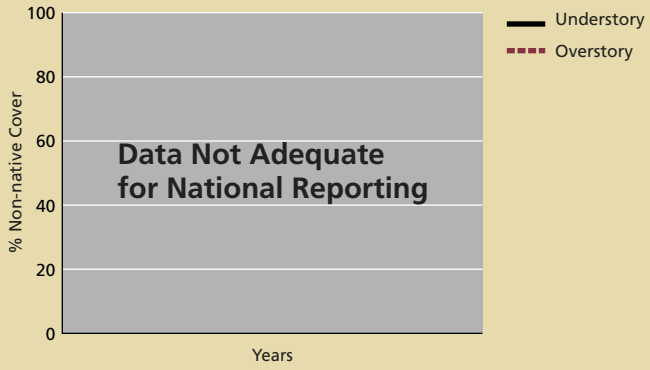
⊖ Area Covered by Non-native Plants

What Is This Indicator, and Why Is It Important? This indicator describes the degree to which non-native plants are found in U.S. forests. It will report the percentage of the total area covered by overstory (large trees that form the canopy) and understory (shrubs, ground plants, and smaller trees) that is made up of non-native plants.

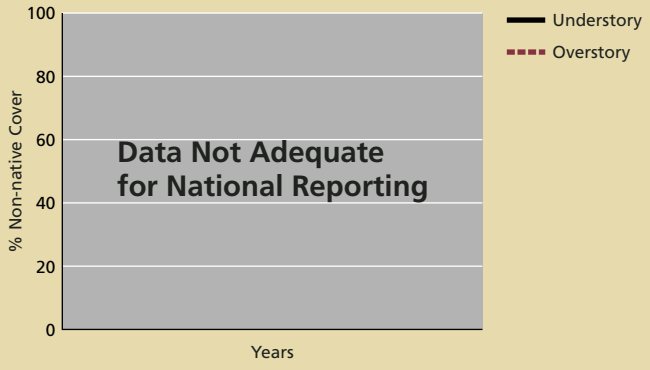
Species are generally considered to be non-native if their natural range does not include North America, although there is growing recognition that species that are native to one part of the United States may cause problems if they spread to other areas. Non-native species may spread aggressively and crowd out species that are native to a region; they may also alter essential habitat of native species, by shading native plants or by consuming large quantities of water, for example.

Well-known non-native species in the East include kudzu, melaleuca, and ailanthus, while western species include eucalyptus and Russian olive. Some non-native plants were introduced accidentally; others were originally planted for landscaping (e.g., Norway maple, multiflora rose) or for purposes such as erosion control (Russian olive). In general, forests with greater coverage by non-native species are subject to higher levels of ecological disruption, which may in turn have economic consequences.

Forest Area Covered by Non-native Plants, West



Forest Area Covered by Non-native Plants, East



Why Can't This Indicator Be Reported at This Time? The USDA Forest Service Forest Inventory and Analysis (FIA) program is developing and testing protocols for reporting non-native plant cover. Data from this program will be included in future reports.

For other non-native species indicators, see pp. 76, 104, 145, and 169.

The technical note for this indicator is on page 242.

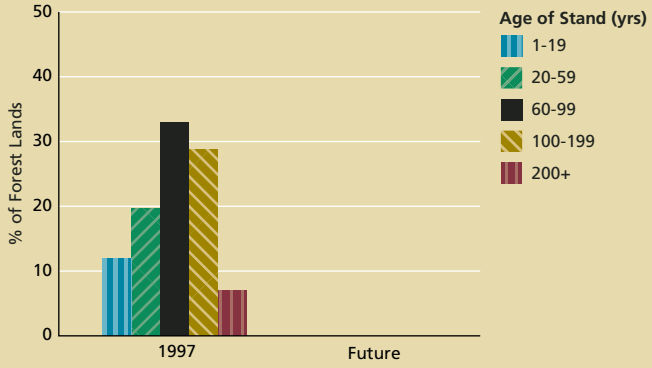
Forest Age

Forest Age

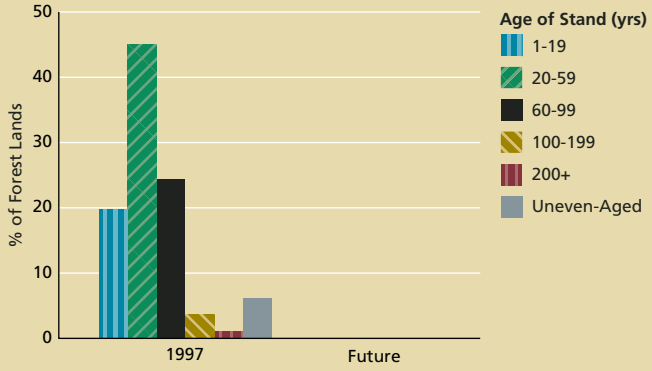
Data Not Adequate for National Reporting on

