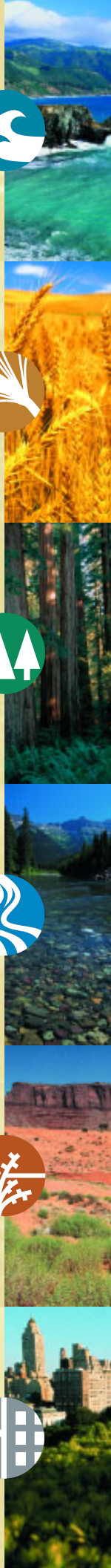
Summary and Highlights

The State of The Nation's Ecosystems

Measuring the Lands, Waters, and Living Resources of the United States



The H. John Heinz III Center for Science, Economics and the Environment

The Heinz Center

The State of the Nation's Ecosystems: Summary and Highlights

Americans are familiar with an array of well-accepted indicators: statistics that measure our economic well-being, or that help gauge our personal health. There are no such commonly accepted measurements for describing the nation's lands, waters, and living resources.

The State of the Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States initiates a series of periodic reports on the lands, waters, and living resources of the United States. This report was prepared *for* those who seek a succinct, comprehensive, scientifically sound, and nonpartisan view of "how we are doing." And it was prepared *by* nearly 150 experts from these businesses, environmental organizations, universities, and federal, state, and local government agencies, working over five years. (The organizations from which these experts were drawn and those that funded the project are listed on pages vi–viii.) The indicators reported in *The State of the Nation's Ecosystems* 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. It also presents a synopsis of the best available national data to report on these indicators.

This *Summary and Highlights* volume is just that—a summary of why we undertook this process and what principles governed our work, and highlights of our findings. It condenses the fruits of five years of work into a very few pages and distills description of the most important characteristics of more than three million square miles of land and huge expanses of both fresh and salt waters. By necessity, such a condensation leaves out rich and important details, and we strongly encourage readers to explore the full *State of the Nation's Ecosystems* report, available as a book from Cambridge University Press and online at www.heinzctr.org/ecosystems (see the back cover for ordering information).

This short summary and the full *State of the Nation's Ecosystems* are the first steps in what must become a regular feature of the ongoing debate over the use, conservation, and management of our nation's vast natural wealth. Such discussions will benefit greatly from a well-accepted set of set of benchmarks to gauge our progress. *The State of the Nation's Ecosystems* provides those benchmarks and a blueprint for reporting on them in the future.

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The State of The Nation's Ecosystems

Measuring the Lands, Waters, and Living Resources of the United States

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Cambridge University Press

About the Heinz Center

Established in December 1995 in honor of the late Senator John Heinz, The H. John Heinz III Center for Science, Economics and the Environment is a nonprofit, nonpartisan institution dedicated to improving the scientific and economic foundation for environmental policy through multisectoral collaboration. Focusing on issues that are likely to confront policymakers within two to five years, the Center fosters collaboration among industry, environmental organizations, academia, and government in each of its program areas and projects. It uses the best scientific and economic analyses to develop viable options for solving problems, and its findings and recommendations are widely disseminated to public and private sector decision makers, the scientific community, and the public.

About this document

This document is a short version of

The H. John Heinz III Center for Science, Economics and the Environment. 2002. *The State of the Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States.* Paperback. xxii + 276 pages. 200 line diagrams. 15 halftones. 50 tables. ISBN 0-521-52572-1. Cambridge University Press, New York: $25.00.

The full report may be purchased from the publisher, Cambridge University Press; telephone toll-free 1-800-872-7423 in the United States and Canada, or order online at http://us.cambridge.org. The report is also available in full on the World Wide Web at www.heinzctr.org/ecosystems.

Copies of this short report are available free of charge from

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Contents

B Project Participants and Funding Support

Both the individuals who participated in the *State of the Nation's Ecosystems* project and the institutions that funded it (see page viii) reflect The Heinz Center's commitment to a four-sector approach, in which business, environmental organizations, universities, and government agencies collaboratively address key environmental problems.

Project Participants

Nearly 150 individuals from businesses, environmental organizations, universities, and federal, state, and local governments participated over the past five years as formal members of project committees and work groups. The report was developed in two distinct phases, and *State of the Nation's Ecosystems* represents a consensus of those individuals participating during the three years (2000–2002) leading to its completion. In addition, nearly 100 other individuals participated as external peer reviewers. The names, titles, and affiliations of project participants are included in the full report, and both participants and reviewers are listed on the report's Web site (www.heinzctr.org/ecosystems).

