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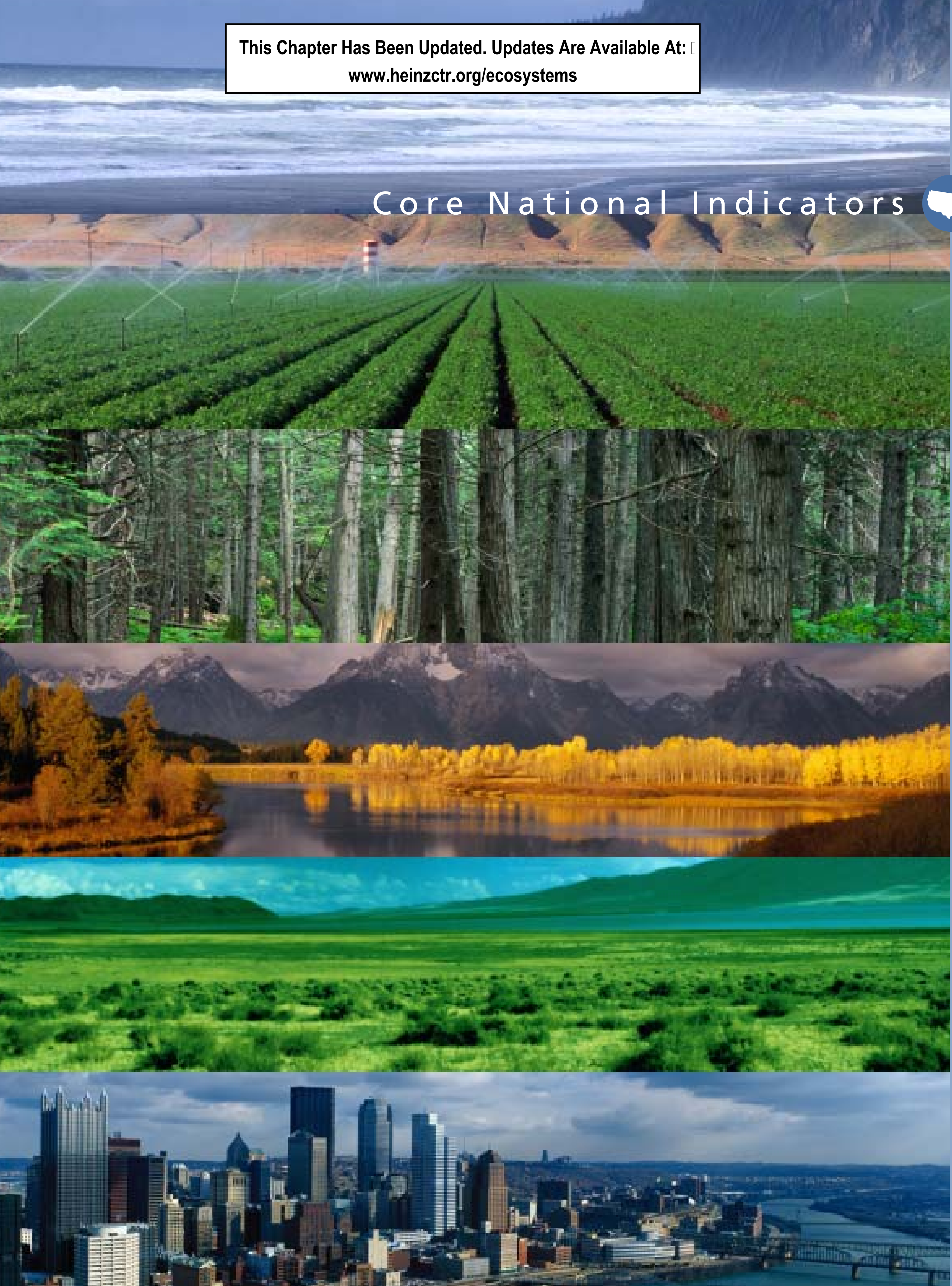
Core National Indicators



	What are the Core National Indicators?		Can we report trends? Are there other useful reference points?
SYSTEM DIMENSIONS			
◐	Ecosystem Extent	What is the area of the six major ecosystem types?	Some trends
(?)	Fragmentation and Landscape Patterns	How fragmented are natural lands into smaller, more isolated patches? How are developed lands intermingled within the natural landscape?	No data reported
CHEMICAL AND PHYSICAL CONDITIONS			
●	Movement of Nitrogen	How much nitrogen leaves watersheds across the country, and how much is delivered to coastal waters?	Trends
◐	Chemical Contamination	How frequently are chemical contaminants found in ecosystems, and how often do they exceed standards and guidelines for the protection of human health and aquatic life?	Current data only, federal standards and guidelines
BIOLOGICAL COMPONENTS			
◐	At-Risk Native Species	How many native species are at different levels of risk of extinction?	Current data only
(?)	Condition of Plant and Animal Communities	What fraction of U.S. lands and waters are highly managed or highly altered, and what levels of disturbance are found on natural/semi-natural lands?	No data reported
●	Plant Growth Index	What are the trends in plant growth in different regions and different ecosystems?	Trends
HUMAN USES			
●	Production of Food and Fiber and Water Withdrawals	How are the quantities of key ecosystem-related commodity goods changing over time?	Trends
◐	Outdoor Recreation	How often do people take part in outdoor recreation activities, and which kinds?	Current data only
(?)	Natural Ecosystem Services	What other services, such as soil building and flood protection, are provided by natural ecosystems?	No data reported

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

Chapter 4: Core National Indicators

America's ecosystems are enormous, and enormously diverse. They range from deep ocean trenches to wide grassy plains, from above the Arctic Circle to the tip of Florida. In this chapter, rather than focusing on specific ecosystems, as we do in succeeding chapters, we present ten indicators that describe key characteristics of the entire array of America's ecosystems.

These ten core national indicators provide a broad, yet succinct, description of the condition and use of ecosystems in the United States. They describe and track changes in key aspects of the area and configuration of ecosystems, significant chemical and physical conditions, biological components, and the goods and services that people derive from these systems. In doing so, they parallel the indicators presented in the six following chapters, each of which focuses on a single ecosystem. These chapters also cover ecosystem area and configuration, chemical and physical properties, biological components, and human uses, but they do so using a larger number of indicators that focus on a subset of the nation's lands and waters.

What can we say about the condition and use of U.S. ecosystems, based on these core national indicators?

Partial or complete data are available for seven of the ten core national indicators. Four of the seven have data from a long enough period to judge trends, and one uses federal benchmarks to help readers judge the significance of ecosystem conditions. The three indicators for which data are not presented require further development.

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 presentation 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

The national indicators include two measures of extent and pattern. The first is the most basic description of the state of our nation's lands and waters, the area of each of the component systems and how they change through time. The second measure, not yet developed, will describe the intermingling of the various system types across the national landscape.

- **What is the area of the six major ecosystem types?** Grasslands and shrublands and forests each occupy about a third of the area of the lower 48 states, and farmlands about a quarter. The area of forest and grasslands and shrublands has declined since European settlement, as has the area of freshwater wetlands, and the extent of cropland and urban and suburban areas has grown. More recent trends show decline in forest, croplands, grassland and shrublands, and freshwater wetlands, and increases in urban and suburban areas (Table 4.1).

  The area of ecosystems is a very basic characteristic but, for various reasons, is complex to report. The main reason is that the area of different ecosystems is often tallied by different agencies, using different methods and definitions of the systems. Satellite remote sensing, which can provide an integrated view, is available at the appropriate scale for only one time period (1992) and thus cannot provide information on changes in the area of different ecosystems.

Table 4.1. Core National Extent Measurements (lower 48 states)

Ecosystem	Core National Extent Measurements	Area in Millions of Acres	Percent of Land Area[a]	Estimated Presettlement Area (as % of Total Land Area)	Changes from 1950s, Millions of Acres (%)[a]
Grasslands and Shrublands	Total area (not including pastures)	683	36%	52%	Declining, amount and rate unknown
Forests	Total area	618	33%	48%	–9 (–1.1%)
Farmlands	Area of croplands	455	24%	—	–23 (–4.8%)
Freshwater	Area of Freshwater Wetlands	94	5%	11%	–11 (–10%)
Urban and Suburban areas	Urban and suburban lands	32	1.7%	—	Increasing, amount and rate unknown
Coasts and Oceans	Coastal brackish water	Unknown	—	Unknown	Unknown

Source: Grasslands and shrublands and urban and suburban areas: Multi-Resolution Land Characterization Consortium and the U.S. Geological Survey; data are for 1992. Forests: USDA Forest Service Forest Inventory and Analysis program; data are for 1997. Croplands: USDA Economic Research Service (see p. 91 for estimates from other agencies); data are for 1997. Freshwater and coastal wetlands: U.S. Fish and Wildlife Service; data are for mid-1990s. Coverage: lower 48 states.

[a] This table does not include 100% of lands in the United States. For example, urban and suburban areas, as defined in this report, do not include all developed areas (some developed areas are too small to be considered "suburban" or "urban"). Thus, declines in the area of forests, grasslands and shrublands, croplands, and freshwater wetlands are not—nor should they necessarily be—offset by corresponding gains in urban and suburban lands. In addition, the area of wetlands and portions of urban and suburban areas may also be counted as croplands, forests, or grasslands and shrublands. For these reasons, the figures in this table should not be added to obtain an overall estimate of U.S. land area.

Table 4.1 presents estimates from multiple sources, which means that care must be taken in comparing and adding data about different ecosystems and in tracking gains and losses from one system to another.

- **How fragmented are natural lands into smaller, more isolated patches? How are developed lands intermingled within the natural landscape?** This indicator requires further development. There is widespread recognition that these patterns are important ecologically and that they can affect people's quality of life, but there is less agreement among scientists on the most appropriate indicators to use in measuring such patterns and the most appropriate geographic scales on which to apply them. This report includes several indicators of fragmentation and landscape pattern—for forests (p. 120), farmlands (pp. 93 and 94), grasslands/shrublands (p. 163), and urban/suburban areas (pp. 182 and 183)—but these indicators focus on different aspects of fragmentation and pattern from system to system. This indicator requires further development.

Chemical and Physical Conditions

Out of the many important indicators of chemical and physical condition, we have identified two as national indicators. Nitrogen is a vital plant nutrient, but if present in excess it can cause ecological problems, especially in coastal waters. One indicator tracks the amount of nitrogen that leaves the land and is delivered to coastal waters. The second is a multipart indicator that tracks such contaminants as pesticides, PCBs, and heavy metals in streams, sediment, groundwater, and fish.