- Forest Lands Other Than Those Classified As Timberlands

Partial Indicator Data: West (Timberlands Only)



Partial Indicator Data: East (Timberlands Only)



Data Source: USDA Forest Service. Coverage: all 50 states (timberlands only.)

Note: "Timberlands" is a USDA Forest Service designation for lands that grow at least 20 cubic feet of wood per acre per year, which is considered be sufficient to support commercial harvest under current economic conditions. Lands on which harvest is prohibited by statute are not included as "timberlands." Note also that the term "uneven-aged" is being phased out; such stands are composed of intermingled trees that differ considerably in age.

What Is This Indicator, and Why Is It Important? This indicator reports the percentage of forest lands with stands in several age classes. Forests of different ages often provide different goods, services, and values. For example, woodpeckers and species that need trunk cavities for nesting find older forests, with their dead trees, a suitable habitat. Younger forests, with their rapid growth and smaller trees, provide habitat for species such as the Kirtland's warbler, which can only live in forests recently regrown after fire.

What Do the Data Show? Sixty-five percent of eastern timberlands, where most of the nation's timber products are produced (see Timber Harvest, p. 130), are less than 60 years old, and 90% are less than 100 years old. Most of the nation's older timberland stands are in the West—about 35% of western timberlands are more than 100 years old, and about 30% are less than 60 years old. Although not included in this indicator, most of the nation's forests in wilderness areas and national parks, which contain many old stands, are also in the West (see Forest Management Categories, page 119).

Why Can't This Entire Indicator Be Reported at This Time? Data are currently available only for timberlands. Data on the age class of forest trees are not available for national parks and wilderness areas and other forest land not classified as timberlands. These data will be available for future reports.

Discussion Forest age structure reflects historic and current management as well as natural factors. For example, the high percentage of younger forests in the eastern United States reflects such factors as the reforestation of former agricultural land, the management of many private landholdings for commercial harvesting, and the fact that very old stands are much less common in the East.

The technical note for this indicator is on page 242.

Forest Disturbance: Fire, Insects, Disease

What Is This Indicator, and Why Is It Important? This indicator reports the acreage of forest affected each year by several important types of disturbance: forest fires, insects, and diseases of trees.

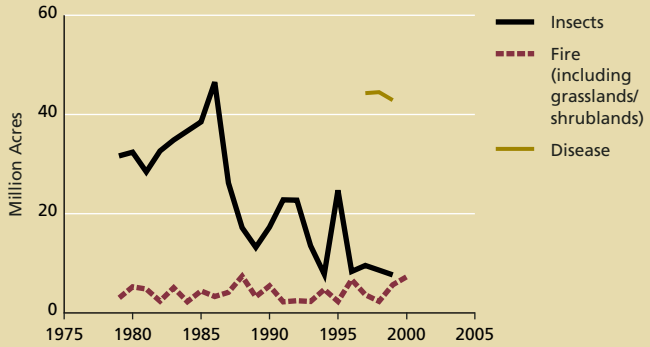
Fires, insects, and diseases are, for the most part, natural influences on forests. However, at times, such influences can exceed or otherwise differ from what might be encountered in an undisturbed ecosystem. For example, fire suppression may foster the conditions necessary for catastrophic fires, and introduced pests like gypsy moths and Dutch elm disease can devastate large areas.

What Do the Data Show? Fewer acres have been burned by wildfire in recent decades than in the first half of the 20th century. Since 1980, between 2 million and 7 million acres burned per year, down from a high of 52 million acres in 1930; the decline is largely due to fire suppression policies and practices. Note that the data reported here describe all wildfires, including both forest fires and grassland/shrubland fires. Although nationwide data do not show an increase in recent decades, data (not shown here) from national forests, which are mostly in the West, do show a significant increase.