As an illustration of the breadth of involvement in the project, we list below the institutions from which these individuals were drawn. Since project participants took part in the project as individuals rather than as representatives of their organizations, the list below does not imply endorsement of the entire contents of this report by each listed organization. Nonetheless, the diversity of perspectives that contributed to this report—as shown by the diversity of institutions from which participants were drawn—adds to the strength and importance of its findings.

The Academy of Natural Sciences
American Rivers
American Sportfishing Association
Arizona State University
Bethlehem Steel Corporation
Brown and Caldwell
The Cadmus Group
California Resources Agency
Carnegie Mellon University
Ocean Conservancy/
    Center for Marine Conservation
ChevronTexaco Energy Research and
    Technology Company
Colorado State University
Conservation Science, Inc.
Cornell University
Defenders of Wildlife
Department of Agriculture
    Agricultural Research Service
    Economic Research Service
    Forest Service
    Natural Resources Conservation Service
Department of the Interior
    Bureau of Land Management
    U.S. Fish and Wildlife Service
    U.S. Geological Survey
Dewees Island
Dooley, Herr & Williams
Duke Energy Corporation
The Ensign Group
Environmental Defense
Environmental Health Center
Environmental Protection Agency
Farmers National Marketing Group

The Field Museum
Florida State University
The Groundfish Forum
Harvard University
    Kennedy School of Government
The Heinz Endowments
Hogan and Hartson, LLP
International Paper
John Deere & Co.
King Ranch
Malcolm Pirnie, Inc.
Malpai Borderlands Project
Marine Biological Laboratory
Michigan State University
Monsanto Company
Montana State University
National Audubon Society
National Council for Air and Stream
    Improvement, Inc.
National Fisheries Institute
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
National Ocean Service
National Sea Grant Review Panel
National Wildlife Federation
Natural Resources Consultants
The Nature Conservancy
The Nature Conservancy of Wyoming
NatureServe
North Carolina State University
Office of Science and Technology Policy
Oregon Ocean Program
Pennsylvania State University
Pioneer Hi-Bred International
Portland Metro
Portland State University
Procter & Gamble Company
Rayonier, Inc.
Resources for the Future
Royal Caribbean Cruise Lines
Soil and Water Conservation Society
State University of New York College of
    Environmental Sciences
Southern California Coastal Water Research
    Project Authority
The Urban Land Institute
The Wilderness Society
U.S. House of Representatives
University of California, Davis
University of Colorado
University of Georgia
University of Louisville
University of Maryland
    Appalachian Laboratory
    Horn Point Laboratory
University of Michigan
University of Minnesota
University of Southern California
University of Toledo
University of Washington
University of Wisconsin
University of Wyoming
Utah State University
Virginia Polytechnic Institute and State University
Wallace Center for Agricultural and
    Environmental Policy
West Texas A&M University
Weyerhaeuser Company
Wildlife Conservation Society
Wildlife Management Institute
Wisconsin Department of Natural Resources
World Wildlife Fund

In addition, several independent experts participated on committees or work groups as individuals, and many other individuals and institutions provided assistance in less formal, but nonetheless very important, ways.

Funding Support

Funding for this project was provided by a diverse array of sources, private and public.

We would like to thank our corporate and foundation funders:

Chevron Company
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John Deere & Company
Electric Power Research Institute
Georgia-Pacific Corporation
Vira I. Heinz Endowment
Andrew W. Mellon Foundation
Richard King Mellon Foundation
Charles Stewart Mott Foundation
David and Lucile Packard Foundation
Procter & Gamble Company
Royal Caribbean Cruise Lines

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Department of Agriculture
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Environmental Protection Agency
Federal Emergency Management Agency
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
National Science Foundation
Office of Naval Research
(grants administration support)

Meeting a Clear Need

We all rely on a familiar set of indicators—interest rates, unemployment and inflation rates, the Dow Jones average, and GDP, for example—to gauge the performance of the national economy. In the medical arena, we rely on a set of well-established indicators like body temperature, blood pressure, and pulse rate to tell us whether our bodies are functioning well or not.