- **How much nitrogen leaves watersheds across the country, and how much is delivered to coastal waters?** Delivery of nitrogen from rivers and streams to coastal waters can cause excess algae growth, which reduces recreational and aesthetic values and can contribute to low-oxygen conditions. Watersheds in the upper Midwest and Northeast contribute the most nitrogen per square mile to rivers and streams. The amount of nitrate carried by the four largest rivers in the United States increased over the past few decades, with the amount carried by the Mississippi River—which drains more than 40% of the area of the lower 48 states—tripling since the 1950s.

- **How often are chemical contaminants found in ecosystems, and how often do they exceed standards and guidelines for the protection of human health and aquatic life?** This indicator describes the numbers of contaminants that can be detected and the frequency with which concentrations exceed applicable standards or guidelines. The indicator covers stream water, streambed and coastal sediments, freshwater and saltwater fish, and groundwater. Numbers of contaminants found, and the frequency with which they exceed applicable standards or guidelines, vary by ecosystem. For example, all streams tested averaged one or more contaminants at detectable levels throughout the year, as did 94% of freshwater fish samples and about 90% of groundwater wells tested. About three-quarters of stream samples and half of stream sediments tested had one or more compounds that exceeded guidelines for the protection of aquatic life, and about 60% of estuary sediments exceeded levels that indicate probable negative effects on aquatic life. About 15% of stream sites and one-quarter of groundwater wells had concentrations of contaminants that exceeded standards or guidelines for the protection of human health. No trend data are available for this indicator.

Biological Components

Three indicators describe biological conditions. The first tracks how many plant and animal species are at risk of extinction, because plants and animals are important as components of ecosystems and because people value them for many reasons. A second indicator, not yet developed, will measure how much of U.S. lands and waters are altered, to varying extents, from natural conditions. A third indicator tracks trends in annual plant growth, the energy that drives and sustains ecosystems.

- **How many native plant and animal species are at different levels of risk of extinction?** About 19% of native animal species and 15% of native plants species in the U.S. are ranked as "imperiled" or "critically imperiled"; such species are typically found in 20 or fewer places, may have experienced steep or very steep declines, or display other risk factors. In addition, about 4% of animals and 1% of plants are, or are believed to be, extinct. When species ranked as "vulnerable" are included, about one-third of all plant and animal species are "at risk." The degree of risk for any particular plant or animal species varies considerably, from those species at relatively low risk, to those that are in imminent danger of extinction. Hawaii has a much higher percentage of at-risk plants and animals than any other region, followed by the Pacific Coast. The Midwest and Northeast/Mid-Atlantic have the lowest percentages.

  Interpreting these figures is complicated, however, because the rankings are influenced by differences in the number of naturally rare species among regions and species groups, as well as by different types and levels of human activities that can cause species declines.
- **What fraction of U.S. lands and waters are highly managed or highly altered, and what levels of disturbance are found on natural/semi-natural lands?** How highly managed or altered an area is affects the type of species the area can support, and this directly influences the goods and services available from the area. This indicator requires further development. It is possible to identify areas that are physically altered (that is, they have a high percentage of asphalt, concrete, etc.) or highly managed (that is, they are farms, forest plantations, golf courses, etc.). However, it is not now possible to distinguish among the different levels of disturbance in natural/semi-natural lands.

- **What are the trends in plant growth in different regions and different ecosystems?** The plant growth index utilizes satellite data to estimate the amount of energy (sunlight) that is captured by plants. Changes in this index, over large regions, could signal changes in ecosystem functioning that may affect crop yields, timber growth, or other ecosystem outputs. No overall trend in plant growth can be seen for the 11-year period for which data are available, either nationally or within any region or ecosystem type. Year-to-year variation is quite high, and this variation is similar among regions and ecosystems. During 2000, plant growth nationwide was less than the 11-year average. Growth was about average in the Pacific states and the Midwest and lower than the 11-year average in the other four regions. Plant growth was farthest below the 11-year average in the Southwest.

Human Use

People rely—in many ways—on the goods and services that ecosystems provide. We distill these ways into three core national indicators. The first focuses on the commodities we get from natural ecosystems: the crops, livestock, fish, timber, water, and other goods that are sold on the market. The second tracks another major use, outdoor recreation. A third indicator, not yet developed, will focus on other services provided by ecosystems, such as flood protection and purification of air and water.

- **How are the quantities of key ecosystem-related commodity goods changing over time?** Over the past half-century or so, agricultural and forest production and freshwater withdrawals have all increased. Agricultural production grew the fastest; its growth has generally been at a higher rate than that of the U.S. population. Forest production has generally tracked population growth; in the late 1970s and early 1980s, production increased to record levels, but it has fallen somewhat in more recent years. Withdrawals of freshwater increased faster than population through 1980, declined by about 10% by the mid 1980s, and has grown slowly since then. Marine fish landings grew slowly from the late 1970s, when reliable statistics became available, through the mid-1990s, but have declined since then. Most of the regional patterns of food and fiber production and water withdrawals match the national patterns above.
- **How often do people take part in outdoor recreation activities, and which kinds?** "Fitness activities" such as walking and biking are by far the most common outdoor recreation activity for which information is available. Nature viewing and swimming and beachgoing are next in terms of overall popularity, followed by outdoor social activities like picnics and family gatherings. Altogether, people camped and hiked about as much as they went to picnics and family gatherings, and more than they hunted and fished. For many water-related activities (e.g., swimming, boating), it is not possible to distinguish whether the activity took place in fresh or salt water.
- **What other services, such as soil building and flood protection, are provided by natural ecosystems?** This indicator requires further development. There is widespread recognition that such services are important to society, but measuring them is quite challenging.

A Note about Regions

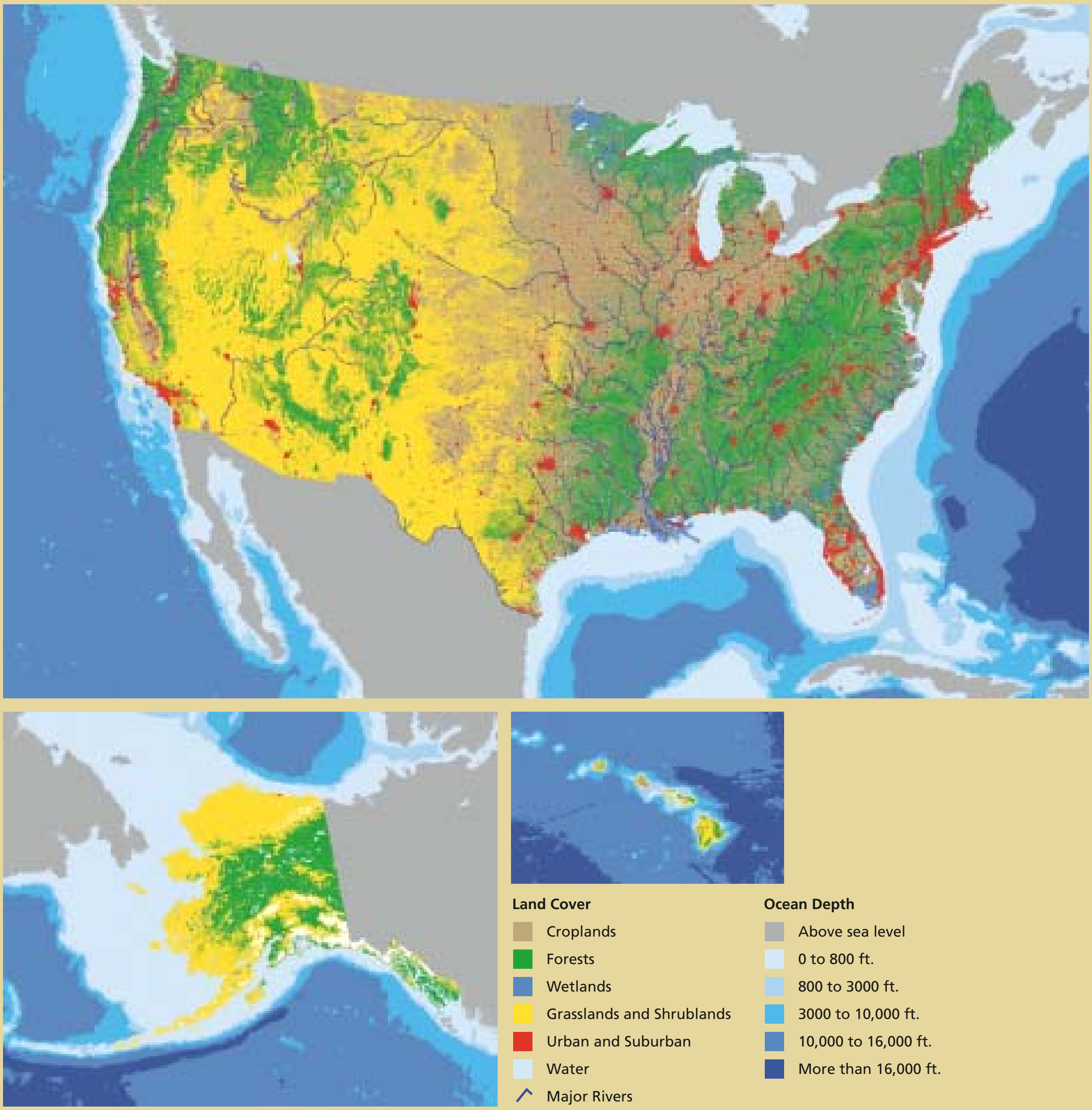
Data for three of these core national indicators (at-risk native species, p. 52; plant growth index, p. 56; and production of food and fiber and water withdrawals, p. 58) are presented on a regional basis, while a fourth (movement of nitrogen, p. 46) is presented in mapped form. The regional scheme, developed specially for this project, is also used to report the at-risk species indicators in the forest, grasslands and shrublands, and freshwater chapters. See Map 4.1.

Map 4.1. Regions Used for Reporting Selected Core National Indicators

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	

◐ Ecosystem Extent

Map 4.2. U.S. Land Cover and Ocean Depth



This map uses satellite remote sensing information to show the distribution of the ecosystems described in this report. It covers forests, croplands (including pastures and haylands), grasslands and shrublands, urban and suburban areas, most wetlands, and rivers with flows that exceed 1000 cubic feet per second. The map also includes information on the depth of coastal waters, which will be replaced by data on the extent of brackish coastal waters, when such data become available.