Insect damage varies dramatically from year to year. Five insect species together affected between 8 million and 46 million acres per year from 1979 to 1999, with a clear trend toward fewer acres over that time. Many insect populations go through major cycles of year-to-year variation. For example, much of the variation over the past 20 years results from such cycles for gypsy moth and southern pine beetle.

In recent years, 43–44 million acres have been affected by two major diseases/parasites (fusiform rust and dwarf mistletoe).

Fire, Insects, and Disease: Recent Trends

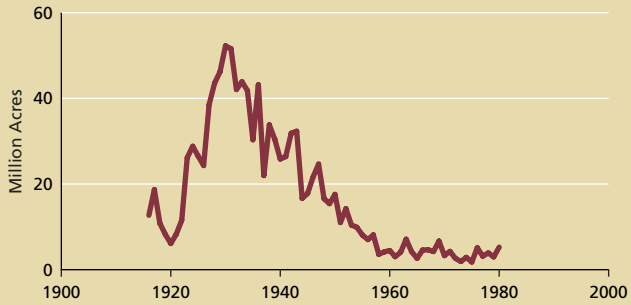


Insects: gypsy moth, spruce budworm, southern pine beetle, mountain pine beetle, western spruce budworm (all but the gypsy moth are native to the United States.)

Diseases: fusiform rust, dwarf mistletoe

Data Source: USDA Forest Service Forest Health Protection/Forest Health Monitoring Program (insects, disease), National Forest System (fire); note that these data are not limited to national forests. Coverage: all 50 states

Historic Wildfire Acreage (Forests and Grassland/Shrubland)



Data Source: USDA Forest Service, National Forest System; note that these data are not limited to national forests. Coverage: all 50 states

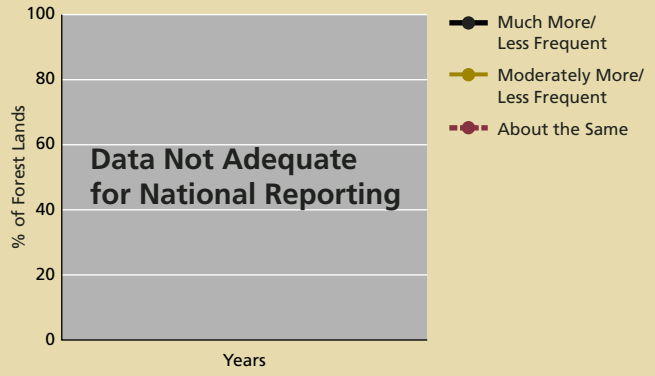
Discussion It would be desirable to be able to report on acreage affected by forest fires (as distinct from other wildfires), on the acreage subject to different levels of fire intensity, and on the acreage of prescribed fire (fires that are intentionally set as a management tool). In addition, data on the acreage affected by other diseases is not available. Finally, some non-native insects, such as the hemlock woolly adelgid, which affects half of all eastern hemlock forests, may spread widely before it causes damage that is apparent from aerial surveys.

See also Fire Frequency (p. 128).

The technical note for this indicator is on page 242.

⊖ Fire Frequency

Fire Frequency, Compared to Presettlement



What Is This Indicator, and Why Is It Important? This indicator describes the frequency with which forests are burned by wildfire. It would report the fraction of forest lands that experience wildfire much more or less frequently, moderately more or less frequently, or with about the same frequency as in presettlement times. Thus, a forest that, historically, burned every 50 years on average will be considered moderately altered if it burns every 100 years, and significantly altered if it burns only every 150 years, and about the same if it burns once every 50 years.

Fire has always been an important influence on most forest types—indeed, it is necessary for the maintenance of some forest types—and it will continue to be important in the future. Periodic fires shape forest composition by allowing certain fire-adapted species to thrive while removing other, less tolerant, trees. For most of the past 10,000 years (since the last Ice Age), most forests in the lower 48 states burned regularly, with fires started by lightning or by American Indians, who used fire to manage forests and grasslands. There is increasing interest in forest management practices that incorporate fire and other disturbances in ways that mimic historic patterns.

Why Can't This Indicator Be Reported at This Time? This indicator requires information on both the historic and current fire frequency. While current fire frequency data are not difficult to collect, it is not simple to determine the historic fire frequency of an area or forest type. Researchers have estimated historic fire frequencies, but at this time, fire frequency data has been measured (from tree ring scars and similar evidence) at only a few sites.

