

The State of the Nation's Ecosystems: Philosophy, Framework, and Findings

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This volume is intended as the first in a series of periodic reports on the extent, condition, and use of the lands, waters, and living resources of the United States. The “ecosystem indicators” that form the heart of the *State of the Nation's Ecosystems* have been selected through a nonpartisan collaboration among government, environmental organizations, the private sector, and the academic community. The indicators thus represent a unique consensus on how the nation's ecosystems can be described—and their status tracked over time—in a fair and balanced way. They characterize what is most important to know about the nation's ecosystems, rather than merely reflecting what happens to have been measured. Finally, the data presented for each indicator are based on solid science—on verified measurements, not opinion—that have been reviewed by experts from all sectors of society.

For all these reasons, this report will be a valuable tool for environmental decision makers at all levels and in all sectors of society. It should also provide Americans with a new way of looking at and talking about ecosystems that will help them evaluate the potential, and actual, effects of both public and private management decisions.

Part I lays out the fundamental principles on which this report is based, describes the nature of the indicators and defines the ecosystems on which we report, and summarizes the highlights of our findings.

The State of the Nation's Ecosystems

- Is designed as a blueprint for periodic reporting
- Is written for decision makers and the public, by scientists and other experts
- Presents a succinct set of indicators chosen by representatives from business, environmental organizations, academia, and federal, state, and local government
- Describes conditions without saying whether they are “good” or “bad” or recommending policies or actions
- Reports on the state or condition of ecosystems, not on pollution or other stresses, or on government or private programs and actions
- Describes a balanced range of ecosystem conditions and goods and services that benefit society
- Includes trends or other comparative information where available
- Highlights key information gaps

Chapter 1:

Reporting on the State of the Nation's Ecosystems

A Clear Need

Americans' support for sound environmental policy is strong, nonpartisan, and consistent,¹ reflecting recognition of the high cost—both monetary and otherwise—of a damaged environment. But the costs of ensuring a clean, safe, and healthy environment are also significant. In 1994, the last year for which government estimates are available, the United States spent more than \$120 billion on pollution abatement and control—nearly 2% of the nation's gross domestic product²—and this amount is only a part of the total cost of ensuring a clean, healthy, and vibrant environment.³

Each year, the federal government alone spends more than \$600 million collecting environmental data and, through regulatory requirements, imposes additional costs on the private sector, for monitoring of emissions and effluents.⁴ State and local government and environmental organizations also devote considerable resources to environmental monitoring, as does the private sector, above and beyond what is required for simple compliance. These efforts, reported in a host of individual documents and Web sites, provide crucial information without which this project would not have been possible. They do not, however, provide the high-level, comprehensive account on the state of the nation's ecosystems that is the goal of this project.

Given the importance and cost of environmental protection, it is hardly surprising that the need for a periodic report on “how we are doing” in our environmental management efforts has been recognized for at least three decades. In 1970, the Council on Environmental Quality noted in its first annual report to Congress that the efforts of that time did “not provide the type of information or coverage necessary to evaluate the condition of the Nation's environment or to chart changes in its quality and trace their causes.”⁵ Since then, virtually every comprehensive study of national environmental protection has called for more coherent and comprehensive information on the state of our environment. The National Academy of Sciences and the National Academy of Public Administration are among the many organizations that have recognized this need.⁶

But despite some excellent syntheses of data on specific problems and places, there is no periodic, comprehensive, and reliable compilation of essential information about the overall state of the nation's environment.⁷ As a result, policymakers and other stakeholders are swamped by increasing volumes of data that nonetheless seem to neglect important issues. Society all too often ends up arguing not about the issues, but about the relevance and validity of the data on which the prospects for a substantive policy debate depend.

For a nation deeply committed to protecting the environment, this is an unacceptable state of affairs. It is as though we would seek to develop sound economic policy without having reliable measures of the nation's GDP, unemployment, or inflation rate, relying instead on idiosyncratic reports from individual firms, sectors, unions, and local chambers of commerce. We cannot know whether our current environmental policies and practices are sound, and we cannot make new policy with confidence, without a similar set of generally accepted measures of fundamental properties of the environment.

Origin, Principles, and Process

Late in 1995, as part of its review of federal environmental monitoring efforts, the White House Office of Science and Technology Policy (OSTP) asked The Heinz Center to create a nonpartisan, scientifically grounded report on the state of the nation's environment. Acknowledging the relatively sophisticated reporting that already existed on many physical and chemical components of the environment (e.g., air quality, stream flows), OSTP proposed that The Heinz Center focus on ecosystems—that is, on the nation's living resources and the landscapes and waters they inhabit.

In undertaking this effort, The Heinz Center and its collaborators were guided by a fundamental conviction that, to be useful, *The State of the Nation's Ecosystems* must

- **Be scientifically credible.** Too many earlier efforts were disregarded because they were perceived as willing to accept any data available, or because their conclusions were not based in sound science. The report's content must benefit from input and review from a wide range of scientific and technical experts.
- **Be nonpartisan, both in content and in process.** Too many previous reporting efforts failed because they were perceived to be politicized or because they seemed to promote the perspectives of particular interests. Any hope for greater success requires that this effort be seen as fair and unbiased by a broad cross section of political interests.
- **Engage the expertise and experience of the nation's environmental monitoring programs and professionals.** Any attempt to characterize the state of the nation's ecosystems will fail without the cooperation of those who are engaged full time in the exacting and important profession of ecosystem monitoring and reporting.
- **Benefit from experimentation and learning.** No effort as ambitious as this could be expected to get everything right the first time around. Any hope for success depends on the ability to learn from the inevitable mistakes and to incorporate new data and understanding as they become available.

To implement these principles, the Center developed a funding strategy that depended upon joint support from government, industry, and private foundations. It assembled a small in-house staff and a large team of part-time collaborators drawn from government, the private sector, environmental organizations, and academia. A Design Committee, with members drawn from all of these groups, oversaw the entire project and made crucial decisions regarding approach, indicator selection, content, tone, and format of the overall document. Technical Work Groups, also representing a cross section of societal perspectives, were assembled to provide expertise in particular ecosystems. Their members identified the indicators included in this report, selected and assessed the data sources we relied upon, and drafted much of the descriptions and technical materials. Finally, a group of senior advisors and the Center's own Board of Trustees reviewed the project's strategic directions, with special attention to ensuring broad and balanced representation. Overall, nearly 150 individuals have participated in the project as committee and group members, with many more involved as contributors, reviewers, and advisors. (See p. x for a listing of committee members and p. xvii for additional acknowledgments.)

The Heinz Center established its working committees and began working intensively in late 1997. The project reached a key milestone with the release in late 1999 of a prototype report for public comment, covering three ecosystems: forests, farmlands, and coasts and oceans. This prototype was revised significantly in response to comments, and three additional ecosystems (fresh waters, grasslands and shrublands, and urban and suburban areas) were added. The process concluded with an extensive external review of a draft version of the present text in late 2001. Nearly 100 sets of comments were received from reviewers in business, environmental, government, and academic institutions. The end result of these steps—the first full report on *The State of the Nation's Ecosystems*—is presented in the chapters that follow.

Next Steps

This first edition of the *State of the Nation's Ecosystems* is issued simultaneously in a print version, published by Cambridge University Press, and in a Web version available at www.heinzctr.org. Subsequent reports in this series will incorporate new data and understanding, as well as comments, criticism, and suggestions from users of this initial edition. The Heinz Center actively solicits feedback, either by mail or through the *State of the Nation's Ecosystems* Web site.

This report is the first in what is intended to be a regular series of reports on the state of the nation's ecosystems. A variety of activities will be needed to produce the next edition. These include filling data gaps and improving the consistency of both data and indicators, consulting with key scientific communities in order to refine and clarify certain indicators, working with public and private agencies to regularize the provision of data in the form needed for national reporting, and strengthening the linkages between this project and others concerned with ecosystem reporting. The Heinz Center plans to undertake such activities following publication of this first report and is currently seeking the resources to do so, in anticipation of publishing the next report in the series in 2007.

One of the needs for the immediate future is to create the mechanisms for producing and updating the report on a regular basis. New editions will be issued in print and on the Web every five years; these will incorporate new understanding of the performance of ecosystems and of the most appropriate indicators and monitoring techniques to track that performance. Between these major new editions, substantial revisions—for example, to incorporate new data sets that become available—will be issued in an annual update to the Web version, with minor updates and corrections published on the Web as necessary.

Regular production of the report will require both long-term stable funding and an appropriate institutional “home.” While no decision has been made about whether The Heinz Center should continue to host the effort after the 2007 edition, what is clear is that the institutional and funding arrangements that support the project must ensure its continued independence and scientific credibility. Finally, besides what is required to produce the next report, it is likely that additional resources will need to be marshaled in order to fill some of the data gaps identified here.

Meeting the Need

This document responds to a clearly defined need—periodic information, worthy of trust, about the condition of our nation's lands, waters, and living resources. Where it is possible to do so, the extent, condition, and use of these precious assets are described. Where it is not possible, we have provided a road map to guide future efforts. These are valuable steps, but the true and lasting value of this project will be realized only if the effort is repeated regularly and is accompanied by significant enhancement of the base of scientific understanding and by continuation and improvement of high-quality monitoring programs.

The Structure of this Report

The remainder of Part I summarizes the findings of this project. Chapter 2 describes the reporting framework developed by the Design Committee for characterizing the state of the nation's ecosystems. Chapter 3 summarizes the overall findings of the report, including both what can be reported now and those gaps in data and understanding that will have to be filled before a fully comprehensive account of the state of the nation's ecosystems is possible.

Part II presents the indicators that characterize the state of the nation's ecosystems. Chapter 4 presents the core national indicators, which cut across the six ecosystems, and chapters 5–10 present the indicators that describe the state of the individual ecosystems that the project identified—Coasts and Oceans, Farmlands, Forests, Fresh Waters, Grasslands and Shrublands, and Urban and Suburban Areas.