No similar set of measures is currently available to describe the environment. This is unacceptable for a nation that has demonstrated a strong, nonpartisan, and consistent commitment to environmental protection—and that backs up this commitment with significant expenditures: 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 product—and this is only a part of the total cost of ensuring a clean, healthy, and vibrant environment.

The State of the Nation's Ecosystems provides a way to "take the pulse" of America's lands and waters and living resources. It identifies what should be measured, counted, and reported so that decision makers and the public can understand the changes that are occurring on the American landscape, set priorities for action, and see whether we are achieving our environmental goals.

Having identified a crucial set of ecosystem characteristics, the report uses the best available national data to describe these characteristics. Where such data are not available, the report clearly specifies what is needed to fill the gap.

The State of the Nation's Ecosystems—and future volumes in this series—will be valuable tools for environmental decision makers at all levels and in all sectors of society. The report will 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.

Such reporting won't eliminate deeply held differences over environmental policy, but it will provide a common yardstick for measuring the effectiveness of our policies and setting future priorities.

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 judging whether they are "good" or "bad" or recommending policies or actions.
- Reports on the state or condition of ecosystems—on the resources people care most directly about—not on pollution discharges 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

Deciding What To Measure

The State of the Nation's Ecosystems identifies ten major characteristics of ecosystem condition and use that together provide a broad, balanced description of any ecosystem type (Table 1).

We describe these key characteristics for the six major ecosystem types that make up the American landscape: coasts and oceans, farmlands, forests, fresh waters, grasslands and shrublands, and urban and suburban areas, and for the nation as a whole (see Map 1 on page 3). We provide about 15 indicators—

Table 1. Ecosystem Characteristics and Indicators

Ecosystem Characteristic	What Do the Indicators Measure—and Why Are They Important?
SYSTEM DIMENSIONS	
Extent	How much area does an ecosystem or land cover type occupy? *The area of an ecosystem is its most basic characteristic—increases or decreases mean gains or losses of all the goods and services associated with that system.*
Fragmentation and Landscape Pattern	What are the shapes and sizes of patches of an ecosystem type, and how are they intermingled with one another? *These characteristics can greatly influence the goods and services an area provides, such as wildlife habitat, filtering of sediments from runoff, and providing solitude.*
CHEMICAL AND PHYSICAL CONDITIONS	
Nutrients, Carbon, Oxygen	How much nitrogen, phosphorus, oxygen, and carbon are found in different systems? *Nitrogen and phosphorus are key plant nutrients, but in excess can cause water quality problems. Carbon storage in ecosystems is a key consideration in global warming discussions, and oxygen in rivers, lakes, and coastal waters is needed for fish and other animals to survive.*
Chemical Contaminants	How many synthetic compounds and heavy metals are found in ecosystems, and how often do these compounds exceed regulatory or advisory thresholds? (For urban and suburban areas, we also include air pollution from ozone in this category.) *Chemical contaminants can harm people and damage ecosystems through their effects on plants and animals.*
Physical Conditions	What is the condition of key aspects of the physical makeup of an ecosystem, such as the temperature of the water or the amount of salt in the soil? *Plants and animals are adapted to certain physical conditions and can be harmed by changes in these conditions.*
BIOLOGICAL COMPONENTS	
Plants and Animals	What is the status of native and non-native plant and animal species? *People care deeply about wildlife, and the condition of plants and animals can reflect broader ecosystem conditions. Non-native species can disrupt ecosystems and cause economic damage.*
Biological Communities	What is the condition of the plant and animal communities—the more-or-less stable groupings of plants and animals found in particular habitats—that make up an ecosystem? *These biological communities form the "biological neighborhood" within which individual species exist.*
Ecological Productivity	What are the trends in plant growth on land and in the water? *Changes in the amount of plant growth may signal important changes in overall ecosystem condition.*
HUMAN USE	
Food, Fiber, and Water	How is the amount and quality of key ecosystem products changing over time? *Ecosystems produce goods that meet a variety of important human needs and that are important to the national economy.*
Other Services, Including Recreation	How often do people take part in outdoor recreation activities, and what other services, such as soil building and flood protection, are provided by natural ecosystems? *Though less tangible, these other services are also important both to people and to the ecosystems themselves.*