Discussion Active suppression of forest fires dramatically changes forest composition, structure, and ecology. In suppressed areas, there are often more trees per acre and a higher frequency of certain species whose spread was formerly controlled by fire. In the East, for example, red maple has increased in eastern oak and pine forests, and in the West, white fir and incense cedar are now more common in ponderosa pine and giant sequoia forests. In some forests, like ponderosa pine, the denser forests produced by fire suppression are subject to hotter fires, which kill more trees. In other areas, such as eastern oak forests, fire suppression favors trees like maples, birches, and beech, with a corresponding decrease in both flammability and the number of oaks.

See page 171 for an indicator of fire frequency in grasslands and shrublands.

The technical note for this indicator is on page 243.

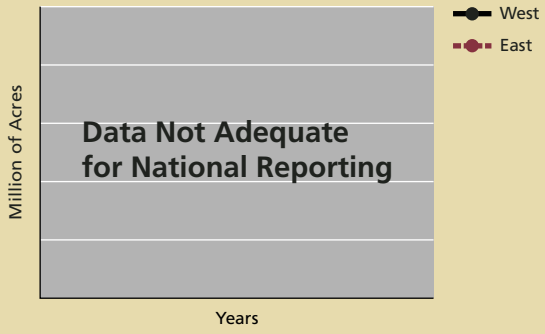
⊖ Forest Community Types with Significantly Reduced Area

What Is This Indicator, and Why Is It Important? This indicator would report whether those forest community types that cover significantly fewer acres than they did in presettlement times are increasing or decreasing in area, and by how much. It would also report the total area occupied by these much-reduced forest community types—those that have been reduced by 70% or more in area.

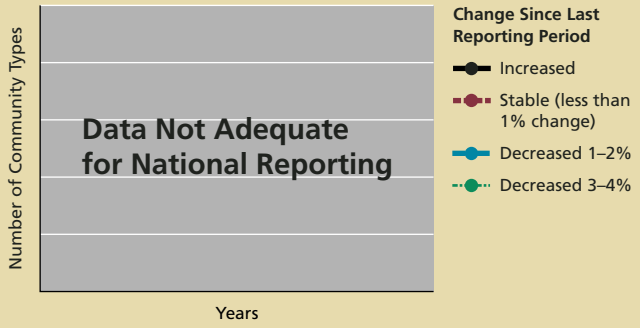
Forest community types, such as Virginia pine–oak, American beech–southern magnolia, Douglas fir, and longleaf pine–oak, are characterized by certain plant and animal species that depend on the particular habitat provided by that forest type. When the area occupied by a forest community declines, populations of animals and plants that are highly dependent upon that community type may also decrease.

Some forest community types occupy much less area than they did at the time of European settlement. For example, redwood forest, which occupied an estimated 2.19 million acres before European settlement, now occupies 1.32 million acres, a decline of 40%. Similarly, Great Lakes pine forest, which occupied an estimated 18 million acres before European settlement, now occupies 4.1 million acres, a decline of 77%, and oak savanna, which covered about 30 million acres of the Midwest at the time of European settlement, covered only about 7000 acres, or about 0.02% of its historic area, in 1985.

Total Area of Forest Community Types with Significantly Reduced Area



Change in Area of Forest Community Types with Significantly Reduced Area



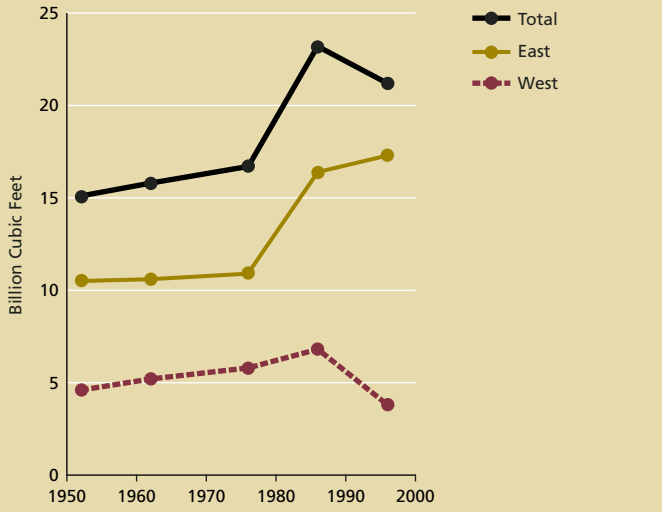
These declines may result from outright conversion, such as the clearing of forests for agriculture, or they may result from less direct changes: when fire is suppressed for long periods, different species thrive, creating a different community type.