Data Source: lower 48 states: Multi-Resolution Land Characterization (MRLC) Consortium; Alaska: Flemming (1996); Hawaii: NOAA; Bathymetry data: NOAA; anaylsis by USGS EROS Data center.

◐ Ecosystem Extent *(continued)*

What Is This Indicator, and Why Is It Important? This indicator presents the area of the four major land-based ecosystem types covered in this report (forests, farmlands, grasslands and shrublands, and urban and suburban areas) as a percentage of the total U.S. land area, for the most recent 50-year period and compared to presettlement estimates. It also reports on a key component of freshwater ecosystems (freshwater wetlands) and will report on the area of brackish water, a key component of coastal and ocean ecosystems when data become available. The change in area since 1955 is also shown for each ecosystem type.

The area occupied by an ecosystem is one of the most basic elements of its condition. The area devoted to different ecosystem types directly influences the character of the American landscape and largely determines the ecosystem goods and services that are derived from it. Conversion from one ecosystem to another means that the ecosystem goods and services that can be derived from the original ecosystem are no longer available, replaced by the goods and services provided by the new system.

Even though ecosystem area is a basic ecosystem characteristic, reporting on it is not simple. The area of different ecosystem types is tallied by different agencies, using different methods and definitions of the ecosystems. These estimates provide important trend data and are generally well regarded. However, because they use different methods and definitions, data from these different sources cannot be compared or pieced together for a full national picture. Satellite remote sensing can provide such an overall, integrated view (see Map 4.2). However, it is only available at the appropriate scale for one time period (1992) and thus cannot provide information on changes in ecosystem area. In this report, we have generally used the estimates provided by the various agencies as the basis for reporting on ecosystem extent. We present the satellite data for comparison purposes and because, if repeated, it can provide frequent, consistent, and non-overlapping estimates of changes in ecosystem extent.

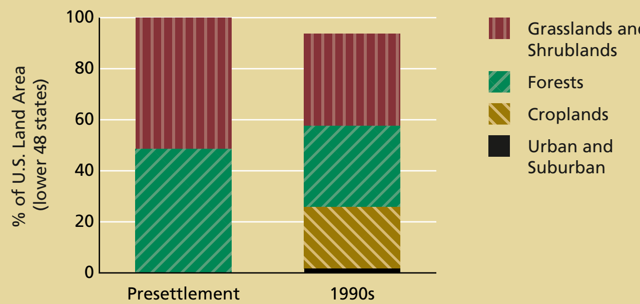
What Do the Data Show? Before European settlement, the land that was to become the United States was dominated by forests and grasslands and shrublands. Researchers have estimated that, before European settlement, there were about 920 million acres of forests

Ecosystem Area: Long-Term Changes and Recent Trends

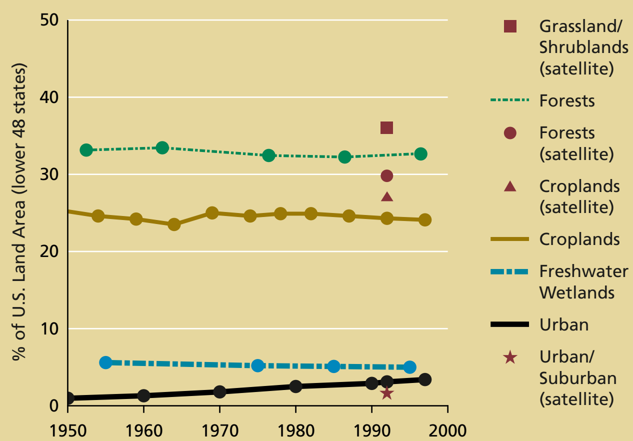
Data Not Adequate for National Reporting on

- Extent of brackish coastal waters

Partial Indicator Data: Long-term Changes for Forests, Croplands, Grasslands/Shrublands, Urban/Suburban



Partial Indicator Data: Recent Trends for Forests, Croplands, Grasslands/Shrublands, Urban/Suburban, Freshwater Wetlands



Data Source: USDA Forest Service (forests, current area, recent trends), USDA Economic Research Service (croplands trends, urban area trends), Multi-Resolution Land Characterization Consortium (MRLC; all satellite data, including current estimate of grass/shrub and urban/suburban area in top graph). Presettlement estimates are from Klopatek et al. (1979). Coverage: lower 48 states

Note: Because these estimates are from different sources, they do not sum to 100% of U.S. land area. Approximately 5% of lands are not accounted for by these data sources. They include some wetlands, some non-suburban developed areas, disturbed areas such as mines and quarries, and the like. In addition, freshwater wetlands currently occupy approximately 5% of the area of the lower 48 states, a reduction of about 50% since presettlement times. However, because they are found within forests, grasslands and shrublands, or croplands, they are not shown separately on the graph. See pp. 69 and 139. Finally, the "urban" trend line in this graph is based on a different definition from the one in this report (see p. 181) and is presented here to illustrate general trends. The definition used in this report was used to generate the "urban/suburban (satellite)" area estimate.

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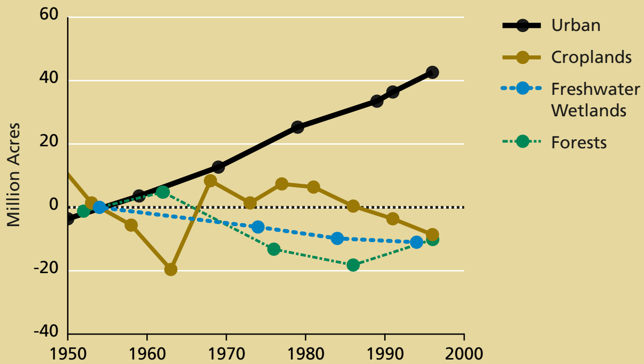
◐ Ecosystem Extent *(continued)*

Change in Ecosystem Area (Compared to 1955)

Data Not Adequate for National Reporting on
- Extent of brackish coastal waters

Partial Indicator Data: Forests, Croplands, Grasslands/ Shrublands, Urban/Suburban, Freshwater Wetlands



Data Source: USDA Forest Service (forest trends), USDA Economic Research Service (cropland and urban area trends), U.S. Fish and Wildlife Service (FWS, freshwater wetlands trends. Coverage: lower 48 states.

Note: The "urban" line in this graph is based on a different definition from that used in this report. It is presented here to illustrate general trends. The definition used in this report was used to generate the "urban/suburban (satellite)" area estimate in the preceding graph.

and between 900 million and 1 billion acres of grasslands and shrublands. Thus, each covered roughly half of the lower 48 states. While these estimates are necessarily imprecise, it is clear that croplands (including pastures) and urban and suburban areas—totaling together about 500 million acres—were created on lands that were either forests or grasslands and shrublands, causing the acreage of these ecosystems to drop. In addition, the area of freshwater wetlands has declined by about 50% since European settlement.

In reading these figures and the ones that follow, it is important to remember that the data presented here are from several sources; they do not add to 100% of the U.S. land area, and gains and losses cannot be tracked accurately from one system to another.

Coasts and Oceans include all waters in the U.S. Economic Exclusion Zone (EEZ), which extends 200 miles from the coastline. Because the area of the EEZ changes only when territory is acquired or international law changes, this indicator focuses on the dynamic area of mixed salt and fresh waters, or brackish waters, surrounding the U.S. coastline. Changes in the extent of brackish water reflect changes in the volume of freshwater runoff from the land, which can be altered by changes in climate and by modification of river flows by dams and other diversions. There are no current or historical data at a national scale on the area of brackish water. Another important aspect of the extent of coastal waters is the area covered by coastal wetlands, coral reefs, and shellfish and seagrass beds (see Coastal Living Habitats, p. 69).

Croplands, that portion of farmlands that is actively used for crop production (including pastures), occupy about 24% of the land area of the lower 48 states, or about 455 million acres. About 23 million fewer acres are in active farmland use than in 1949, but over this period, farmland area has fluctuated. American Indians had some lands under cultivation before European settlement, but there are no firm estimates of this amount. Satellite-based methods produce an estimate of just over 500 million acres of croplands in 1992. This report also identifies a "farmland landscape," which includes both croplands and intermingled and nearby forests, grasslands and shrublands, wetlands, and developed areas; see p. 92.

Forests cover about 33% of the land area of the lower 48 states, or just under 620 million acres. When Alaska is added in, the total is about three-quarters of a billion acres, down from just over 1 billion acres before European settlement. In the lower 48 states, forested area has declined by about 10 million acres since 1955. However, there is more forest now than in the middle of the 19th century (not shown in the illustrations), when many parts of the country were cleared for agriculture and settlement (see the forest area indicator, p. 117). Satellite-based methods produce an estimate of about 560 million acres of forest in the lower 48 states.

◐ Ecosystem Extent *(continued)*

Fresh waters include 94 million acres of wetlands in the lower 48 states, or about 5% of total land area. About half the freshwater wetlands that existed at the time of European settlement have been converted to other uses; about 10% of the wetlands existing in 1955 had been converted by the mid-1990s, although the rate of loss slowed after the 1980s. Comparable data do not exist for Alaska. Wetlands occur in many ecosystem types, so their area is often counted as part of the area of forests, grassland and shrublands, farmlands, and urban and suburban areas. Satellite-based methods estimate about 80 million acres of wetlands. While freshwater wetlands are a critical and highly visible aspect of the extent of freshwater systems, the area of lakes and ponds and the number of miles of streams are also important (see Freshwater Extent, p. 139).

Grasslands and shrublands, often called rangelands, occupy about 36% of the land area of the lower 48 states, or about 680 million acres. These figures do not include pastures and haylands. For this national estimate, these pastures and haylands—some of which resemble "natural" grasslands and shrublands and some of which are highly managed—are counted as croplands. In the chapter on grasslands and shrublands, however, these lands are included in the area estimates for this system (p. 161). If these less-managed (uncultivated) pastures were reported as grasslands and shrublands, the decline in grassland and shrubland area would be less than is indicated on the top graph on p. 41.

Urban and suburban areas take up about 32 million acres, or 1.7% of the area of the lower 48 states. This figure is based on a newly developed definition applied to satellite imagery; comparable satellite-based data from earlier periods are not available. To show trends, therefore, we also present a USDA estimate, based upon the Census Bureau definition of urban area. (This definition uses population, rather than the percentage of land area covered by buildings, roads, and the like, to define "urban.") Using the Census-based definition, urban areas cover 64 million acres—twice the area produced by the satellite-based method—and have grown by 40 million acres since 1955. Because it focuses on actual land cover, the satellite-based definition is more appropriate for this report and is used as the basis for the urban and suburban indicators (see Area of Urban and Suburban Lands, p. 181).