An appendix describes in greater detail the data gaps identified in this document (see page 199).

Finally, the extensive technical notes (pp. 207–270) provide the technical foundations for the indicators. They include not only information on data sources and access, but also discussions of how the data have been manipulated and comments on their quality.

Notes and References

1. S.P. Hays. 1989. *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955–1985*. Cambridge, UK: Cambridge University Press.
The following sources provide polling data that demonstrate the nature and depth of public opinion on the environment: The Polling Report, Inc. Multiple polls, including Gallup, ABC News, Newsweek, Harris. Accessed at www.pollingreport.com/enviro.htm on April 26, 2002.
League of Conservation Voters Education Fund. Multiple polls from 1999 and 2000. Accessed at http://www.voteenvironment.org/media_debunking_env_myths_data.html on November 21, 2001.
2. Christine Vogan. *Pollution Abatement and Control Expenditures, 1973–94*. Survey of Current Business, Bureau of Economic Analysis, U.S. Department of Commerce. <http://www.bea.doc.gov/bea/an/0996eed/maintext.htm>; accessed August 8, 2001.
3. Note that costs of compliance with wetlands, endangered species, and similar regulatory programs, plus voluntary actions by the public and private sector, are probably also significant as well, but are not included.
4. Executive Office of the President, National Science and Technology Council, Committee on Environment and Natural Resources. *National Environmental Monitoring and Research Workshop Proceedings*. February 25, 1997.
5. Council on Environmental Quality. 1970. *Environmental Quality: The First Annual Report of the Council on Environmental Quality*, p. 237. Washington, DC: U.S. Government Printing Office.
6. National Academy of Public Administration. 1995. *Setting Priorities, Getting Results: A New Direction for the Environmental Protection Agency*. Washington, DC: National Academy of Public Administration.
National Research Council, Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environments. 2000. *Ecological Indicators for the Nation*. Washington, DC: National Academy Press. <http://www.nap.edu/catalog/9720.html>.
7. This situation exists in spite of several efforts to prepare and sustain periodic reporting on indicators and trends. For example, the Council on Environmental Quality published two major reports on environmental indicators and trends, one in 1981 and one in 1989, and the Conservation Foundation, a nonprofit organization, prepared three major reports (in 1982, 1984, and 1987) on environmental indicators and trends:
Conservation Foundation. 1982. *State of the Environment 1982: A Report from the Conservation Foundation*. Washington, DC.
Conservation Foundation. 1984. *State of the Environment: An Assessment at Mid-decade*. Washington, DC.
Conservation Foundation. 1987. *State of the Environment: A View toward the Nineties*. Washington, DC.
Council on Environmental Quality. 1981. *Environmental trends*. Executive Office of the President, Washington, DC.
Council on Environmental Quality. 1989. *Environmental trends*. Cosponsored by the Interagency Advisory Committee on Environmental Trends, Executive Office of the President. Washington, DC.

Chapter 2:

The Reporting Framework

This chapter describes the basic framework developed by the Design Committee to characterize the state of the nation’s ecosystems. It discusses the strategic guidelines that shaped the report, defines both the major ecosystem types and the major categories of indicators described in this report, and concludes with an overview of the nature of the data included in the report.

Goals

In developing a framework for reporting on the state of the nation’s ecosystems, the Design Committee reviewed a wide range of previous reporting efforts, consulted broadly with relevant stakeholders, users of environmental information, and experts, and incorporated feedback from the 1999 prototype of the present report. In addition, it built on three seminal documents: the proceedings of a National Environmental Monitoring and Research Workshop held at the Smithsonian Institution in 1996¹; the National Science and Technology Council’s *Integrating the Nation’s Environmental Monitoring and Research Networks and Programs: A Proposed Framework*,² published in 1997; and the National Research Council’s study *Ecological Indicators for the Nation*,³ published in 2000. Recruitment of key contributors to each of these documents as members of this report’s Design Committee ensured continuity and cumulative learning across the several efforts. The Design Committee developed and refined the goals for this report:

- **The report is written for decision makers and opinion leaders concerned about the “big picture” of the nation’s ecosystems.** Its goal is to identify what the nation most needs to know about its ecosystems in order to conduct enlightened policy debate; we also summarize what is known—and what is not known—about those key characteristics. More generally, the report seeks to educate a broader audience by highlighting important aspects of the nation’s ecosystems and by characterizing patterns of change in those conditions.
- **The report identifies a succinct set of strategic indicators to characterize the nation’s ecosystems.** It does not characterize every aspect of the environment or the ecosystems of particular regions. Rather, it identifies strategic indicators that can serve as meaningful reference points for broad-ranging policy discussions.⁴ In doing so, we seek to complement, not replace, existing reporting frameworks developed for particular management, regulatory, or scientific needs. Such programs provide data on many characteristics of ecosystems that we do not describe, and they can highlight changes that may not appear large at a national scale but are nonetheless quite important at a local scale.
- **The report provides scientific information on which decisions can be based, while avoiding value judgments and policy recommendations.** It thus seeks to be policy relevant while avoiding bias or advocacy. Rather than imposing our judgments of whether conditions are “good” and “bad,” the report assists readers in interpreting its content by including time trends and maps from which regional comparisons can be made. When possible, the report characterizes conditions in terms of departures from generally accepted standards (e.g., safe drinking water standards), while recognizing that there are judgments involved in setting such standards.
- **The report focuses on the *state* (or condition) of the nation’s ecosystems.** It leaves to others the task of identifying the stresses (pressures) that might be changing ecosystems, and of analyzing the effects

of actions taken by governments, private individuals, or businesses to reduce those stresses.

Information on pressures and societal responses is clearly important, and it has been incorporated in widely used environmental reporting frameworks.⁵ For this project, however, we chose to focus on *state* for two reasons. First, there is a strong need to complement existing reporting about environmental pressures and responses with information about society’s ultimate concern: the state of the nation’s ecosystems. Second, the difficulties of determining “cause and effect” can influence perceptions of the scientific credibility and political neutrality of both data and reporting efforts. Experience with other national reporting efforts (particularly those concerned with the nation’s economy) suggests that a broadly accepted characterization of system state can make an enormous contribution to policy development and understanding, even when disagreements persist on the causes of and appropriate policy responses to that state.

- **The indicators selected for this report reflect both key properties relating to ecosystem condition and the goods and services derived from ecosystems.** Ecosystems are incredibly complex, and reporting on them necessarily involves focusing on some characteristics and excluding many others. In addition, the values held by different people can lead them to place greater importance on some aspects of ecosystems than on others; some people place primary emphasis on the goods and services ecosystems produce, while others focus on their condition. The question is not *whether* to select, but only who does the selecting, and *how* it is done. The indicators included here were extensively discussed and negotiated by the members of our Design Committee and technical Work Groups, which included a balanced array of representatives from the private sector, environmental organizations, government, and academia. Although the selection of the indicators was inevitably a value-driven process, we took great care to make it fair and inclusive. The specific numbers assigned to those indicators were determined through a peer-reviewed scientific process, which we took great care to make transparent and credible.
- **The report identifies critical gaps in data and in monitoring programs that must be filled in order to fully, and in a balanced way, characterize the state of the nation’s ecosystems.** It leaves to the future, however, any discussion of how to fill those gaps. In preparing this report, we first identified ecosystem characteristics most important for a balanced national report. We then made extensive and good faith efforts to locate sufficiently high-quality and extensive data to report on those characteristics. Where such data are not available, the report calls attention to the gaps. In implementing this strategy, we have resisted the temptation to focus only on what happens to be illuminated by the lamp-posts of existing monitoring and reporting programs. Instead, the report identifies where lamps need to be posted in order to provide the kind of illumination of ecosystems that the nation most needs.

Defining Ecosystems

At the heart of this report are a set of six ecosystem types (coasts and oceans, forests, farmlands, fresh waters, grasslands and shrublands, and urban and suburban areas) and the indicators that, taken together, describe the state of these ecosystems and of the nation as a whole. It is reasonable to think about—and to seek indicators for characterizing—the ecosystem of a small watershed, or of the planet as a whole, or of places at any scale in between. However, like the recent National Research Council study on *Ecological Indicators for the Nation*, this report focuses on indicators that can support policy debate and decision making at the national scale.⁶

Ecosystems, Land Cover, and Geography

The word “ecosystem” is used in a number of ways, and there are two common organizational approaches we might have taken—land cover and geographic. The land cover approach defines

ecosystem types based on their dominant vegetation or other physical characteristics. Thus, one would speak of a “forest ecosystem,” a “cropland ecosystem,” or a “freshwater ecosystem.” The geographic approach considers all living and nonliving things in a region to be an ecosystem⁷ regardless of vegetation type. In this approach, boundaries can be defined in many ways: watersheds and ecoregions⁸ are common examples.

We have chosen the land cover approach and we use the terms “land cover types,” “ecosystems,” and “ecosystem types” more or less interchangeably. However, we also use a more geographic approach in some cases, such as when we define a farmland landscape that includes both croplands and interspersed natural areas.

We have chosen the land cover approach in large part because many natural resource management decisions are differentiated by land type. Forests, grasslands and shrublands, farmlands, and so on produce different products, respond to different management approaches, are owned for different reasons, and are, in plain terms, different. Significant government and private activities are aligned with these land cover distinctions, and we believed that a report reflecting this structure would be most useful at this time.

Nevertheless, a growing number of “place-based” efforts are working to implement management strategies that consider all of the interactions within a watershed, ecosystem, or region. These efforts are supported by monitoring and information systems that help decision makers and the public see their region as an integrated whole, rather than as distinct elements to be managed separately.⁹ We strongly support the development of such reporting and information systems, and we have had preliminary discussions on the application of the reporting framework presented in this report to smaller geographic regions.¹⁰

Ecosystem Types

This report uses six major ecosystem types as its basic reporting units.