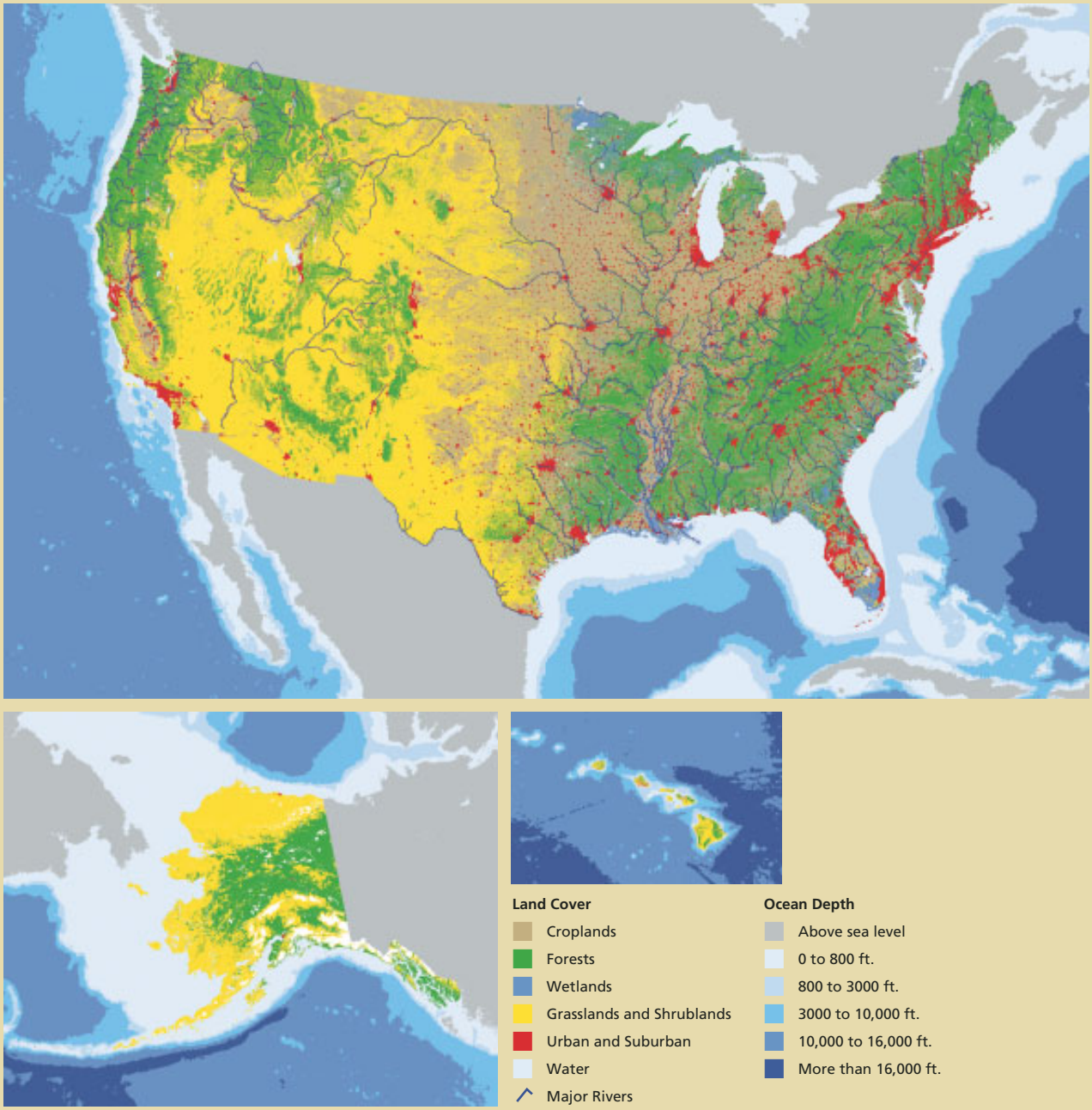
measurements of specific ecosystem conditions—for each major ecosystem type, and a set of ten "core national indicators" that provide a very broad perspective on national trends and conditions.

The table on pages 8 and 9 lists all the indicators in the report by ecosystem type and the major characteristic they describe. Together, these 103 indicators provide a rich, yet manageable, view of "the state of the nation's ecosystems."

These indicators give a broad overview of conditions and trends, rather than providing an encyclopedic review of all possible elements of ecosystem condition. Such an overview is essential for understanding "the big picture" and can provide useful context for more detailed information used in making on-the-ground decisions in particular places.