The technical note for this indicator is on page 207.

Fragmentation and Landscape Pattern

Fragmentation and Landscape Pattern

Indicator Development Needed

What Is This Indicator, and Why Is It Important? Fragmentation of ecosystems into small patches can reduce habitat for wildlife species that require larger, connected patches. It can hinder the movement of some species and introduce predators, parasites, and competitors associated with different land uses. Fragmentation can also alter the frequency and extent of fire and affect the dispersal and regeneration of plants. Suburban and urban development, farmlands, roads, railroads, powerline corridors, and other land uses cause various kinds and degrees of fragmentation.

Species that require large, unbroken expanses of habitat are often most sensitive to the effects of fragmentation. In some cases, the effects of fragmentation on sensitive species are a direct result of changes in the size and arrangement of suitable habitats across the landscape. In others, impacts are due mainly to more frequent interactions of species with humans, vehicles, or predators, or to other factors associated with an intruding land use.

People also react to changing landscapes. Areas that were primarily forest, grasslands, or shrublands but are now fragmented by other uses or bisected by roads provide a very different level of solitude and visual attraction. Likewise, the character of farm landscapes and communities changes radically when they are broken up by suburban development.

Human activity can also create landscapes that are less varied than the landscapes historically experienced by native species. Particularly in the West, natural fires create a patchy landscape, where forest and grasslands are intermingled in a mosaic that supports many different species. Fire suppression and the large fires that result after long periods of suppression can create broad expanses of very similar vegetation, with negative effects on species that thrive on the formerly varied landscape.

Landscape patterns affect people and other species in different ways and at different geographic scales. Some species are very sensitive to fragmentation, while others are more tolerant. Some effects, such as the changes that occur in farming communities undergoing suburbanization, operate at a county level, while other effects, such as those affecting forest birds, involve distances measured in feet or yards. The magnitude of fragmentation and its context are also important. A single incursion may not cause significant effects, but many such changes taken together may have a larger impact. Similarly, a modest amount of fragmentation in an abundant habitat may not be significant, but the same amount of fragmentation in a rare habitat may be cause for concern.

Why Can't This Indicator Be Reported at This Time? There are clear and obvious linkages between landscape patterns, the kinds of plants and animals that thrive in a region, and the ways in which people use the land. However, there are many different ways to characterize these patterns and the ways in which they are changing, and scientists do not agree on a single "best" measure. Additional work is necessary to select the specific features that should be measured, the geographic scale at which they should be monitored, and how they should be reported and interpreted.

Fragmentation and Landscape Pattern *(continued)*

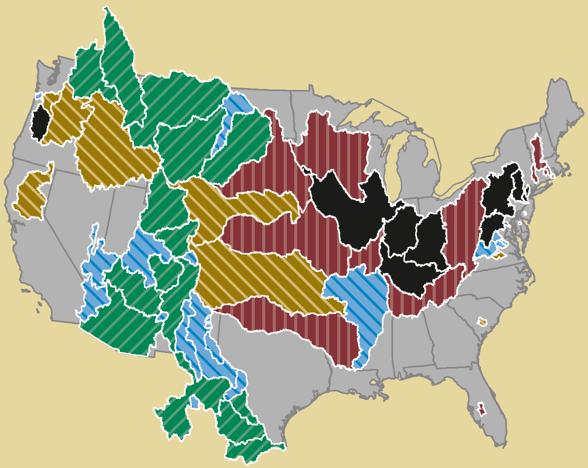
This report includes measures of fragmentation or landscape pattern for grasslands and shrublands (p. 163), farmlands (pp. 93 and 94), forests (p. 120), and urban and suburban areas (pp. 182 and 183). Although some of these indicators require additional research, it is clear that there is more agreement among scientists on how to measure landscape pattern for specific ecosystem types than there is for an overall national measure.

What Steps Are Necessary To Achieve Reliable National Coverage? This is an area of active scientific investigation. Many possible indicators are being evaluated to determine which ones, or which combinations, provide the best view of the important changes that are occurring in the American landscape.

There is no technical note for this indicator.

The Movement of Nitrogen

Yield of Total Nitrogen from Major Watersheds (1996–1999)



Total Nitrogen (pounds of nitrogen per sq. mile per year)

- Data Not Available
- Less than 10
- 10-600
- 600-1,500
- 1,500-3,000
- 3,000-10,000

Data Source: U.S. Geological Survey National Stream Quality Network (NASQAN), National Water Quality Assessment (NAWQA), and Federal–State Cooperative Program. Coverage: selected areas of lower 48 states.

What Is This Indicator, and Why Is It Important? This indicator reports the yield of nitrogen from major watersheds: pounds of nitrogen per square mile of watershed area that enters rivers and streams through discharges, runoff, and other sources. It also reports the load of nitrate, a common form of nitrogen, from major rivers: tons of nitrate carried to the ocean each year by the four largest U.S. rivers.

Nitrogen is a component of protein and is essential to all life. Nitrate is an important plant nutrient and is often the most abundant form of nitrogen that is readily usable by aquatic plants, including algae. Nitrate and other forms of nitrogen occur both naturally and as a result of human activities.

In excess, however, nitrogen can cause significant water quality problems by stimulating the growth of algae. Overabundance of algae can reduce oxygen levels to near zero, especially in coastal waters (see Areas with Depleted Oxygen, p. 71). "Dead zones," or areas where oxygen levels are so low that fish and shellfish cannot live, are created when nutrients, particularly nitrate and other forms of nitrogen, are overabundant. The largest of these dead zones occurs every summer in the Gulf of Mexico, covering 5,000 or more square miles of one of the nation's most important commercial and recreational fisheries. Excess nitrogen in certain forms is also toxic to human beings and other animals.

Sources of nitrogen include wastewater treatment plants, runoff from fertilized lawns and cropland, failing septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors. Atmospheric deposition is also a significant source of added nitrogen in ecosystems. Burning of fossil fuels releases nitrogen into the atmosphere, where it can travel for long distances before being deposited in snow, rain, or dust.

Although this indicator reports on nitrogen in aquatic systems, excess nitrogen in soil, often derived from atmospheric deposition, can change the number and type of species in an ecosystem and otherwise alter the way the system functions.

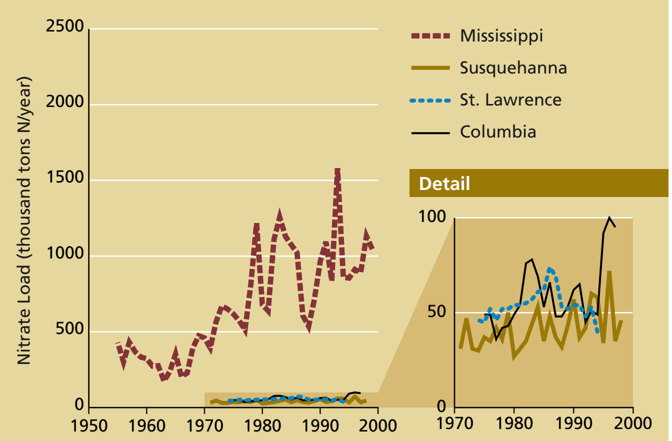
What Do the Data Show? The map shows 1996–1999 average annual yield of total nitrogen from major watersheds for which data are available. Watersheds in the upper Midwest and the Northeast contribute the most nitrogen per square mile to rivers and streams ("yield").

The amount of nitrate carried by most major U.S. rivers ("load") has increased over the past several decades. The four largest rivers in the United States—the Mississippi, Columbia, St. Lawrence, and Susquehanna—together account for approximately 55% of all freshwater flow to the sea from the lower 48 states. The Mississippi has had the most striking increase in nitrate load. The Mississippi, which drains more than 40% of the area of the lower 48 states, carries roughly 15 times more nitrate than any other U.S. river, and this amount has approximately tripled since the 1950s. The increases in nitrate load for the Columbia and Susquehanna rivers are also significant, although some multiyear declines also occurred during the period.

The Movement of Nitrogen *(continued)*

The peaks and valleys within the overall upward trend generally reflect years with higher rainfall (peaks) and those with less rainfall (valleys). In wet years, increased runoff from land surface carries more nitrogen into streams, increasing nitrogen loads; the reverse is true in dry years.

Nitrate Load Carried by Major Rivers



Data Source: U.S. Geological Survey National Stream Quality Network (NASQAN), National Water Quality Assessment (NAWQA), and Federal–State Cooperative Program. Coverage: selected major rivers.

Discussion Higher values for both loads and yields reflect greater "leakage" of nitrogen from a watershed, with potentially significant downstream effects, particularly on marine ecosystems.

Total nitrogen is the preferred form for reporting on the amount of nitrogen delivered from the U.S. landscape to our coastal waters, but because the historical record for it for the Mississippi River is short, we chose instead to present river nitrate loads. Nitrate is the largest component of total nitrogen and serves as a strong indicator of total nitrogen loads. The longer historical record for nitrate reveals the significant increases that have occurred over the past few decades. Future reports may present loads of total nitrogen.

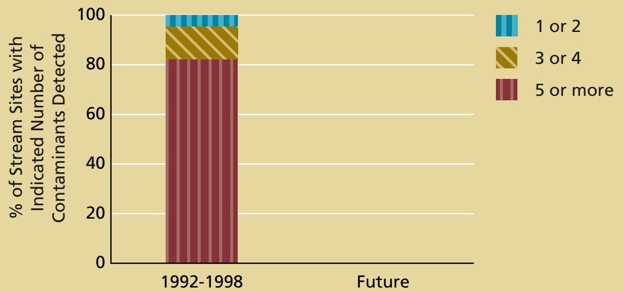
Other indicators (see pp. 95, 122, 164, and 186) report on the amount of nitrate dissolved in streams or groundwater in farmlands, forests, grasslands and shrublands, and urban and suburban areas.

The technical note for this indicator is on page 210.