- Coasts and Oceans
- Farmlands
- Forests
- Fresh Waters
- Grasslands and Shrublands
- Urban and Suburban Areas

This scheme is intended to cover all the lands and waters of the United States, including the ocean out to the limit of U.S. national jurisdiction. Obviously, these broad ecosystem or land cover types are neither homogeneous nor mutually exclusive. For example, the grasslands and shrublands ecosystem includes bare-rock desert and tundra, as well as the prairies and shrubland its name evokes. Freshwater wetlands are described along with lakes, streams, and so on, but are also tallied within the acreage of forests, farmlands, and other land covers. We describe each ecosystem type, including overlaps with other types, in greater detail in the opening section of each ecosystem chapter.

Map 4.2 (p. 40) shows where these ecosystems occur.

Coasts and Oceans. This ecosystem consists primarily of estuaries and ocean waters under U.S. jurisdiction. Estuaries are partially enclosed bodies of water (this term includes bays, sounds, lagoons, and fjords); they are generally considered to begin at the upper end of tidal or saltwater influence and end where they meet the ocean. By definition, U.S. waters extend to the boundaries of the U.S. Exclusive Economic Zone (EEZ), which extends 200 miles from the U.S. coast, but not all indicators report on this entire area. In addition, several indicators characterize shorelines along both estuaries and

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oceanfront areas. In these cases, we focus on the margin between land and water, not on uplands or watersheds that may influence coastal conditions.

Farmlands. We focus both on *croplands*—lands used for production of annual and perennial crops and livestock—and on a larger *farmland landscape*, which includes field borders and windbreaks, small woodlots, grassland or shrubland areas, wetlands, farmsteads, small villages and other built-up areas, and similar areas within and adjacent to croplands. Some indicators focus on croplands only, while some describe the entire farmland landscape.

Forests. We generally rely on the USDA Forest Service definition of forest: lands at least 10% covered by trees of any size, at least one acre in extent. This includes areas in which trees are intermingled with other cover, such as chaparral and pinyon–juniper areas in the Southwest, and both naturally regenerating forests and areas planted for future harvest (plantations or “tree farms”).

Fresh Waters. Our freshwater ecosystems include

- Rivers and streams, including those that flow only part of the year
- Lakes, ponds, and reservoirs, from small farm ponds to the Great Lakes
- Groundwater, which is often directly connected to rivers, streams, lakes, and wetlands
- Freshwater wetlands, including forested, shrub, and emergent wetlands (marshes), and open water ponds
- Riparian areas—the usually vegetated margins of streams and rivers (although this term can also apply to lake margins)

Obviously, there are overlaps and gradations among these systems. Wetlands often occur at the margins of streams and rivers, in what is also considered the riparian area. Some ponds are shallow and thus may also be classified as wetlands. In some rivers, dams create reservoirs, and these may be classified as rivers, reservoirs, or both.

Grasslands and Shrublands. The title of this system (which many people call *rangelands*) is quite descriptive: lands in which the dominant vegetation is grasses and other nonwoody vegetation, or where shrubs (with or without scattered trees) are the norm. Bare-rock deserts, alpine meadows, and arctic tundra are included in this system as well. We also include pastures and haylands, which represent an overlap with the farmland system; less-managed pastures and haylands fit well within the grassland/shrubland system, while more heavily managed ones fit well as part of the farmlands system. Most monitoring programs do not distinguish between the levels of management for pastures, however.

Urban and Suburban Areas. This system consists of those places where the land is primarily devoted to buildings, houses, roads, concrete, grassy lawns, and other elements of human use and construction. Urban and suburban areas, in which about three-fourths of all Americans live, span a range of density, from the unmistakable city center, characterized by high-rise buildings, concrete, and relatively little green space, to the suburban fringe—where development thins to an obviously rural landscape. This definition does not include all developed lands. It includes areas that we believe are large enough and built-up enough to qualify as “urban and suburban.” Many areas—small residential zones, the area of rural interstate highways, farmsteads, and the like—are “developed” but would not be considered “urban or suburban.”

Indicator Categories

This report identifies ten major characteristics of ecosystem condition and use that together provide a broad, balanced description of any ecosystem type. These ten characteristics cover the physical dimensions of the systems, their chemical and physical conditions, the status of their biological components, and the amounts of goods and services people receive from them.

These ten major characteristics are described for each of the six major ecosystem types, using between fourteen and eighteen indicators to cover all ten characteristics. As a general rule, for each of the six ecosystem types, there is at least one indicator describing each of the ten major ecosystem characteristics.

We have also identified ten “core national indicators” that provide a very broad and succinct view of national ecosystem condition and use.

Table 2.1 lists the ecosystem characteristics and briefly describes the related indicators. The table on pp. 28–29 lists all indicators in the report by ecosystem type and ecosystem characteristic.

Ecosystem Characteristic	Indicator Description
SYSTEM DIMENSIONS	
Extent	Area of an ecosystem or land cover type and its major components
Fragmentation and Landscape Pattern	Shapes and sizes of patches of an ecosystem type, and their relation to one another
CHEMICAL AND PHYSICAL CONDITIONS	
Nutrients, Carbon, Oxygen	Amounts and concentrations of key plant nutrients (nitrogen and phosphorus) and key ecosystem elements (oxygen and carbon)
Chemical Contaminants	Numbers of selected contaminants found in ecosystems, and how often these chemicals exceed regulatory or advisory thresholds
Physical Conditions	Condition of key aspects of the physical makeup of an ecosystem, such as erosion or water temperature
BIOLOGICAL COMPONENTS	
Plants and Animals	Status of native and non-native plant and animal species
Biological Communities	Condition of the plant and animal communities that make up an ecosystem
Ecological Productivity	Plant growth on land and in the water
HUMAN USE	
Food, Fiber, and Water	Amounts and values of key products for human use
Other Services, Including Recreation	Tangible and intangible services provided by ecosystems

Indicators of System Dimension

Extent. The extent of an ecosystem and its various components—measured either as area or as linear distance, as for rivers—is one of the most basic aspects of its condition, and provides background and context for other indicators. Indicators in this category generally describe the overall dimensions of the system—in absolute size and as a fraction of total U.S. land area. Some indicators also provide information on the composition of the system (e.g., acreage of major forest types) or on land use characteristics (e.g., area of grassland and shrublands used for livestock raising).

Fragmentation and Landscape Pattern. The size and shape of patches of forest, farmland, or other ecosystem types, and how patches of different ecosystem types are intermingled, help determine the quality and quantity of some ecosystem benefits or services. Examples of services that are believed to be strongly affected by landscape pattern include wildlife habitat, the ability to filter sediment and other contaminants from runoff, and the value for solitude and recreation.

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Indicators of Chemical and Physical Condition

Nutrients, Carbon, Oxygen. These are key ecosystem building blocks. We report the amount of nitrogen and phosphorus in water, the amount of carbon in soil and other ecosystem components, and, for aquatic systems, the amount of oxygen in the water. Nitrogen and phosphorus are key plant nutrients; in excess, however, they can contribute to water quality degradation. Most animals need oxygen to survive, and carbon is a critical component of living tissue. Moreover, increased carbon storage by ecosystems can offset emissions of carbon dioxide, of concern because of climate change.

Chemical Contaminants. Chemical contaminants can harm people and impair ecosystem functioning through their effects on plants and animals. We report on two key characteristics of this phenomenon: how many chemicals are found in water, sediments, and soil, and how often their concentrations exceed standards and guidelines set to protect human health and ecosystem condition. Indicators report on selected contaminants in stream water, groundwater, stream and estuary sediments, fish tissue, and soil.

Physical Conditions. Features such as the degree of erosion of farmland soils and the timing and size of low and high flows in streams have a strong influence on the plants, animals, and microorganisms that inhabit ecosystems and on the goods and services ecosystems produce. The specific physical features that are most important differ greatly among ecosystems, so there is less consistency among these indicators than among indicators describing other major characteristics.

Indicators of Biological Condition

Plants and Animals. Plants and animals are fundamental components of ecosystems, their condition can reflect broader ecosystem conditions, and many people care deeply about their status. Indicators generally focus on the relative risk of extinction of specific groups of species, the number and extent of non-native species, and unusual mortality events.

Biological Communities. Species do not exist in isolation; rather, they occur in characteristic groupings, adapted to a particular location and climate. These communities—each with its own characteristic set of species—form the biological “neighborhood” within which individual species exist.

Indicators of the Microscopic World

A number of indicators in this report touch upon the microscopic world, which exists in all ecosystems. For many people, terms like “plants and animals” and “biological communities” may bring to mind trees, flowers, fish, mammals, birds, and the like, along with their communal groupings. However, microscopic plants—algae—capture the sun’s energy and thus support much of life in the oceans; they also produce much of the oxygen necessary for animal life. Bacteria, which are neither plants nor animals, perform a host of chemical transformations in soil and water, without which these systems simply would not function. See Coastal Areas with Depleted Oxygen (p. 71); Harmful Algal Blooms (p. 78); Coastal Chlorophyll Concentrations (p. 80); Soil Biological Condition (p. 102); and Forest Disturbance: Fire, Insects, and Disease (p. 127).

Ecological Productivity: Plants, including algae, capture the sun’s energy, which is the basis for almost all life on earth. The amount of plant growth in various ecosystems is a fundamental indicator of their condition.

Indicators of Human Use

Food, Fiber, and Water. The major commodity goods produced by ecosystems meet human needs and are important to the national economy. For each ecosystem, except for urban and suburban areas, we report on major commodity or commodity-like products: fish landings, timber harvest, agricultural production, fresh water withdrawals, and range-fed cattle. We report basic quantities of the commodity, often accompanied by

information that relates to the long-term stability of production: factors such as agricultural yield, status of fish stocks, and the ratio between timber harvest and annual growth.