Why Can't This Indicator Be Reported at This Time? Data on historic and current area of many forest types are not available. Methods are being developed to obtain estimates of current area from existing USDA Forest Service data. It is also possible to estimate historic area, but this has not been done on a comprehensive basis.

The technical note for this indicator is on page 243.

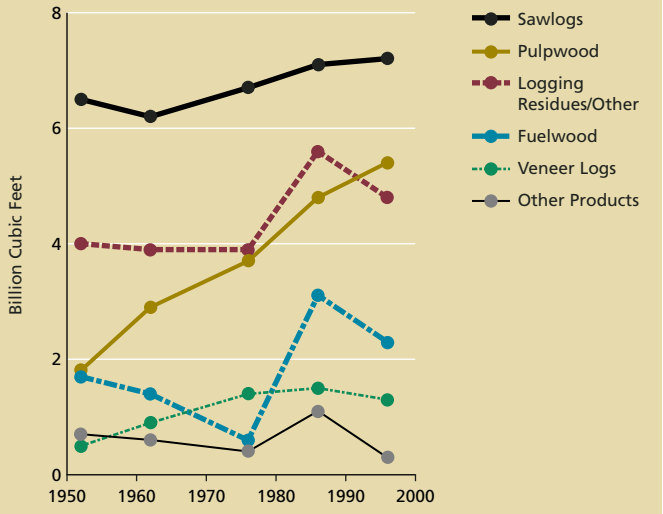
Timber Harvest

Timber Harvest by Region



Data Source: USDA Forest Service. Coverage: all 50 states.

Timber Harvest by Use



Data Source: USDA Forest Service. Coverage: all 50 states.

What Is This Indicator, and Why Is It Important? This indicator reports trends in timber harvest, by region and by primary product category (sawlogs, pulpwood, etc.)

The production of wood products provides employment, generates economic benefits, and meets society's needs for wood, paper and other products. Demand for these products drives harvesting and other forest management activities.

What Do the Data Show? Nationally, timber harvest increased by about 40% from 1952 to 1996. There was slow, steady growth through 1976, followed by a sharp increase from 1976 to 1986, and a subsequent decline. After 1986, harvest continued to rise in the East, but this increase was more than offset by decreases in harvest in the West.

Pulpwood production tripled from 1952 to 1996, increasing to 25% of total harvest (pulpwood is used for paper and similar products). One-third of the total harvest is used to produce sawlogs; this fraction is down slightly from 1952, despite a 20% increase in harvest for this purpose. Harvest for all uses other than pulpwood and sawlogs declined in 1996 compared to 1986.

See Growth and Harvest (opposite page) for a discussion of harvest trends on public and private lands.

The technical note for this indicator is on page 244.

Timber Growth and Harvest

What Is This Indicator, and Why Is It Important? This indicator reports the amount of new wood grown and the amount of wood harvested each year on public and private timberlands, by region. The balance between growth and harvest tells us whether the amount of wood potentially available for harvest is increasing or decreasing.

What Do the Data Show? Growth exceeds harvest on both public and private timberlands in both the East and West; with the exception of private timberlands in the West, this has been true for the past 50 years. This difference is increasing in the West (particularly on public lands) and decreasing in the East.

Growth is higher on public and private lands in both East and West than it was in the 1950s, although growth in eastern forests (both public and private) is lower than it was at its peak in the mid-1970s.

Following a peak in the mid-1980s, harvest decreased on public lands in the West; harvest levels in the 1990s on both public and private lands were below those of the 1950s. Harvest on public and private lands in the East increased from the mid-1980s to the mid-1990s, with private lands accounting for the vast majority of both overall and increased production. Nationally, private lands account for almost 90% of total harvest, a figure that has grown only slightly since the 1950s.

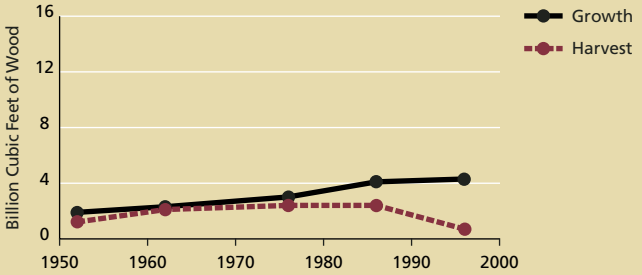
Although not shown, there may be substantial differences between northern and southern areas within the eastern and western regions shown here.