◐ Chemical Contamination

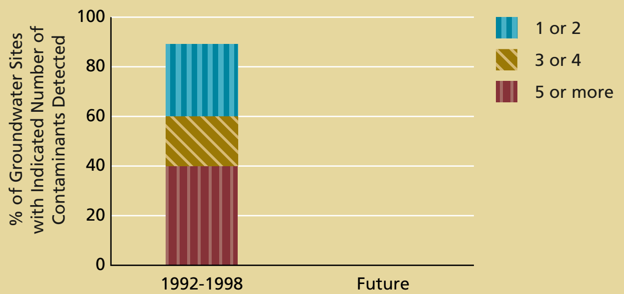
Contaminant Occurrence

Streams



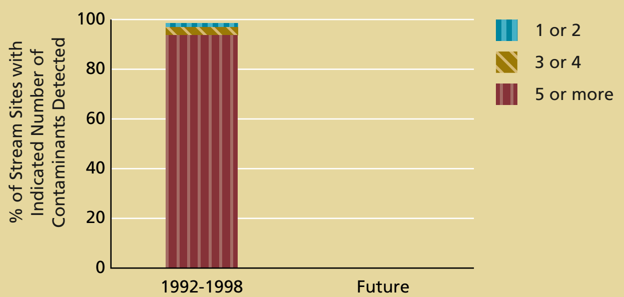
Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Groundwater



Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Streambed Sediment

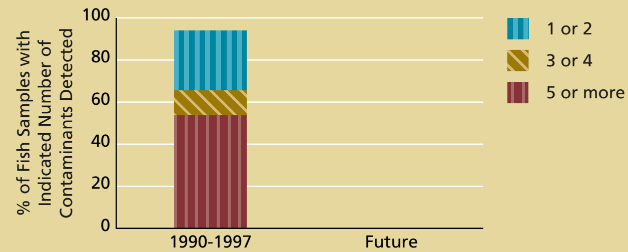


Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Fish Tissue

Data Not Adequate for National Reporting on
- Saltwater Fish

Partial Indicator Data: Freshwater stream fish only

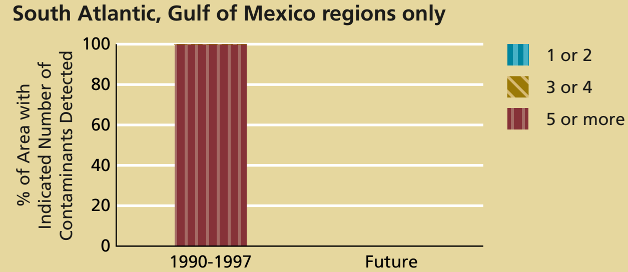


Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Coastal Sediment

Data Not Adequate for National Reporting on
- Ocean Sediments
- Estuaries in Other Regions

Partial Indicator Data: Estuaries in Mid-Atlantic, South Atlantic, Gulf of Mexico regions only



Source: U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program (EMAP). Coverage: Selected regions as indicated.

What Is This Indicator, and Why Is It Important? This indicator reports on contaminants found in streams, groundwater, sediment, and fish tissue. The graphs above report how often different numbers of contaminants are found, and those on p. 49 report how often these contaminants exceed standards and guidelines for the protection of human health and aquatic life. Contaminants reported here include many pesticides, selected degradation products, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), volatile organic compounds, other industrial contaminants, trace elements, nitrate, and ammonium. (Because nitrate, ammonium, and trace elements such as cadmium and chromium occur naturally, they are not included in the contaminant occurrence graphs.)

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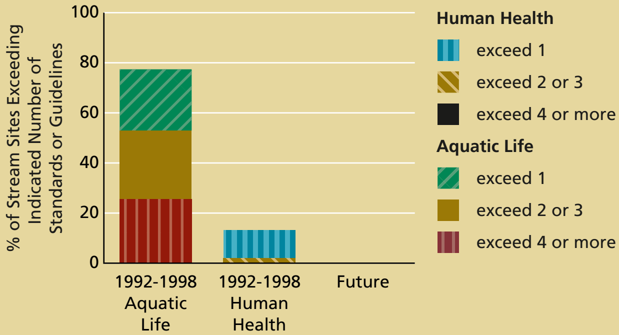
◐ Chemical Contamination *(continued)*

Contaminants above Standards and Guidelines

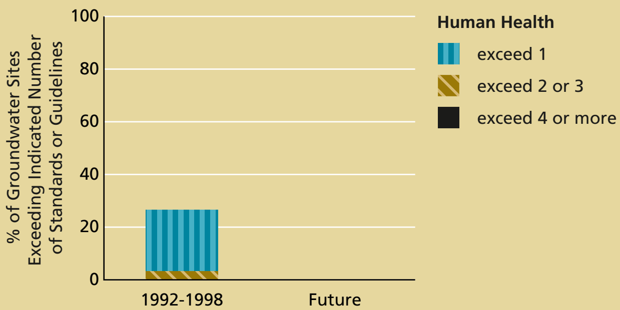
Streams



Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Groundwater

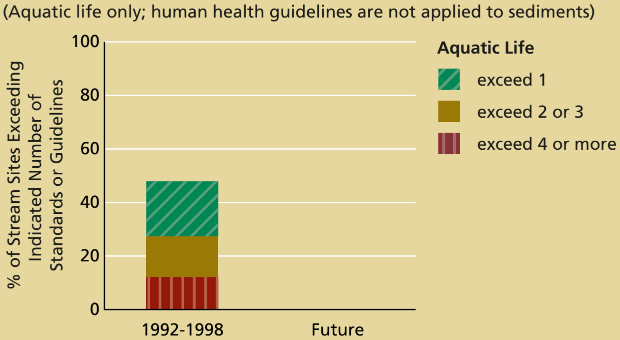
(Human health only; aquatic life guidelines are not applied to groundwater)



Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Streambed Sediment

(Aquatic life only; human health guidelines are not applied to sediments)



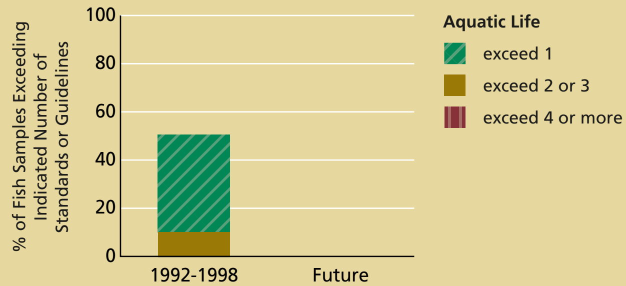
Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states.

Fish Tissue

Data Not Adequate for National Reporting on

- Saltwater Fish
- Human Health Standards

Partial Indicator Data: Freshwater stream fish and aquatic life standards only



Data source: U.S. Geological Survey National Water Quality Assessment (NAWQA) Program. Coverage: lower 48 states

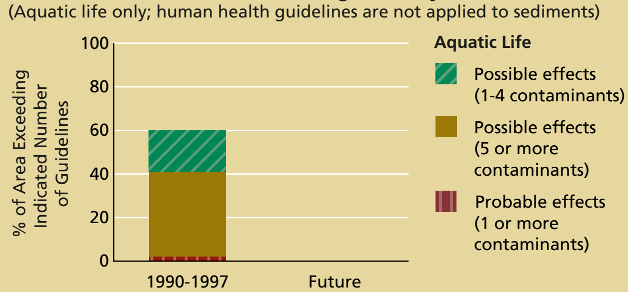
Coastal Sediment

Data Not Adequate for National Reporting on

- Ocean Sediments
- Estuaries in Other Regions

Partial Indicator Data: Estuaries in Mid-Atlantic, South Atlantic, Gulf of Mexico regions only

(Aquatic life only; human health guidelines are not applied to sediments)



Source: U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program (EMAP). Coverage: Selected regions as indicated.

◐ Chemical Contamination *(continued)*

Synthetic chemicals, trace elements, and other contaminants can, in sufficient quantities, harm people as well as fish and other wildlife. Both the frequency of chemical contamination and the degree to which these contaminants exceed applicable standards and guidelines are important in understanding the extent and significance of chemical contamination. The number of contaminants found in streams, groundwater, and the like provides basic information on how widespread these compounds are in the environment. However, the presence of chemical contamination does not necessarily mean that the levels are high enough to cause problems; comparison to standards and guidelines provides a useful reference to help judge the significance of contamination.

There are no standards or guidelines for many contaminants. For example, drinking water standards and guidelines do not exist for 33 of the 76 pesticides analyzed in fresh waters, and there are no aquatic life guidelines for 48 of these 76 pesticides. Current standards and guidelines do not account for mixtures of chemicals and seasonal occurrences of very high concentrations. These gaps increase the importance of information on the occurrence of chemical contaminants. In addition, potential effects on reproductive, nervous, and immune systems, as well as on particularly sensitive people, are not yet well understood.

What Do the Data Show?

Streams. All tested streams averaged one or more contaminants at detectable levels throughout the year; about 80% averaged five or more contaminants at detectable levels. Three-fourths of streams tested had one or more contaminants at levels that exceeded guidelines for the protection of aquatic life; approximately one fourth had concentrations of four or more contaminants that exceeded these guidelines. Thirteen percent had at least one contaminant at levels that exceeded standards or guidelines for the protection of human health. Stream water was tested for pesticides, selected pesticide degradation products, and selected nutrients.

Groundwater. About 90% of groundwater wells tested had an average of one or more contaminants at detectable levels, and 40% had an average of five or more contaminants at detectable levels. About one fourth had contaminants at levels that exceeded human health standards or guidelines. Groundwater was tested for pesticides, selected pesticide degradation products, volatile organic contaminants, trace elements, and selected nutrients.

Stream sediments. Nearly all stream sediments tested had an average of five or more contaminants at detectable levels. About half had one or more contaminants at concentrations exceeding aquatic life guidelines. Stream sediments were tested for organochlorine pesticides, PCBs, PAHs, other industrial contaminants, and trace elements.

Freshwater fish. About half of fish tested had at least five contaminants at detectable levels, and approximately the same number had one or more contaminants at levels that exceeded standards for the protection of wildlife. Data are not available on exceedances of human health standards. Whole fish were tested for organochlorine pesticides, PCBs, and trace elements.

Although not shown on the graphs, all fish tested in the Great Lakes had five or more detected contaminants, and all Great Lakes fish had PCB concentrations that exceeded human health standards. (Great Lakes testing focuses on fish with a high likelihood of such contamination, such as coho salmon and lake trout.)

Coastal sediments. More than 99% of estuary sediments tested had five or more contaminants at detectable levels. About 60% of estuary sediments tested had contaminants above the levels designed to predict “possible effects” on aquatic life for one or more contaminants, and about 2% exceeded the level designed to predict “probable effects.” Estuary sediments were tested for PCBs, PAHs, pesticides, and trace elements. Data on ocean sediments are not adequate for national reporting.