Other Services, Including Recreation. Ecosystems produce an enormous variety of “services”—from opportunities for recreation to the building of soil, reduction in flooding, and pollination of crops. This is an area of intense scientific interest, but the methods for quantifying these services are not well developed. In several instances, we highlight the importance of the underlying services but also the lack of developed indicators.

Data: Quality, Coverage, and Context

The final major element of our reporting framework involves how we selected and reported data. As noted above, we selected *indicators* on the basis of what is needed to fairly characterize the state of the nation’s ecosystems rather than because the *data* happened to be available. We then had to decide on criteria for including data from particular sources, on what to do when adequate data were not available, and on how to give meaning to the measurements we report. We summarize our design decisions below.

Quality and Coverage

For each indicator, we reviewed available data sources, using both the knowledge of individuals on our various working groups and input from a large number of collaborators and reviewers. Data included in this report had to meet three key criteria:

- Data had to be of sufficiently high quality to provide a scientifically credible description of actual ecosystem conditions
- Data had to have adequate geographic coverage to represent the state of the *nation’s* ecosystems
- Data had to be collected through an established monitoring program that offers a reasonable likelihood of future data availability

Data quality—meaning that the data provide a reasonably accurate representation of actual conditions and do not include any substantial known sources of bias or distortion—was the key criterion for selection of data sources. Quality was assessed using the expert knowledge of the participants in the project, supplemented by information provided by the managers of certain data sets; we also commissioned analyses of data sets specifically for this project.

A data set must also provide enough information on the resource or issue in question. This criterion is met by data sets with complete coverage (such as those based on satellite measurements) and those based on representative samples from which reasonably accurate estimates of overall conditions can be made. In practice, this led to the selection of data sets that covered most states or a significant fraction of the ecosystem in question. Obviously, there are large amounts of high-quality data that do not meet this criterion. For example, states and research institutions collect many potentially relevant data, but unless they are aggregated and reviewed to determine whether the collection methods are compatible, the data are not available in practice for national reporting, and so are not included in this report.

Third, we decided that data must be from ongoing programs, with a reasonable chance of the measurements being repeated at regular intervals in the future. Although all monitoring and reporting programs are subject to changes in funding and priorities, established programs are clearly different from one-time studies. One-time efforts can be quite valuable, since they often break new ground scientifically and may serve as baselines against which to compare future conditions. But until and unless they are performed regularly, they do not advance the goal of periodic national reporting.

Inadequate Data and Indicators Requiring Development

Applying the data selection criteria noted above, we identified a number of high-quality, nationally representative data sets with good prospects for future continuity. Inevitably, however, adequate data sets did not exist for all indicators.

Confronted with this dilemma, we tried to be pragmatic. Where small changes in the definition of an indicator would enable us to use existing data, we considered revising the indicator—provided, of course, that the modification would not compromise the indicator’s basic purpose. We also avoided indicators that seemed likely to require extraordinary technical advancement beyond current monitoring methods, or extraordinary human or fiscal resources.

Nevertheless, for a substantial number of the indicators selected for this report, adequate data could not be assembled. We identify such cases in the text, to highlight where future data monitoring work is needed. (These gaps are discussed in more detail in Chapter 3, p. 17, and in the Appendix, p. 199.)

Data Not Adequate for National Reporting. There are several causes for these data shortfalls, each with a distinctly different remedy. In some cases, the data needed for reporting are available, but additional processing or analysis—requiring either more money or more time than was available for this project—was needed. For example, there are several indicators of fragmentation and landscape pattern for which the appropriate remote sensing data are available, but which would require additional processing to calculate the relevant measures (see, for example, pp. 93 and 94). These cases represent relatively simple, low-cost opportunities for filling gaps identified in this report. Table A.2 (p. 205) lists the indicators in this category; the table also lists several indicators for which data are currently being collected, thus requiring no new action to fill a gap.

Second—and by far the largest category of indicators with missing data—are those cases where many data probably exist, but they are not available in a form that we could use. Most commonly, relevant data are collected, but by different entities (e.g., states, local governments, research institutions), potentially using different methods. For example, data on groundwater levels in major

aquifers are collected by a wide variety of entities to help them understand their water supply situation (see p. 151). However, no group has gathered these data and assessed whether the monitoring methods are comparable. Filling these data gaps might simply require aggregation of existing data, or it might require development and adoption of consistent methods by data collectors.

Third, there are situations where data are not widely collected, but could be if an adequately funded program were in place. The condition of microscopic animals in cropland soils (p. 102) and the contamination of bottom sediments in ocean waters (p. 72) are two examples. The challenge here is operational rather than conceptual.

Indicator Development Needed. Finally, in several cases, we could not select a specific measure, and thus could not evaluate whether data are available. For some indicators, there are multiple competing approaches to measuring a particular

What does “Data Not Adequate for National Reporting” mean?

Data selected for this report had to

- Be scientifically credible and high quality
- Cover most of the United States
- Have a reasonable likelihood of being available for future reporting

We use the phrase “data not adequate for national reporting” to indicate that we were not able to identify a data set meeting these criteria.

In many cases, some indicator data are available. However, these data may cover only a limited geographic area, may never have been assembled from the states, local governments, or research institutions that collected them, or may have been the result of one-time studies. Many of these data sets are excellent examples of the kind of monitoring necessary, and they may serve as the basis for future national reporting.

phenomenon, and progress could be made rapidly if a single method could be selected (see, for example, the stream habitat index, p. 105). Other indicators require conceptual development before data availability can be assessed (see the suburban/rural land use change indicator, p. 182).

Trends and Other Context-Setting Information

Data without context are apt to have little meaning. In order to provide context, and instead of providing “grades” for particular indicator values, we have, wherever possible, provided one or more of the following:

- Information on how the indicator value has changed over time (trends). We tried to find data for the period from 1950 through the present, although this was possible in relatively few cases. In addition, where appropriate, we also provide information on long-term historical comparisons (to presettlement conditions, for example). Presettlement comparisons are meant to give context, not to represent “ideal” conditions.
- Information on regional differences. Frequently, we display data on a regional basis to allow users of the report to compare values in one part of the country with those in another.
- Comparisons with widely accepted reference points. Where they exist, we compare data to regulatory and related standards and guidelines that have become widely used and accepted national reference points, while recognizing that there are judgments inherent in setting such benchmarks. Such standards, guidelines, and related reference points are available primarily for indicators related to nutrients and chemical contaminants. In several cases, indicators are based on comparison to relatively undisturbed “reference sites.”

A Note About Regions

We have generally relied on the regional groupings used by the agency providing the data. So, for example, we report on many forest indicators using USDA Forest Service regions and on several coastal indicators using National Oceanic and Atmospheric Administration regions. In a few cases, we used a set of regions developed by The Heinz Center that considered climate, topography, and vegetation.

Since no two agencies share the same regional boundaries, the regions used in this report vary considerably. While it may be desirable to report all indicators on a common geographic basis, in practice this is not currently possible. We are certainly not the first to make this observation, and there are many efforts under way within federal agencies and elsewhere to address this issue. Ideally, data on ecosystem conditions, as reported here, should be gathered and managed so as to enable reporting on any geographic basis; this would allow comparison and aggregation of information collected by different agencies and programs.

Notes and References

1. Executive Office of the President, National Science and Technology Council, Committee on Natural Resources. 1997. National Environmental Monitoring and Research Workshop: Proceedings. February 25, 1997. <http://www.epa.gov/cludygxb/Pubs/nemrwork.pdf>.
2. Executive Office of the President, National Science and Technology Council, Committee on Natural Resources, Environmental Monitoring Team. 1997. Integrating The Nation’s Environmental Monitoring and Research Networks and Programs: A Proposed Framework. <http://www.epa.gov/cludygxb/Pubs/framewrk.pdf>.
3. National Research Council (NRC), Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environments. 2000. Ecological Indicators for the Nation. Washington, DC: National Academy Press. <http://www.nap.edu/catalog/9720.html>.
4. The scientific feasibility of such a strategic approach to ecosystem characterization has recently been endorsed by the National Academy of Sciences. See NRC op. cit.

The Reporting Framework

5. The Organization for Economic Cooperation and Development developed what is widely known as the “pressure-state-response” framework for reporting on environmental conditions. See Organization for Economic Cooperation and Development. 1991. *The State of the Environment* (Paris).
6. Local- and regional-scale ecosystem indicators clearly are needed to guide many types of public and private decisions. The need for global-scale indicators to support international environmental agreements is increasingly recognized, and has called forth large scale efforts such as the UN Environment Programme’s *Global Environmental Outlook* reports and the international Millennium Ecosystem Assessment. National ecosystem indicators are nonetheless also needed, not only to support sound policymaking by nations but also to provide context for domestic regional efforts and input to global reporting efforts. NRC, op. cit.
Millennium Ecosystem Assessment (<http://www.ma-secretariat.org/en/index.htm>).
United Nations Environment Programme. 2000. *Global Environmental Outlook—2000*.
<http://www.unep.org/Geo2000/ov-e/index.htm>.
7. For example, Odum (1971) defines an ecosystem as “Any unit that includes all of the organisms (i.e., the “community”) in a given area interacting with the physical environment so that a flow of energy leads to a clearly defined trophic structure, biotic diversity, and material cycles (i.e., exchange of materials between living and nonliving parts) within the system is an ecological system or *ecosystem*.” E.P. Odum. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
8. An ecoregion is “a relatively large area of land or water that contains a geographically distinct assemblage of natural communities”. R.A. Abell et al. 2000. *Freshwater Ecoregions of North America: A Conservation Assessment*. Washington, DC: Island Press.
9. L.H. Gunderson, C. S. Holling, S. S. Light (eds.). 1994. *Barriers and Bridges to the Renewal of Ecosystems and Institutions*. New York: Columbia University Press.
10. In May 2000, a 1½-day meeting was held in Bozeman, Montana, under the joint sponsorship of The Heinz Center and the Department of the Interior. This meeting was with representatives of a range of public and private interests in the Greater Yellowstone area (GYA). While the meeting was not intended to be conclusive, there was general agreement that the basic framework of indicator categories used in this report was applicable in the GYA, and perhaps in other regional/ecosystem contexts as well.