See also Timber Harvest (opposite page).

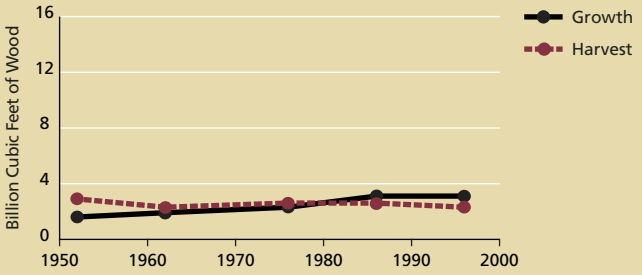
The technical note for this indicator is on page 245.

Timber Growth and Harvest

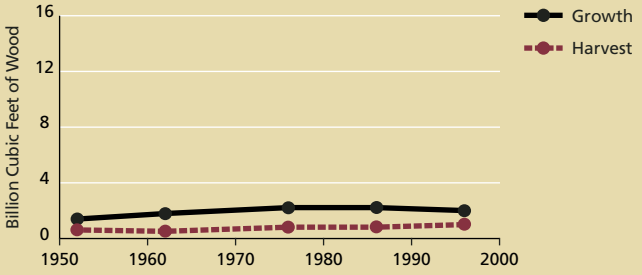
Timber Growth and Harvest, West, Public Timberlands



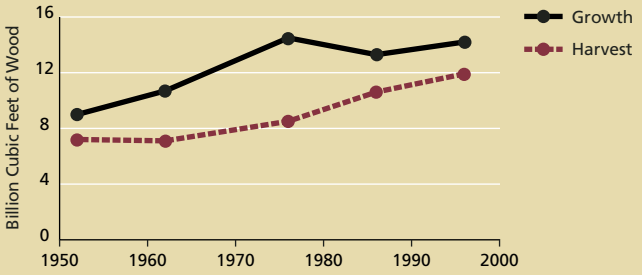
Timber Growth and Harvest, West, Private Timberlands



Timber Growth and Harvest, East, Public Timberlands



Timber Growth and Harvest, East, Private Timberlands

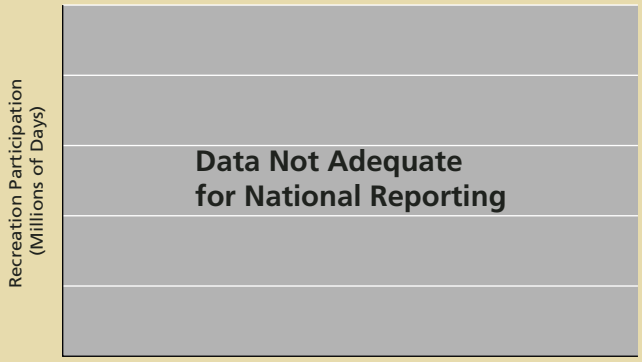


Data Source: USDA Forest Service. Coverage: all 50 states.

Note: "Timberlands" is a USDA Forest Service designation for lands that grow at least 20 cubic feet of wood per acre per year, which is considered to be sufficient to support commercial harvest under current economic conditions. Lands on which harvest is prohibited by statute are not included as "timberlands."

⊖ Recreation in Forests

Recreation on Forest Land



What Is This Indicator, and Why Is It Important? This indicator would report the number of days per year that people engage in a variety of recreational activities in forests. Activities such as walking, hiking and backpacking, fishing and hunting, wildlife viewing, cross-country and downhill skiing, and snowmobiling would be included.

A great deal of recreational activities takes place within our nation's forests. Recreation is a benefit that is derived from forests in much the same way that we derive products such as timber.

Why Can't This Indicator Be Reported at This Time? There are no national data sets that document the type and amount of recreation in forests. The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (http://fa.r9.fws.gov/surveys/surveys.html) and the National Survey on Recreation and the Environment (http://www.srs.fs.fed.us/trends/nsre.html) both provide reliable data on these activities, but neither survey identifies whether these activities take place in forests, on grasslands or shrublands, on farmlands, or elsewhere.

Adequate reporting would require modification of existing surveys to elicit information either on the location of recreational activities or on the amount of recreation in forested areas.

This report also includes other indicators of recreational activity. See pp. 60, 109, 153, and 174.

There is no technical note for this indicator.