◐ Chemical Contamination *(continued)*

Discussion The data shown here do not represent assessments of the risks posed to people or ecosystems in any specific location, since they do not incorporate factors such as whether the water tested is actually used as a drinking water source or whether aquatic animals are biologically active at the time of year when the contaminants are found.

The standards and guidelines used in this indicator are useful reference points, but they must be interpreted carefully, since different standards reflect different levels of protection from harm. Furthermore, different standards and guidelines may apply to water, sediments, and fish tissue.

Guidelines for the protection of aquatic life are often numerically lower than standards and guidelines to protect human health. Aquatic animals spend much or all of their life in water, and may be more sensitive to specific contaminants.

People consume drinking water from both streams and groundwater, and they eat fish, so human health standards and guidelines apply to all three. Guidelines to protect aquatic life are not applied to groundwater, and standards and guidelines to protect human health are not applied to either stream or estuary sediments.

Different agencies and programs are responsible for the collection and analysis of data from freshwater systems (streams and groundwater) and estuaries. The objectives of these programs differ, leading to different site selection procedures, suites of contaminants measured, and collection and analysis procedures. Guidelines for freshwater fish are set to protect fish-eating wildlife, and aquatic life guidelines for coastal sediments differ from those for stream sediments. Thus, the results are not directly comparable.

The contaminants that were analyzed in different media (streams, groundwater, etc.) varied, depending on the chemical properties of the contaminants, known environmental occurrence, and potential for adverse effects on people or ecosystems. For example, volatile organic compounds were analyzed in groundwater but not in stream sediments because their chemical properties make it extremely unlikely that they would be found there.

Data are not available to compare either fresh or saltwater fish contaminant concentrations with human health/consumption guidelines.

See also the coastal, farmland, and urban contaminants indicators (pp. 72, 97, and 189).

The technical note for this indicator is on page 210.

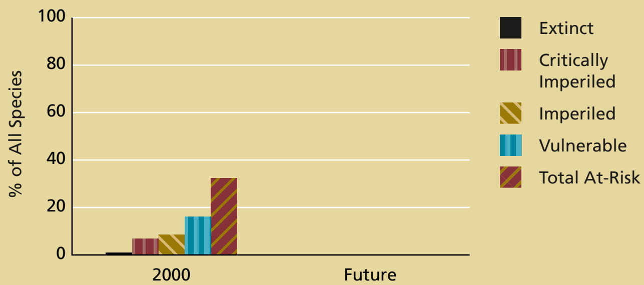
◐ At-Risk Native Species

At-Risk Plant Species, by Risk Category

Data Not Adequate for National Reporting on

- Marine Species

Partial Indicator Data: Land Plants, Freshwater Plants



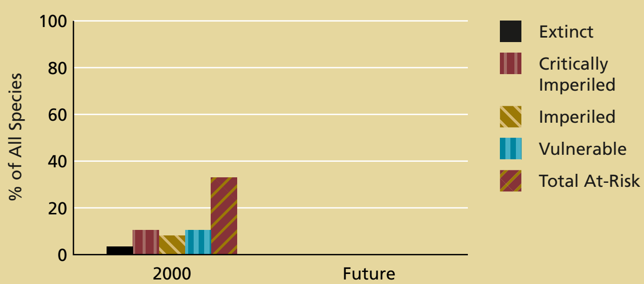
Source: NatureServe and its natural heritage member programs.
Coverage: all 50 states.

At-Risk Animal Species, by Risk Category

Data Not Adequate for National Reporting on

- Marine Species

Partial Indicator Data: Land Animals, Freshwater Animals



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 plant and animal species. The degree of risk for any particular plant or animal species varies considerably, from those species at little or no risk, to those that are in imminent danger of extinction. The data cover many of the best-known groups of native plants and animals, totaling about 22,000 native species.

Each species is ranked on such factors as the number and condition of individuals and populations, population trends, the area occupied by the species, and known threats. For example, "critically imperiled" species often are found in five or fewer places, may have experienced very steep declines, or show other evidence of very high risk. "Imperiled" species often are found in 20 or fewer places, may have experienced steep declines, or display other risk factors. "Vulnerable" species often are found in fewer than 80 places, may have recently experienced widespread decline, or show other signs of moderate risk. The remaining plant and animal species are regarded as "secure" or "apparently secure." In all cases, a wide variety of factors contribute to overall ratings.

Increased risk levels for a particular species may be due to historical or recent population declines, or they may reflect natural rarity; biologists often consider very rare species to be at risk even in the absence of recent declines or current threats.

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

What Do the Data Show? About 19% of native animal species and 15% of native plants species in the U.S. are ranked as "imperiled" or "critically imperiled," and another 1% of plants and 3% of animals may already be extinct—that is, they have not been located despite intensive searches. When "vulnerable" species are counted, about one-third of plant and animal species are considered to be "at risk."

Hawaii has a much higher percentage of at-risk plants and animals than any other region, followed by the Pacific Coast. In contrast, the Midwest and Northeast/Mid-Atlantic have the lowest percentages.

◐ At-Risk Native Species *(continued)*

Interpreting these figures is complicated 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? Data are not available on at-risk species in U.S. coastal waters.

Discussion At least 200,000 native plant, animal, and microbial species are thought to live in the United States, but little is known about the status and distribution of most of these. This indicator summarizes the status of 16,000 plant species and 6,000 animal species, which include all 22 species groups for which comprehensive status assessments are available. These species represent all higher plants, all terrestrial and freshwater vertebrates (mammals, birds, reptiles, amphibians, and freshwater fishes), selected invertebrate groups, including freshwater mussels and snails, crayfishes, butterflies and skippers, and about 2,000 species of grasshoppers, moths, beetles, and other invertebrates. This sample of species is believed to provide a powerful, yet practically manageable snapshot of the condition of U.S. species.

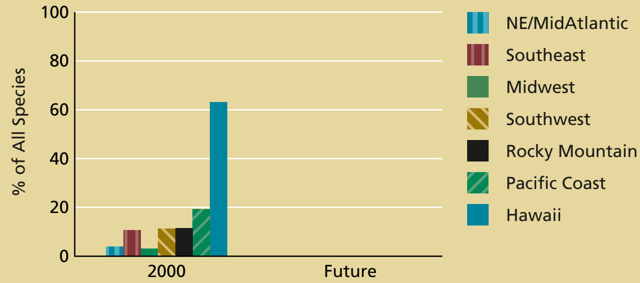
See http://www.natureserve.org/explorer/ranking for a description of these conservation status ranks and details of the assessment criteria.

At-Risk Species, by Region

Data Not Adequate for National Reporting on

- Marine Species

Partial Indicator Data: Land and Freshwater Species



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

See also the indicators for at-risk coastal (p. 75), forest (p. 124), freshwater (p. 144), and grassland and shrubland species (p. 168), as well as those for species in farmland (p. 103) and urban and suburban areas (p. 191).

The technical note for this indicator is on page 214.

Condition of Plant and Animal Communities

Condition of Plant and Animal Communities

Indicator Development Needed

What Is This Indicator, and Why Is It Important? This indicator would report on the percentage of land area and stream and coastline length according to the level of disturbance, management, or physical alteration. Different levels of ecosystem alteration correspond to changes in both the type and number of species of plants and animals found in an area. Plants and animals in areas with high levels of alteration will be very different from those in similar areas that are relatively undisturbed.

The types of plants and animals found in areas that are highly managed or altered have in large part been determined by human activity. These areas are relatively easy to define, and more data about them are available:

- **Physically altered:** Areas in which a high percentage (for example, 30% or more) of the land surface is covered by asphalt, concrete, or buildings, is quarried or strip-mined, or, in the case of stream banks or shorelines, is "armored" with riprap or other materials.
- **Highly managed:** Areas in which human activity has directly and significantly altered the species, especially plants, found there; farms, plantation forests, golf courses, and intensively grazed grasslands and shrublands fall into this category.

In areas that are less substantially modified, the mix of plants and animals is less directly determined by people and more affected by ecological conditions. There are, however, no generally accepted methods for distinguishing between levels of alteration in these natural or semi-natural lands. This indicator presumes that such methods will be developed and that it will be possible to classify these areas into three broad categories:

- **Undisturbed:** Areas of relatively undisturbed biological communities where the types of plants and animals found are similar to what they would be without human influences. Examples might include wilderness areas and much of interior Alaska.
- **Disturbed:** Areas with a modified mix of plant and animal species. Examples might include areas with a high proportion of non-native species, or a different mix of native species as a result of the long-term exclusion of fire.
- **Less disturbed:** Areas with communities with changes intermediate between "disturbed" and "undisturbed."

The species that occur in a place strongly affect the goods and services an ecosystem provides. Areas that are highly managed or physically altered provide important and socially desired goods and services as a result of this management or alteration, but that set of goods and services is quite different from those provided by more natural communities.

Why Can't This Indicator Be Reported at This Time? Although there are data on the status of plants and animals across large regions of the country (see the At-Risk Native Species indicator, p. 52), there are few data on the mix of species found within smaller areas or stretches of stream and coastline. The best data are for land intensively used by people—highly managed and physically altered lands are distinct enough to be identified from satellite measurements.

Condition of Plant and Animal Communities *(continued)*

For semi-natural and natural areas, however, there are two problems. First, species composition is monitored for some systems (e.g., percent cover of non-native plants in forested areas), but not for all systems or for all types of species alterations. Just as important, ecologists have not agreed on how to classify a particular natural or semi-natural area as disturbed, less disturbed, or undisturbed. Again, measures exist for some ecosystem types (for example, see Status of Freshwater Animal Communities, pp. 147 and 193) but not for most.

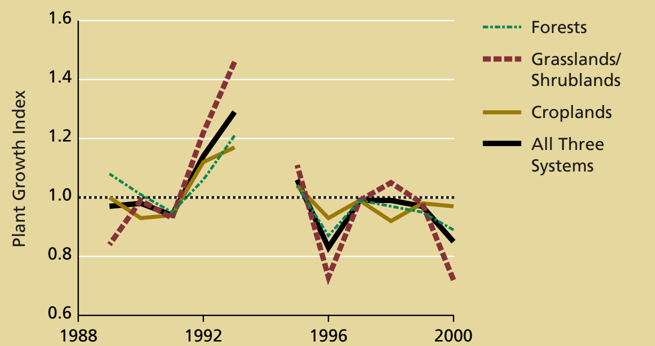
Discussion The biological communities found on and in much of the nation's lands and waters today are very different from those of presettlement times. Much of this change is the result of deliberate human intervention: forests have been cleared for farms, streams dammed to form lakes or to generate power, and land covered with housing and roads. Clearly, the goods and services derived from these altered lands and waters differ considerably from those derived from wilderness areas and other lands in a natural or semi-natural condition.