Chapter 3:

The State of the Nation’s Ecosystems: What We Know and What We Don’t Know

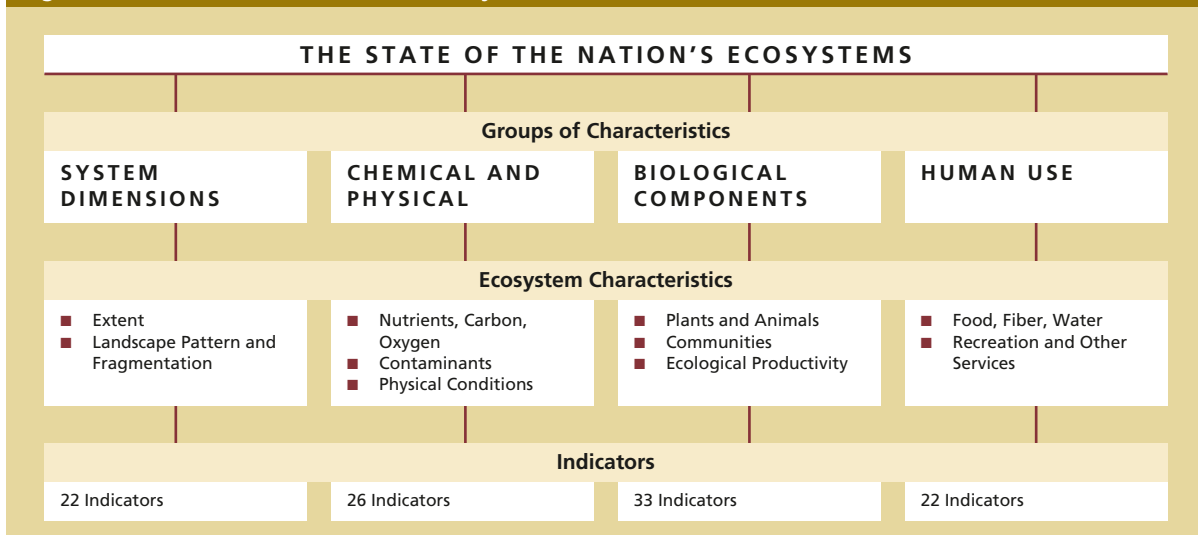
Choosing Indicators and Data

This report is the collective effort of close to 150 researchers, organized into seven committees, working over nearly five years. A multidisciplinary “Design Committee,” with members drawn from industry, environmental groups, government, and universities, identified ten key characteristics of ecosystem condition that are valued by Americans and that, in our judgment, need to be addressed in any credible, balanced and useful report. These ten characteristics describe the physical dimensions of the systems, their chemical and physical conditions, the status of their biological components, and the amounts of goods and services people receive from them (see Figure 3.1). We also decided to report on these indicators for the nation as a whole and for six major ecosystem types that have long been the focus of policy debate, research, management, and monitoring—coasts and oceans, farmlands, forests, freshwaters, grasslands and shrublands, and urban and suburban areas.

Six ecosystem-specific work groups, each with representation from business, environmental, academic, and government institutions, identified between 15 and 20 specific indicators for each system, as well as a set of “core national indicators.” The indicators were selected based on their importance; no indicator was ruled out simply because the data to report on it is not currently available. Each of the ecosystem-specific work groups then carefully examined potential data sources for reporting on each indicator. We used data only if it met high professional standards for integrity and overall quality and allowed us to report on most of the United States, and if there was a reasonable likelihood that the underlying measurements would be repeated over time. Key data gaps became apparent and are identified throughout the report.

Finally, we obtained the required data from the government agencies and private organizations that collect and maintain them. Our primary focus was to present current conditions and to lay the groundwork for future reporting, but wherever possible we sought datasets with records long enough to

Figure 3.1. The State of the Nation’s Ecosystems: Characteristics and Indicators

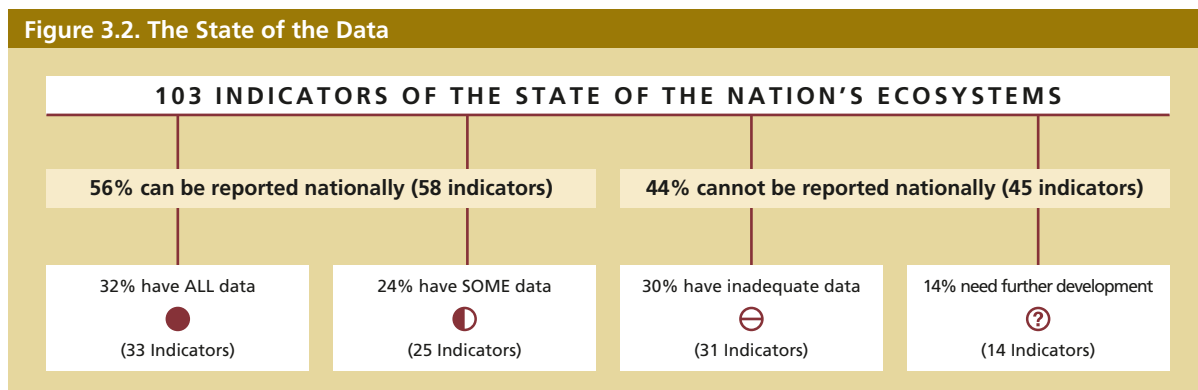


reveal trends. When they were available, we compared data on current conditions with widely accepted reference points, primarily regulatory and related standards and guidelines, while recognizing that there are judgments involved in setting such standards. In many cases, we also provided data on a regional basis, allowing comparisons between regions.

The State of the Data for Reporting on the Nation's Ecosystems

In seeking data, we found a classic case of a glass that is both half empty and half full. In applying the selection criteria outlined above, we found adequate data for more than half of the selected indicators, with trends or other context information on many of these, allowing us to report meaningfully on many aspects of ecosystem condition. However, substantial gaps remain, and until and unless these gaps are filled, Americans will not have access to a complete picture of the “state of the nation’s ecosystems.” Even with these gaps, however, consistent tracking and reporting of those indicators for which we found adequate data would produce a much more useful picture of the state of the nation’s ecosystems than has ever been available.

Our full analysis of data availability and gaps is presented in the Appendix, p. 199. Highlights are summarized in Figure 3.2 and described below.



- This report presents 103 indicators. Data are adequate to support national reporting for 58. Of these, we have all the desired data for 33 indicators (●). Important gaps remain for the other 25 indicators (◐).
- Of the 58 indicators with data, we present trends for 31. For 11 other indicators, we provide comparisons against widely accepted standards, or against undisturbed or “reference” conditions. For the remaining 16 indicators, neither trends nor appropriate reference points were available.
- We provide no data for 45 indicators. For 31 of these, data availability is the only impediment to national reporting. These indicators are clearly marked with a “data not adequate for national reporting” label and with this icon: ⊖.
- For the other 14 indicators for which no data are reported, the problem is more fundamental: a lack of agreement on how the relevant ecosystem characteristic can be measured most meaningfully and effectively. For these indicators, additional work is required in the appropriate scientific communities to build a consensus on the specific measurements that should be reported. Indicators in this category are marked with an “indicator development needed” label and with this icon: ⊕.
- Data availability varies by ecosystem: about three-fourths of forest indicators have some or all data, contrasting with grasslands and shrublands and urban and suburban areas, where only about 40% have data. Data availability also varies by ecosystem characteristic: more than 80% of the indicators of ecosystem extent, chemical contamination, and the quantities of food, fiber, and water produced in ecosystems have some or all data, while for several characteristics (landscape pattern and fragmentation, biological communities, and recreation and other services), fewer than a third of the selected indicators have adequate data for national reporting.

The State of the Nation's Ecosystems

What follows is a very brief overview of the findings of this report. In it we present highlights of both actual ecosystem conditions and the availability of data and indicators. We have organized this summary according to the ten major aspects of ecosystem condition that form a key part of our reporting framework. These characteristics are identified in Figure 3.1, and are discussed in detail in Chapter 2. The table on pages 28 and 29 shows all indicators included in this report.

While the summary below does not generally provide highlights of indicators for which adequate data are not available, such indicators are just as important as those for which data *are* presented. It is what should be measured that is important, not whether it has been measured yet.

System Dimensions: Extent

The acreage of a particular ecosystem type (or for features like shorelines and rivers, their length) is a basic characteristic of their condition. Gains or losses in the area devoted to different ecosystem types, or in the acreage devoted to particular uses of land, such as wilderness areas or livestock grazing, change the landscape in important ways. Gains or losses within an ecosystem type—for example, conversion from one forest type to another—are also important.

We present 15 indicators of ecosystem extent. For 13 of these indicators, we located either full or partial data. Historical trend data are available for eight of these.