Until better means are developed to determine what conditions exist on the two-thirds of U.S. lands that are natural to semi-natural, both reporting on and interpreting this indicator will remain difficult.

The technical note for this indicator is on page 215.

Plant Growth Index

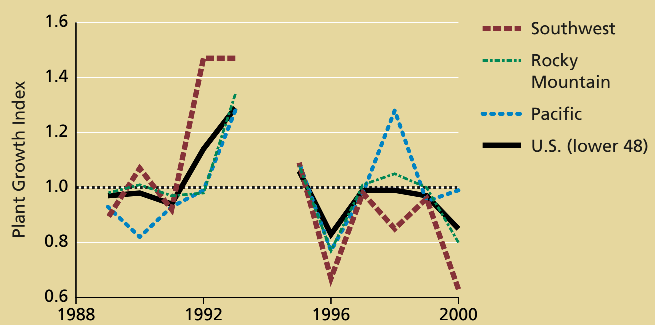
Plant Growth Index: Lower 48 States, by Ecosystem



Data Source: U.S. Geological Survey; Multi-Resolution Land Characterization Consortium. Coverage: Lower 48 states.

Note: Because of satellite problems, no data are available for 1994.

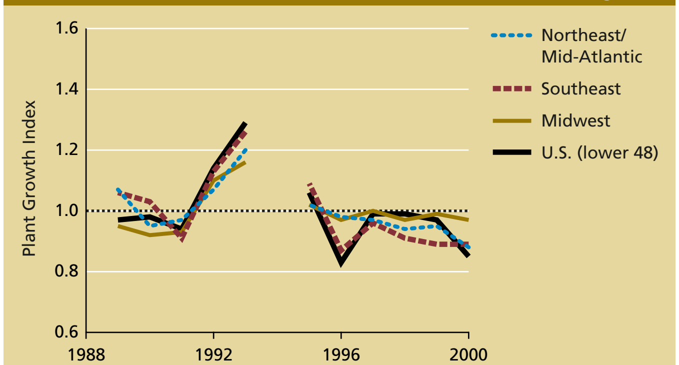
Plant Growth Index: Southwest, Rocky Mountain, Pacific Regions



Data Source: U.S. Geological Survey; Multi-Resolution Land Characterization Consortium. Coverage: Lower 48 states.

Note: Because of satellite problems, no data are available for 1994.

Plant Growth Index: Northeast, Southeast, Midwest Regions



Data Source: U.S. Geological Survey; Multi-Resolution Land Characterization Consortium. Coverage: Lower 48 states.

Note: Because of satellite problems, no data are available for 1994.

What Is This Indicator, and Why Is It Important? This indicator reports a plant growth index, based on satellite measurements of the amount of solar energy absorbed by vegetation and potentially used for photosynthesis.

The index shows, for any given year, whether plant growth in a region or for an ecosystem type was above or below the 11-year average (1989 through 2000, with one missing year). An index value of 1.0 in any year means that the amount of solar energy captured by vegetation and used for photosynthesis in that region or system during that year was the same as the 11-year average.

Plants use energy from the sun to turn carbon dioxide from the air, plus water and nutrients, into plant matter. This process, photosynthesis, drives and sustains virtually all life on earth. The amount of sunlight absorbed by plants is a key factor in determining the amount of photosynthesis and thus the amount of plant growth that occurs in a year. Changes in the amount of energy captured by plants over very large regions, as reported in this measure, may signal significant changes in ecosystem functioning. These changes could lead to increases or decreases in yield of products such as crops or wood and possibly changes in the number and types of species that live in a region. Changes in climate (including temperature and timing and amount of precipitation), as well as factors such as ground-level ozone, increased atmospheric deposition of nitrogen, and increased levels of carbon dioxide, might cause or contribute to changes in plant growth.

What Do the Data Show? No overall trend in plant growth can be seen for this 11-year period, either nationally or within any of the regions or ecosystem types. The similarity in year-to-year variation among regions and systems, however, is striking. For example, in 1993 all regions and systems had higher than average growth index values; in 1996, the opposite was true. The reason for this is not clear.

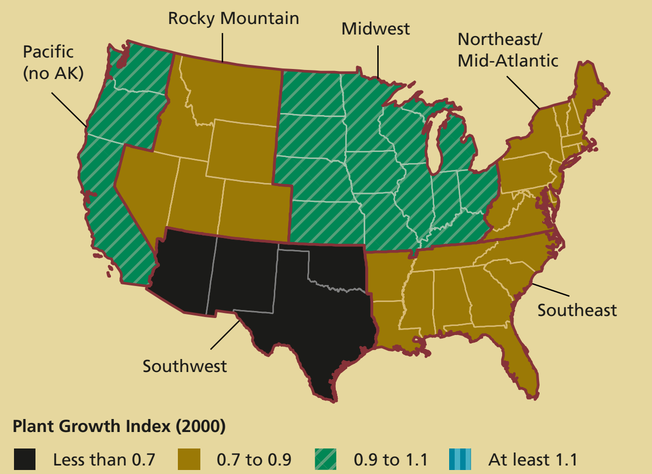
Year-to-year variability of the plant growth index is high nationally, within all six regions, and within all three ecosystem types. Year-to-year variability was greater in grasslands and shrublands than in either forests or farmlands. Variation was also greater in the West,

Plant Growth Index *(continued)*

particularly in the Pacific and Rocky Mountain regions, than in the East or Midwest.

During 2000, the plant growth index nationwide was lower than the 11-year average. The index was about average in the Pacific states and the Midwest and lower than the 11-year average in the other four regions. The index was farthest below the 11-year average in the Southwest.

Plant Growth Index: All Regions, 2000



Data Source: U.S. Geological Survey; Multi-Resolution Land Characterization Consortium. Coverage: Lower 48 states.

Discussion The energy brought into an ecosystem is an overall measure of its performance. How much energy a system absorbs can be affected by factors such as climate and weather, pollution, and how farms, forests, and other areas are managed, to name a few. Long-term changes in the amount of energy absorbed can have significant implications for the way an ecosystem functions.

Some ecosystem types naturally capture more energy than others; that is, they are more productive. Rather than comparing the absolute amount of energy captured, the plant growth index compares each year's growth at a particular location with the long-term average at that location.

Given natural year-to-year variability, the 11 years for which data are available are not enough to determine whether there are any regional or system-specific trends (data for 1994 are not available because of satellite failure). The particular satellite measurement used for this analysis, Normalized Difference Vegetation Index (NDVI), correlates well, but by no means perfectly, with ground measurements of plant productivity. Measurements are taken every two weeks and summed over the entire growing season.

Data for this measure are available only for the land area of the lower 48 states. The Coasts and Oceans section of this report includes a measure related to productivity of algae in coastal waters (p. 80), but that indicator focuses on seasonal peaks rather than annualized measurements, as reported here. In addition, it is possible to measure the plant growth or productivity of freshwater lakes, but these data are not available on a consistent basis nationwide.

The technical note for this indicator is on page 216.

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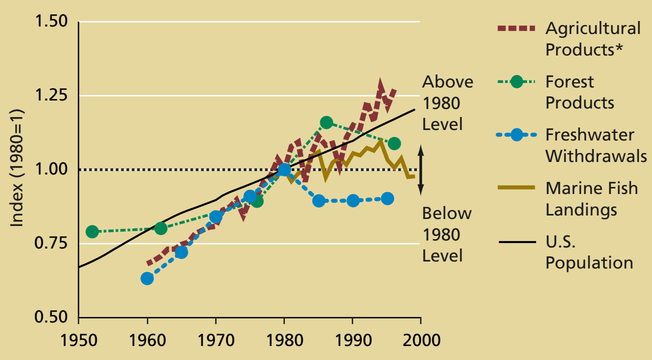
Production of Food and Fiber and Water Withdrawals

Production of Food and Fiber and Water Withdrawals: Entire United States



** Including livestock raised on grasslands and shrublands.*

Note: Fish landings prior to 1978 do not include foreign landings, thus are not displayed. See p. 81 for more detail.

What Is This Indicator, and Why Is It Important? This indicator reports the production of food and fiber and the withdrawals of water, using an index with 1980 as the base year. Values above 1.0 indicate that production or withdrawals were greater than in 1980; values below 1.0 indicate that production or withdrawals were lower than in 1980.

Products from U.S. ecosystems meet much of the nation's food, fiber, and water needs. Changes in the quantities of these goods signal fundamental changes in the direct benefits we receive from ecosystems.

What Do the Data Show? Over the past half-century or so, agricultural and forest production and freshwater withdrawals have all increased. But the rates of increase—and in some cases, periods of decline—vary from system to system. Agricultural production has grown the fastest. Except for a few periodic downturns, growth in agricultural production has generally been faster than the growth in U.S. population. Forest production has generally grown more slowly than population growth, except for a decade of more rapid growth during the late 1970s to 1980s. Forest production has declined since the mid-1980s. Freshwater use increased faster than population through 1980, declined by about 10% by the mid-1980s, and has grown slowly since then. Marine fish landings grew slowly from the late 1970s, when reliable statistics became available, through the mid-1990s, but have declined recently.

Most of the regional patterns of food and fiber production and water withdrawals match the national patterns above, with a few notable exceptions:

- Regional agricultural production generally follows the national growth trends (regardless of regional population growth).
- The recent modest decline in forest production nationally is the result of large declines in the Pacific Coast and Rocky Mountain regions being partially offset by increases in forest production in the Southeast.
- While freshwater withdrawals declined relative to population growth in most regions, withdrawals increased at about the same rate as population in the Southwest.
- Since the late 1970s, increased marine fish landings in the Pacific Coast region have offset declines in the Northeast/Mid-Atlantic and Southeast regions.