Highlights: Ecosystem Extent

- Forests and grasslands and shrublands each occupy about a third of the land area of the lower 48 states, and croplands about a quarter; wetlands and urban and suburban areas each occupy a few percent of the total area. See Table 3.1.
- Since European settlement, the area of both forest and grasslands and shrublands has declined by about a third. Each had initially occupied about half of the land area of the lower 48 states.
- Since the 1950s, the area of forests has declined by about 1%, and the area of croplands by about 5%. Nonfederal grassland/shrubland area

Systems Dimensions: Extent	
Core National	● Ecosystem Extent
Coasts and Oceans	● Coastal Living Habitats ● Shoreline Types
Farmlands	● Total Cropland ● The Farmland Landscape
Forests	● Forest Area and Ownership ● Forest Types ● Forest Management Categories
Fresh Waters	● Extent of Freshwater Ecosystems ● Altered Freshwater Ecosystems
Grasslands/Shrublands	● Area of Grasslands and Shrublands ● Land Use
Urban/Suburban	● Area of Urban/Suburban Lands ● Total Impervious Area ● Stream Bank Vegetation
	● Complete data available ● Partial data available ● Data not adequate for national reporting ● Indicator development needed

Table 3.1. 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

^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.

has decreased since the 1980s by about 3%. The area of urban and suburban lands, although comparatively small, has increased considerably.¹

- The acreage of wetlands has declined by more than half since European settlement, with both freshwater wetlands and coastal wetlands declining (by 10% and 8%, respectively) since the 1950s, although the rate of loss has slowed in recent decades. There are inadequate data to report on coastal wetlands on the West Coast.
- The acreage of forests that are replanted for future harvest and those in wilderness areas and national parks has increased over the past 50 years. Information on land use in grasslands and shrublands is not available.

System Dimensions: Fragmentation and Landscape Pattern

Scientists agree that the pattern of ecosystems on the landscape affects their condition. For example, whether forests are found in large patches or small, and how these patches intermingle with other ecosystem types within a region, affects their value as habitat for different species and the quantities of other goods and services they provide. However, there remain considerable gaps in scientific understanding about which aspects of the size, shape, and proximity of patches of an ecosystem type matter most in different ecosystems and to different species.

We identified seven indicators of fragmentation and landscape pattern. Data are available for only two of these, and those data are for a single point in time only (i.e., no trends). There is no consensus on what should be measured as a national-level indicator of fragmentation and landscape pattern.

Highlights: Fragmentation and Landscape Patterns

- Landscape pattern and fragmentation are important, but they can be measured in many different ways. No single method has appeared that is “best” for all ecosystems.
- About two-thirds of all points in both eastern and western forests are surrounded by an “immediate neighborhood” (roughly 250-foot radius) that is mostly forested (90% or greater forest cover). About a quarter of all forest points are surrounded by larger (roughly 2½-mile radius) neighborhoods that are mostly forest.
- About half of all natural lands (forests, grasslands and shrublands, wetlands) in urban and suburban areas are in patches smaller than 10 acres.

System Dimensions: Fragmentation and Landscape Pattern	
Core National	🕒 Fragmentation and Landscape Pattern
Farmlands	🕒 Fragmentation of Farmland Landscapes by Development 🕒 Shape of “Natural” Patches in the Farmland Landscape
Forests	🕒 Forest Pattern & Fragmentation
Grasslands/Shrublands	🕒 Area and Size of Grassland/ Shrubland Patches
Urban/Suburban	🕒 Patches of Forest, Grasslands/ Shrublands, and Wetlands 🕒 Suburban/Rural Land Use Change
	<ul style="list-style-type: none"> 🕒 Complete data available 🕒 Partial data available 🕒 Data not adequate for national reporting 🕒 Indicator development needed

Chemical and Physical: Nutrients, Carbon, Oxygen— Chemical Building Blocks of Life

Four elements—carbon, oxygen, nitrogen, and phosphorus—play key roles in ecosystems. Nitrogen and phosphorus are important plant nutrients, but human activities sometimes increase their levels to a degree that causes water quality problems. Carbon stored as organic matter in soil improves soil fertility. Moreover, increased storage of carbon in ecosystems can offset emissions of carbon dioxide, of concern because of climate change. Finally, water must have sufficient oxygen if aquatic animals are to survive.

We selected 12 indicators related to nitrogen, phosphorus, carbon, and oxygen. Full or partial data are available for eight of these. For six of these indicators with data, we provide comparisons to regulatory standards or similar benchmarks. For two, we present trend data.

Highlights: Nutrients, Carbon, Oxygen

- The amount of nitrogen carried by major U.S. rivers has increased over recent decades. The amount carried by the Mississippi River, which drains 40% of the lower 48 states, has tripled since the 1950s.
- Farmland streams and groundwater have higher levels of nitrate than those in forests or urban and suburban areas.
- About 20% of groundwater wells and 10% of streams tested in farmland areas exceeded the federal drinking water standard for nitrate.
- Farmland and urban/suburban streams have similar phosphorus levels; both are higher than forest streams.
- At least half of larger rivers in the United States, three-fourths of streams in farmland areas, and two-thirds of urban/suburban streams had phosphorus levels at or exceeding the limit recommended by the Environmental Protection Agency (EPA) for avoiding excess algae growth.
- From the 1950s to the 1990s, carbon stored in trees increased by 80% in the East and remained constant in the West.
- There are inadequate data for national reporting on areas with depleted oxygen in coastal waters.

Chemical and Physical Conditions: Nutrients, Carbon, Oxygen

Core National
● Movement of Nitrogen

Coasts and Oceans
⊖ Areas with Depleted Oxygen

Farmlands
● Nitrate in Farmland Streams and Groundwater
● Phosphorus in Farmland Streams
⊖ Soil Organic Matter

Forests
● Nitrate in Forest Streams
● Carbon Storage

Fresh Waters
● Phosphorus in Lakes, Reservoirs, and Large Rivers

Grasslands/Shrublands
⊖ Nitrate in Groundwater
⊖ Carbon Storage

Urban/Suburban
● Nitrate in Urban/Suburban Streams
● Phosphorus in Urban/Suburban Streams

● Complete data available
● Partial data available
⊖ Data not adequate for national reporting
⊙ Indicator development needed

Chemical and Physical: Chemical Contaminants

Our indicators of chemical contamination generally present two aspects of this issue. First, we report the number of contaminants detected in streams, groundwater, sediments, or fish tissue, which provides a perspective on how widespread such chemicals are. However, because the presence of contaminants does not necessarily mean that levels are high enough to cause problems, we also report on how frequently regulatory and other guidelines or standards are exceeded. See Table 3.2 for a summary of findings.

Table 3.2. Summary of Findings of Contaminants Indicators

	Percent with One or More Contaminants Detected	Percent with One or More Contaminants Exceeding Aquatic Life Guidelines ^a	Percent with One or More Contaminants Exceeding Human Health Guidelines
Streams			
All	100%	77%	13%
Farmlands (pesticides only)	100%	84%	4%
Urban/Suburban	100%	100%	5%
Groundwater			
All	90%	Not applicable	26%
Farmlands (pesticides only)	61%	Not applicable	Less than 1%
Stream Sediments	99%	48%	Not applicable
Freshwater Fish	94%	50%	Data Not Available
Coastal Sediments (estuary data only)	100%	60%	N/A
Coastal Fish	Data Not Available	Data Not Available	Data Not Available

^a For fish, guidelines used refer to fish-eating wildlife, such as eagles and other predatory birds. For coastal sediments, the figure presented here (60%) includes sediments with concentrations exceeding guidelines for possible harmful effects (19% with 1-4 such contaminants; 39% with 5 or more such contaminants), as well as those whose contaminant levels exceed guidelines for probable effects (2%).

Note: The data presented here reflect testing for different chemicals in different environmental media—some compounds typically are found in stream water, for example, but not in sediments. Tested contaminants include many pesticides, selected degradation products, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds, other industrial contaminants, trace elements, nitrate, and ammonium. See the technical note for the national contaminants indicator, p. 210, for details.

Chemical and Physical Conditions: Contaminants	
Core National	● Chemical Contaminants
Coasts and Oceans	● Contamination in Bottom Sediments
Farmlands	● Pesticides in Farmland Streams and Groundwater
Fresh Waters	See the core national, farmlands, and urban/suburban indicators.
Urban/Suburban	● Air Quality ● Chemical Contamination
● Complete data available ● Partial data available ● Data not adequate for national reporting ● Indicator development needed	

We present five indicators of chemical contamination. All have at least partial data, and all include some comparison to regulatory standards or similar benchmarks. Trend data are available for only one indicator.

Highlights: Chemical Contaminants

- All or almost all streams, groundwater, sediments (stream and estuarine), and freshwater fish sampled have at least one contaminant at detectable levels.
- Thirteen percent of streams and 26% of groundwater tested had at least one contaminant at a concentration that exceeded human health standards. (Farmland streams and groundwater show fewer exceedances, but these data cover only pesticides.)
- Guidelines for protection of aquatic life are exceeded more often than are human health standards. Half or more of the streams, freshwater fish, and coastal sediments had at least one contaminant that exceeded aquatic life guidelines.

Chemical and Physical: Physical Conditions

The physical makeup and condition of an ecosystem is critical to its functioning. For example, ocean temperature determines what kind of fish and other aquatic animals will live or thrive in an area, the depth to groundwater influences the ability of plants to survive, and the degree of erosion affects both

Chemical and Physical Conditions: Physical	
Coasts and Oceans	● Coastal Erosion ● Sea Surface Temperature
Farmlands	● Soil Erosion ● Soil Salinity
Fresh Waters	● Changing Stream Flows ● Water Clarity
Grasslands/Shrublands	● Number and Duration of Dry Periods in Streams and Rivers ● Depths to Shallow Water
Urban/Suburban	● Urban Heat Island
● Complete data available ● Partial data available ● Data not adequate for national reporting ● Indicator development needed	

soil quality in farmlands and the degree of off-farm impacts from sedimentation. Because these physical conditions are different for different ecosystems, we include a wide variety of indicators of key physical conditions.

We selected nine indicators of physical conditions. Adequate data for national reporting, including time trends, were available for four of these.

Highlights: Physical Conditions

- Since 1982, the area of cropland with high potential for wind erosion decreased by one-third (to 63 million acres, or 15% of croplands); the area with high potential for water erosion also dropped by a third, to 89 million acres (22% of croplands).
- The number of streams or rivers with major changes in flow compared to a 1930–1949 reference period increased slightly from the 1970s to 1990, to 60%. Streams with high flows well above the 1930–1949 reference period increased markedly after the 1980s, to about 30% of streams. Changes in low flows were more modest.
- Compared to the 1950s and 1960s, fewer grassland/shrubland streams have at least one day with no flow (about 15% in the 1990s), and when no-flow periods occur, they are generally shorter.
- While data are available for sea surface temperature, no trends (either warming or cooling) are evident.

Biological Components: Plants and Animals

Individual species of plants and animals are fundamental building blocks of ecosystems. Species-oriented indicators in this report include those focusing on the percentage of species in particular areas or

ecosystems that are at risk of extinction; the degree to which non-native species are gaining a foothold and spreading; and the frequency of unusual mortality events among selected groups of species.

Sixteen indicators relate to plant and animal species, and complete or partial data are available for eight. Three indicators have sufficient data to report trends.

Highlights: Plants and Animals

- 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. However, because the number of at-risk species is affected both by the number of naturally rare species and by a variety of human activities, it is difficult to interpret these data without information on trends in the number of at-risk species. Trend information is not currently available.
- When species ranked as “vulnerable” are included, about a third of all plant and animal species are “at risk.” The degree of risk for “at risk” species varies considerably, from those species at relatively low risk, to those that are in imminent danger of extinction.
- About 20% of native freshwater animal species are ranked as “imperiled,” as are 9% of forest and grassland/shrubland animals. An ecosystem with a larger percentage of at-risk species does not necessarily have a larger percentage of species that are declining, because some ecosystems have more naturally rare species. Again, it is difficult to interpret these numbers without information on trends, which is not available.
- The only national data on non-native species are for birds and freshwater fish. Only 1% of the 350 major watersheds in the U.S. have no non-native fish; almost two-thirds have between 1 and 10 non-native fish, and the rest have more. In grassland and shrubland areas, populations of invasive and native, non-invasive bird species were changing in about the same proportion for most of the past 35 years.
- About 20% fewer incidents of unusual waterfowl mortality occurred in 1990–1995 than in the previous two 5-year periods. Particularly large mortality events for marine mammals occurred in 1992 (more than 2500 sea lions) and 1999 (215 harbor porpoises and 270 gray whales).

Biological Components: Plants & Animals

Core National

- At-Risk Native Species

Coasts and Oceans

- ⊖ At-Risk Marine Species
- ⊗ Non-native Species
- Unusual Marine Mortalities

Farmlands

- ⊗ Status of Animal Species in Farmlands Areas
- ⊗ Native Vegetation in Areas Dominated by Croplands

Forests

- At-Risk Native Species
- ⊖ Area Covered by Non-native Plants

Fresh Waters

- At-Risk Native Species
- Non-native Species
- Animal Deaths and Deformities

Grasslands/Shrublands

- At-Risk Native Species
- ⊖ Non-native Plant Cover
- Population Trends in Invasive and Non-invasive Birds

Urban/Suburban

- ⊖ Species Status
- ⊖ Disruptive Species

- Complete data available
- Partial data available
- ⊖ Data not adequate for national reporting
- ⊗ Indicator development needed

Biological Components: Communities

Biological communities are the more-or-less stable groupings of plants and animals found in particular habitats. These interacting communities form the biological “neighborhood” within which individual species exist, and their condition reflects a broad array of influences on an ecosystem. As with the indicators of physical condition, indicators of biological community condition differ greatly among ecosystems.

Fifteen indicators describe the condition of biological communities. All or partial data are available for only four of the 15 indicators, and trends for only one. Six indicators lack adequate national data, and five of the indicators require additional development.

Biological Components: Communities	
Core National	⊖ Condition of Plant and Animal Communities
Coasts and Oceans	⊖ Harmful Algal Blooms Ⓢ Condition of Bottom-Dwelling Animals
Farmlands	⊖ Soil Biological Condition ⊖ Stream Habitat Quality
Forests	Ⓢ Forest Age ● Forest Disturbance: Fire, Insects, and Disease ⊖ Fire Frequency ⊖ Forest Community Types with Significantly Reduced Area
Fresh Waters	⊖ Status of Freshwater Animal Communities Ⓢ At-Risk Freshwater Plant Communities ⊖ Stream Habitat Quality
Grasslands/Shrublands	⊖ Fire Frequency ⊖ Riparian Condition
Urban/Suburban	⊖ Status of Animal Communities in Urban/Suburban Streams
	● Complete data available Ⓢ Partial data available ⊖ Data not adequate for national reporting ⊖ Indicator development needed

Biological Components: Ecological Productivity	
Core National	● Plant Growth Index
Coasts and Oceans	Ⓢ Chlorophyll Concentrations
	● Complete data available Ⓢ Partial data available ⊖ Data not adequate for national reporting ⊖ Indicator development needed

Highlights: Communities

- At least half of the estuary area in the Mid-Atlantic, South Atlantic, and Gulf of Mexico regions has bottom-dwelling animal communities that are “undegraded,” compared to an undisturbed site; about one-fifth has “degraded” bottom-dwelling animal communities. Data are not available for other regions.
- About 65% of eastern timberlands and 30% of western timberlands are less than 60 years old. About 5% of eastern timberlands and 35% of those in the West are 100 or more years old. (Data for the roughly one-third of forests that are not classified as “timberlands” are not yet available.)
- Since 1980, wildfires in both forests and grasslands and shrublands have affected between 2 and 7 million acres per year, down from a high of 52 million acres in 1930. (While national data do not show an overall increase in acreage burned over the past 20 years, data from national forests, which are mostly in the West, do show an increase.) Insect damage in forests affected between 8 and 46 million acres per year over the past 20 years; the overall trend is downward.
- About 12% of freshwater wetland plant community types are considered at very high risk of being eliminated, and a total of 60% are considered to be at risk of elimination.

Biological Components: Ecological Productivity

The amount of plant growth in an ecosystem is a direct measure of the amount of energy (from the sun) entering the ecosystem and thus of the amount of energy available to all organisms in the system.

This report includes two related indicators: one measures the solar energy captured by plants across the United States, which is closely related to the amount of plant growth, while the other reports on the concentration of chlorophyll in coastal waters, a measure of growth of algae. Data are available for both.

Highlights: Ecological Productivity

- For plant growth nationwide, no overall upward or downward trends are apparent over the 11-year period for which data are available.

However, there is large year-to-year variation, both regionally and by ecosystem type.

- Data on coastal chlorophyll concentrations are available for only three years, which is too short to determine trends.

Human Uses: Production of Food and Fiber and Use of Water

Ecosystems produce goods that meet a variety of societal demands. In this report, we include 13 indicators of major ecosystem-related commodities. Most of these indicators describe the goods society derives from ecosystems; several also provide information on the ability of the system to continue producing those goods. Data, including trends, are available for ten of these indicators.

Highlights: Production of Food and Fiber and Use of Water

- Agricultural production has increased by about 85% since the 1950s, although there were noticeable fluctuations within the overall increasing trend.
- Per-acre yields of the major crops grown in the United States have increased dramatically over the past 50 years. For all five major crops (corn, wheat, soybeans, hay, and cotton), the increase in yield was close to, or greater than, 100%, with corn yields increasing almost fourfold. The amount of key inputs required to produce a unit of farm output—with the exception of pesticides—has decreased; pesticide inputs have leveled off since 1980.
- Timber harvest is about 40% higher than it was during the 1950s, but it is lower now than at its peak in the 1980s.
- Annual timber growth in both the East and West regions exceeds harvest on both public and private timberlands. This has been largely true for the past 50 years. Private lands account for almost 90% of total harvest.
- Freshwater withdrawals for various human uses increased nearly 60% from 1960 to 1980, when they dropped sharply, followed by a gradual increase.
- The number of human disease outbreaks attributable to contaminated drinking water has declined significantly overall since the mid-1970s; during the same period, the number of outbreaks associated with recreational contact increased significantly. Since 1990, there have been fewer than 20 outbreaks per year in each category.
- Marine fish landings grew by about 10% from the mid-1970s, when reliable data became available, to the mid-1990s. Recent declines mean that current levels are about equal to those of the late 1970s.
- Nationally, from 1981 to the present, about 40% of fish stocks with known population status had decreasing population trends, while about 20% had increasing trends. Population trends are not known for about three-quarters of commercially important stocks.
- The number of range-fed cattle decreased slightly during the 1990s, to about 93 million animals.

Human Uses: Recreation and Other Services

Ecosystems provide “services” to people, such as soil building, plant pollination, natural flood control, and the like, as well as outdoor recreation. We defined nine indicators in this category, seven of which deal with either the number of days of recreational activity or the quality or availability of recreational resources. Data are inadequate for national reporting on all but one of these indicators; partial data, with no trends, are available for one indicator, and two require further development before data availability can be assessed.

While there have been efforts to characterize and measure ecosystem services, there is currently little agreement on how such characteristics measures should be defined, and no national data on conditions or trends. We therefore identify, in two instances, the need for indicators of ecosystem services, but recognize that these indicators require additional development.