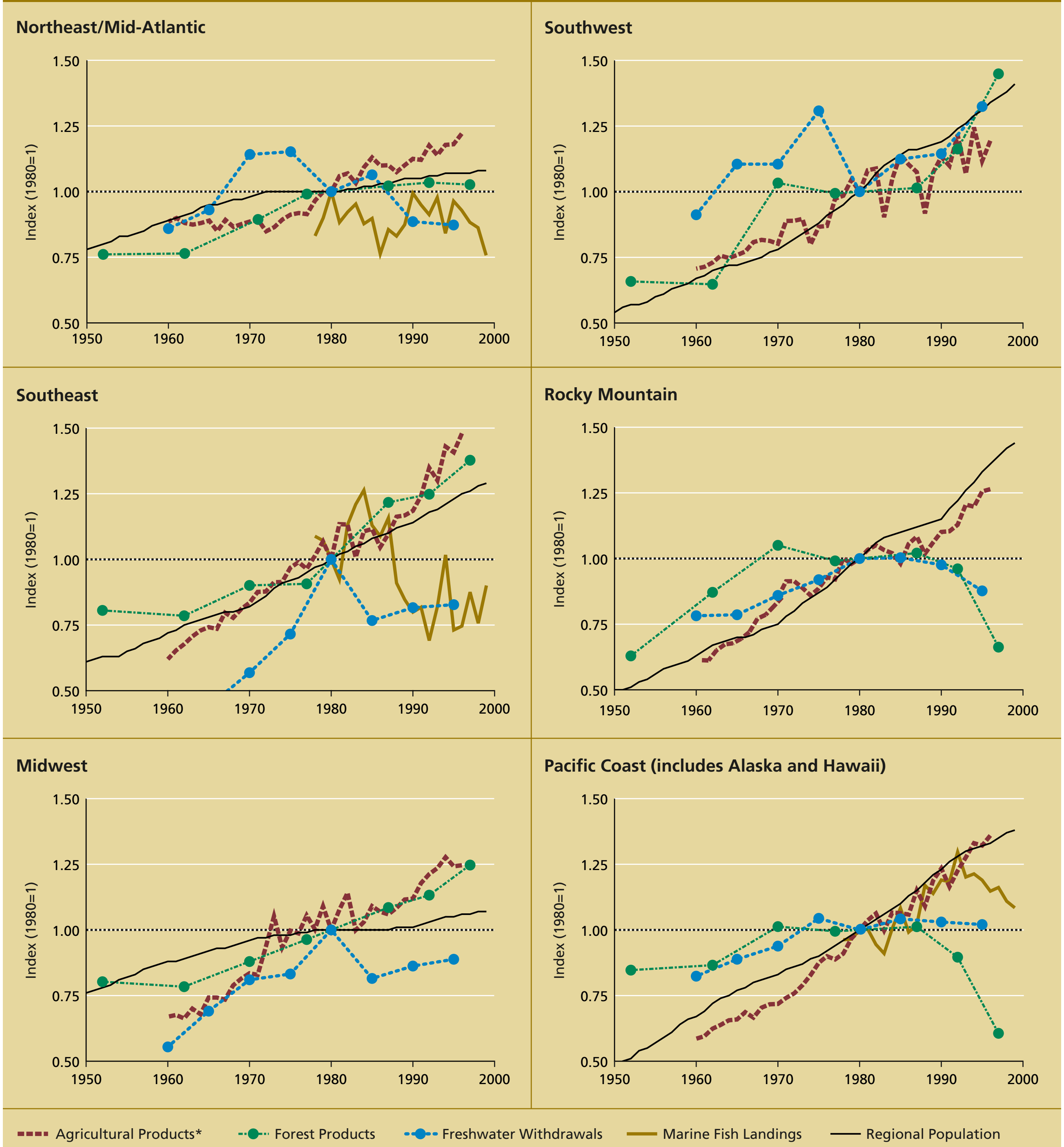
Discussion This indicator allows comparison between the amounts of a single good produced in two time periods. So, for example, an index value for agricultural products that is greater in 1994 than in any other year means that the nationwide harvest in 1994 was greater than at any other time in this 50-year series. The index value for 1994 is approximately 1.25, which means that the harvest in 1994 was about 25% greater than the 1980 harvest.

The index also allows comparison of the rate of growth or decline in production of two different goods. This can be seen, for example, by comparing agricultural production to marine fish landings since 1980. A steadily increasing line, such as in agricultural products, indicates that the amount of products we obtain from that ecosystem continues to grow. In contrast, marine fish landings grew until the mid-1990s, but have since declined to about 1980 levels.

The technical note for this indicator is on page 217.

Production of Food and Fiber and Water Withdrawals *(continued)*

Production of Food and Fiber and Water Withdrawals: Regions



** Including livestock raised on grasslands and shrublands*

Data Source: USDA Economic Research Service, USDA Forest Service, US Geological Survey, National Marine Fisheries Service, U.S. Census Bureau. Coverage: all 50 states. .

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

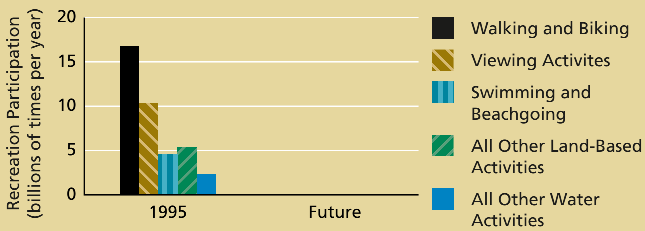
◐ Outdoor Recreation

Participation in Outdoor Recreation Activites

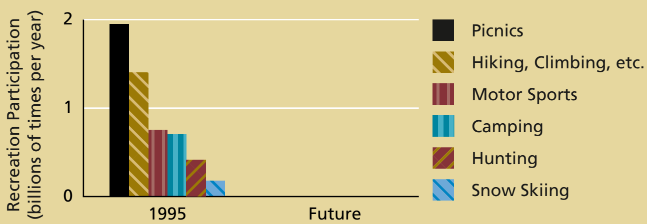
Data Not Adequate for National Reporting on

- Running and Jogging

Partial Indicator Data: Listed Activities



Breakdown of "Other Land-Based Activities"



Breakdown of "Other Water Activities"

Data Not Adequate for National Reporting on

- Recreation Days in Fresh and Salt Water, for Activities Other Than Fishing

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

Note: The scale for the top graph is considerably different from that used on the second two graphs.

What Is This Indicator, and Why Is It Important? This indicator reports the number of times Americans over the age of 15 took part in a variety of outdoor recreational activities. (Each time someone took part in an activity is counted: if the activity took place over multiple days, each day counts as a separate event, and if a person took part in several activities on a single day, each activity is counted as a separate event.)

Outdoor recreation is highly popular, with many people taking part in at least one of the listed activities over the course of the year. Recreation is a benefit that is derived from ecosystems, in much the same way as we derive products such as food, fiber, and water (p. 58) from these systems.

What Do the Data Show? Walking and biking are by far the most common outdoor recreation activity for which information is available. Americans over the age of 15 walk outdoors or bike about 17 billion times per year. Nature viewing and swimming and beachgoing are next in terms of overall popularity, totaling another 15 billion times per year. The lower graphs break out annual participation in "all other land-based activities," and " all other water activities," showing participation in outdoor social activities like picnics and family gatherings, and in hiking, boating, and fishing.

Why Can't This Entire Indicator Be Reported at This Time? The data presented here are from an extensive national survey. However, the list of recreational activities about which data are collected is not exhaustive, and the survey currently does not distinguish between fresh and salt water for many aquatic activities.

Discussion This indicator reports the number of times people participated in various activities, not how long they spent, so an hourlong walk and a day at the beach count the same (as noted above, each day in a multiday trip is counted as a separate event). Therefore, the fact that people participated more frequently in some activities (such as walking) does not necessarily mean that they spent more time on this than another activity.

The technical note for this indicator is on page 217.

Natural Ecosystem Services

Natural Ecosystem Services

Indicator Development Needed

What Is This Indicator, and Why Is It Important? This indicator would report on the levels of key services provided by "natural" ecosystems—forests, grasslands and shrublands, fresh waters, and coasts and oceans. The goods, or products, these ecosystems provide—such as fish, wood products, and food—can be counted, and a monetary value often placed upon them (key ecosystem products are described on p. 58).

Some services, such as recreation, are also fairly easily quantified (pp. 60, 109, 132, 153, and 174). But many of the services provided by natural ecosystems are less tangible and more difficult to quantify, including such vital processes as purification of air and water, detoxification and recycling of wastes, regulation of climate through storage of carbon dioxide, regeneration of soil fertility, and maintenance of the earth's startling variety of plants and animals, which we use to sustain ourselves, but which we also enjoy for their own sake. Natural ecosystem processes reduce the severity of floods, promote pollination of crops and natural vegetation, ensure dispersal of seeds, control agricultural pests, and protect coasts and hillsides from erosion.

These services are often unrecognized, or at best taken for granted—until conversion or loss of the ecosystem results in loss of the services. For example, wetlands and floodplains can play a vital role in minimizing flood peaks, but this was often not recognized until downstream flooding increased following upstream conversion and filling. Or a steep hillside, formerly stabilized by trees and shrubs, slides downward, taking with it the houses that replaced the trees. Indeed, one of the greatest environmental, social, and economic disasters in the nation's history—the Dust Bowl—occurred when the intangible services provided by the natural grassland ecosystem were lost as a result of widespread agricultural conversion.

Land can also change from agricultural use into a more natural condition (this occurs less often for urban lands). For example, demographic and economic changes in New England have replaced farmland production with forest ecosystem services, and the Conservation Reserve Program (which removes environmentally sensitive farmlands from production) implicitly acknowledges that the ecosystem services provided by these lands can outweigh the value of their agricultural production.

Why Can't This Indicator Be Reported at This Time? We report indirectly on some ecosystem services by reporting on changes in the extent of major ecosystem types. Since many ecosystem services are lost or exchanged for other, different, services when natural ecosystems are converted to farmland or urban/suburban use, or when wetlands are filled, tracking changes in ecosystem extent is the best way we currently have of quantifying changes in ecosystem services.

Although it is the best we have, it is not good enough, because changes in the condition of an ecosystem—short of outright conversion to another land use—can alter the amount and type of services the system provides. An alternative, but also unsatisfactory, approach involves very detailed studies of individual systems and services. Neither the broad-brush surrogate method nor the tightly focused individual service approach allows measurement of broad categories of ecosystem services, such as would be necessary for national reporting.

What Steps Are Necessary To Achieve Reliable National Coverage? There is substantial scientific uncertainty about ecosystem services—not about whether they exist or whether they are important to society—but about how to measure them, which ones to track, and the like. This is an area of active research among ecologists and ecological economists.

There is no technical note for this indicator.