Human Uses: Food, Fiber, & Water

Core National

- Production of Food and Fiber and Water Withdrawals

Coasts and Oceans

- Commercial Fish and Shellfish Landings
- ⦿ Status of Commercially Important Fish Stocks
- ⊖ Selected Contaminants in Fish and Shellfish

Farmlands

- Major Crop Yields
- Agricultural Inputs and Outputs
- Monetary Value of Agricultural Production

Forests

- Timber Harvest
- Timber Growth and Harvest

Fresh Waters

- Water Withdrawals
- ⊖ Groundwater Levels
- Waterborne Human Disease Outbreaks

Grasslands/Shrublands

- Production of Cattle

● Complete data available
 ⦿ Partial data available
 ⊖ Data not adequate for national reporting
 ⊕ Indicator development needed

Human Uses: Recreation and other Services

Core National

- ⦿ Outdoor Recreation
- ⊕ Natural Ecosystem Services

Coasts and Oceans

- ⊖ Recreational Water Quality

Farmlands

- ⊖ Recreation on Farmlands

Forests

- ⊖ Recreation in Forests

Fresh Waters

- ⊖ Freshwater Recreation Activities

Grasslands/Shrublands

- ⊖ Recreation on Grasslands and Shrublands

Urban/Suburban

- ⊖ Publicly Accessible Open Space per Resident
- ⊕ Natural Ecosystem Services

● Complete data available
 ⦿ Partial data available
 ⊖ Data not adequate for national reporting
 ⊕ Indicator development needed

Highlights: Recreation and Other Services

- “Fitness activities,” such as walking and biking, and nature viewing—each with more than 10 billion “recreation days” per year—are by far the most common outdoor recreation activity for which information is available. Swimming and beachgoing, which together account for about 5 billion recreation days, is the next most popular activity.
- It is not possible to report on the amount of recreation taking place in specific ecosystem types, like forest or grasslands/shrublands. For most recreational activities, it is not possible to distinguish freshwater activities from saltwater.
- Indicators of ecosystem services, such as soil building and pollination, require additional development.

Notes

1. We estimated urban/suburban land area using a satellite-based method that does not allow for comparison with previous estimates. However, data from the Economic Research Service (see the core national extent indicator, p. 40) indicate that the area of urban lands has grown by more than 300% since the 1950s. Also, as noted below, the USDA Natural Resources Inventory showed substantial increases in nonfederal developed lands from 1982 to 1997.

The State of the Nation's Ecosystems: The Indicators at a Glance

The State of the Nation's Ecosystems: The Indicators at a Glance



Core National Indicators



Coasts and Oceans



Farmlands

SYSTEM DIMENSIONS

Extent	<ul style="list-style-type: none"> ● Ecosystem Extent 	<ul style="list-style-type: none"> ● Coastal Living Habitats ● Shoreline Types 	<ul style="list-style-type: none"> ● Total Cropland ● The Farmland Landscape 	
Fragmentation and Landscape Pattern	<ul style="list-style-type: none"> ⊕ Fragmentation and Landscape Pattern 		<ul style="list-style-type: none"> ⊖ Fragmentation of Farmland Landscapes by Development ⊖ Shape of "Natural" Patches in the Farmland Landscape 	

CHEMICAL AND PHYSICAL CONDITIONS

Nutrients, Carbon, and Oxygen	<ul style="list-style-type: none"> ● Movement of Nitrogen 	<ul style="list-style-type: none"> ⊖ Areas with Depleted Oxygen 	<ul style="list-style-type: none"> ● Nitrate in Farmland Streams and Groundwater ● Phosphorus in Farmland Streams ⊖ Soil Organic Matter 	
Contaminants	<ul style="list-style-type: none"> ● Chemical Contaminants 	<ul style="list-style-type: none"> ● Contamination in Bottom Sediments 	<ul style="list-style-type: none"> ● Pesticides in Farmland Streams and Groundwater 	
Physical		<ul style="list-style-type: none"> ⊖ Coastal Erosion ● Sea Surface Temperature 	<ul style="list-style-type: none"> ● Soil Erosion ⊖ Soil Salinity 	

BIOLOGICAL COMPONENTS

Plants and Animals	<ul style="list-style-type: none"> ● At-Risk Native Species 	<ul style="list-style-type: none"> ⊖ At-Risk Marine Species ⊕ Non-native Species ● Unusual Marine Mortalities 	<ul style="list-style-type: none"> ⊕ Status of Animal Species in Farmland Areas ⊕ Native Vegetation in Areas Dominated by Croplands 	
Communities	<ul style="list-style-type: none"> ⊕ Condition of Plant and Animal Communities 	<ul style="list-style-type: none"> ⊕ Harmful Algal Blooms ● Condition of Bottom Dwelling Animals 	<ul style="list-style-type: none"> ⊖ Soil Biological Condition ⊕ Stream Habitat Quality 	
Ecological Productivity	<ul style="list-style-type: none"> ● Plant Growth Index 	<ul style="list-style-type: none"> ● Chlorophyll Concentrations 		

HUMAN USES

Food, Fiber, and Water	<ul style="list-style-type: none"> ● Production of Food and Fiber and Water Withdrawals 	<ul style="list-style-type: none"> ● Commercial Fish and Shellfish Landings ● Status of Commercially Important Fish Stocks ⊖ Selected Contaminants in Fish and Shellfish 	<ul style="list-style-type: none"> ● Major Crop Yields ● Agricultural Inputs and Outputs ● Monetary Value of Agricultural Production 	
Recreation and Other Services	<ul style="list-style-type: none"> ● Outdoor Recreation ⊕ Natural Ecosystem Services 	<ul style="list-style-type: none"> ⊖ Recreational Water Quality 	<ul style="list-style-type: none"> ⊖ Recreation on Farmlands 	



Forests



Fresh Waters



Grasslands and Shrublands



Urban and Suburban Areas

<ul style="list-style-type: none"> ● Forest Area and Ownership ● Forest Types ● Forest Management Categories 	<ul style="list-style-type: none"> ● Extent of Freshwater Ecosystems ● Altered Freshwater Ecosystems 	<ul style="list-style-type: none"> ● Area of Grasslands and Shrublands ● Land Use 	<ul style="list-style-type: none"> ● Area of Urban/Suburban Lands ⊖ Total Impervious Area ⊕ Stream Bank Vegetation
<ul style="list-style-type: none"> ● Forest Pattern and Fragmentation 		<ul style="list-style-type: none"> ⊖ Area and Size of Grassland/Shrubland Patches 	<ul style="list-style-type: none"> ⊕ Suburban/Rural Land Use Change ● Patches of Forest, Grasslands/Shrublands, and Wetlands
<ul style="list-style-type: none"> ● Nitrate in Forest Streams ● Carbon Storage 	<ul style="list-style-type: none"> ● Phosphorus in Lakes, Reservoirs, and Large Rivers <p>Also see Core National, Farmlands, Forest, Grasslands/Shrublands, and Urban/Suburban Indicators</p>	<ul style="list-style-type: none"> ⊖ Nitrate in Groundwater ⊖ Carbon Storage 	<ul style="list-style-type: none"> ● Nitrate in Urban/Suburban Streams ● Phosphorus in Urban/Suburban Streams
	<p>Also see Core National, Farmlands, and Urban/Suburban Indicators</p>		<ul style="list-style-type: none"> ● Air Quality ● Chemical Contamination
	<ul style="list-style-type: none"> ● Changing Stream Flows ⊖ Water Clarity 	<ul style="list-style-type: none"> ● Number and Duration of Dry Periods in Streams and Rivers ⊖ Depth to Shallow Groundwater 	<ul style="list-style-type: none"> ⊕ Urban Heat Island
<ul style="list-style-type: none"> ● At-Risk Native Species ⊖ Area Covered by Non-native Plants 	<ul style="list-style-type: none"> ● At-Risk Native Species ● Non-Native Species ● Animal Deaths and Deformities 	<ul style="list-style-type: none"> ● At-Risk Native Species ⊖ Non-native Plant Cover ● Population Trends in Invasive and Non-invasive Birds 	<ul style="list-style-type: none"> ⊖ Species Status ⊖ Disruptive Species
<ul style="list-style-type: none"> ● Forest Age ● Forest Disturbance: Fire, Insects, and Disease ⊖ Fire Frequency ⊖ Forest Community Types with Significantly Reduced Area 	<ul style="list-style-type: none"> ⊖ Status of Freshwater Animal Communities ● At-Risk Freshwater Plant Communities ⊕ Stream Habitat Quality 	<ul style="list-style-type: none"> ⊖ Fire Frequency ⊕ Riparian Condition 	<ul style="list-style-type: none"> ⊖ Status of Animal Communities in Urban/Suburban Streams
<ul style="list-style-type: none"> ● Timber Harvest ● Timber Growth and Harvest 	<ul style="list-style-type: none"> ● Water Withdrawals ⊖ Groundwater Levels ● Waterborne Human Disease Outbreaks 	<ul style="list-style-type: none"> ● Production of Cattle 	
<ul style="list-style-type: none"> ⊖ Recreation in Forests 	<ul style="list-style-type: none"> ⊖ Freshwater Recreation Activities 	<ul style="list-style-type: none"> ⊖ Recreation on Grasslands and Shrublands 	<ul style="list-style-type: none"> ⊖ Publicly Accessible Open Space Per Resident ⊕ Natural Ecosystem Services

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

Part II: The Indicators

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In this part of *The State of the Nation's Ecosystems*, we move from background and principles to the indicators themselves. In each of the following seven chapters, we present a suite of indicators, describing, for each one, its significance, current conditions, and historic trends when data are available and, when they are not, why not.

We begin with the core national indicators, which provide a succinct description of ten key aspects of the condition and use of ecosystems in the United States. These core national indicators are followed by chapters that present the indicators for coastal waters, farmlands, forests, fresh waters, grasslands and shrublands, and urban and suburban areas. Each of these ecosystems is described using 14 to 18 indicators.

Each chapter in this part begins with a summary table that briefly describes the indicators, including whether data adequate for national reporting are available or not and, if so, whether there are trends or other useful reference points against which to compare the data. This overview table is followed by a summary of the highlights of each indicator, as well as information on the definition of the ecosystem (e.g., “what do we mean by grasslands and shrublands?”). Finally, since data are presented using a variety of regional schemes, we define these for each ecosystem.

The heart of each chapter is the indicators themselves, which are generally presented in a single page (given their broad scope, the core national indicators are accorded two pages or more, as are several more-complex indicators throughout the report). Each indicator is linked to technical notes, which provide detail on the indicators and the data sources used to report on them; these technical notes begin on page 207.