Selecting indicators involves value judgments about what aspects of ecosystems are most important to track through time. To ensure that the indicators we selected do not overemphasize one set of political or social views over another, we took great care to make the selection process fair and inclusive, and involved people with a wide variety of perspectives. The data used to describe indicator conditions were selected through a transparent scientific process and were extensively peer-reviewed.

Map 1. U.S. Land Cover and Ocean Depth



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

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

Using High-Quality Data

This report includes data from both government agencies and private organizations. In all cases, these data

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

Providing Context and Meaning

The primary purposes of *The State of the Nation's Ecosystems* are to present current conditions and to lay the groundwork for future reporting, but wherever possible we sought datasets with records long enough to 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.

Defining What We Know—and What We Don't Know

Existing monitoring programs of federal, state, and local governments, private regulated entities, and environmental organizations are essential—*The State of the Nation's Ecosystems* report could not exist without these investments and without the high-quality data they produce. These programs enabled us to report on more than half of the selected indicators, providing meaningful descriptions of many aspects of ecosystem condition. (In some cases, all required data are available, while in others, some gaps remain—see Figure 1.)

However, while these programs generate important data that serve a variety of needs, they do not—individually or collectively—provide a high-level, comprehensive account of the state of the nation's ecosystems. In fact, these programs were not designed to provide such an account, and the existence of significant gaps in both their geographic coverage and the characteristics on which they report should not be surprising. However, as long as this is the case, decision makers and the public will remain without a complete picture of the "state of the nation's ecosystems."

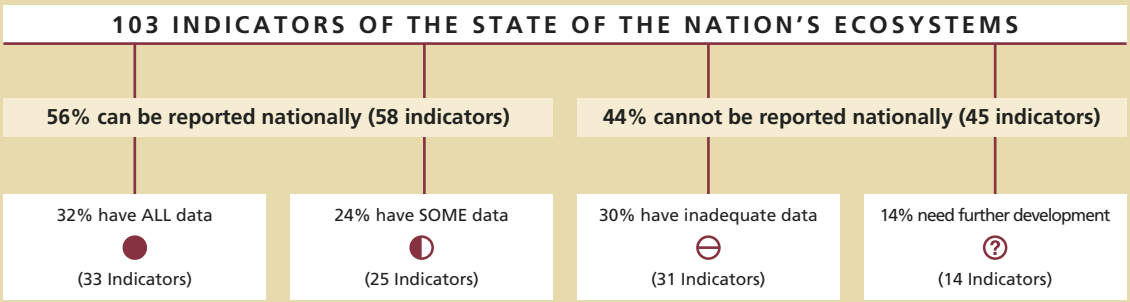
For some indicators, data may be available, but not in sufficient quantity or adequate form to support national reporting. There may be parts of the country or components of the indicator that are not monitored, the data may be collected by different entities, with no mechanism for aggregating and creating a national dataset, or they may result from one-time studies. These indicators are labeled "Data Not Adequate for National Reporting." Many of these datasets are excellent examples of the kind of monitoring necessary, and they may serve as the basis for future reporting.

In some cases, additional work must be done to define the measurements required to report on a specific ecosystem characteristic. These indicators are labeled with the phrase "Indicator Development Needed."

Even with these gaps, however, *The State of the Nation's Ecosystems* tells a useful and interesting story, and provides a firm foundation for the future. A full and complete accounting of ecosystem condition and use would require that monitoring programs that contributed to this volume be sustained and that additional work be done to complement these efforts and fill the gaps.

Throughout the report, we use a set of icons, shown in Figure 1, that describe our ability to report on each indicator.

Figure 1. The State of the Data



Building for the Future

The State of the Nation's Ecosystems is the first in what is intended to be a regular series of reports on the state of the nation's lands, waters, and living resources. New editions, reflecting new ecological understanding and improvements in measuring ecosystem condition, as well as comments, criticisms, and suggestions from users of this initial edition, will be issued every five years. The Web version will be updated annually to incorporate newly gathered or reported data.

The Heinz Center encourages readers to provide feedback, either by mail or through the *State of the Nation's Ecosystems* Web site (www.heinzctr.org/ecosystems), on the content of the report and on refinements that should be incorporated into future editions.

Indicators and Findings

The State of the Nation's Ecosystems presents indicators for coasts and oceans, farmlands, forests, fresh waters, grasslands and shrublands, and urban and suburban areas, and a set of ten "core national indicators" that provide a very broad description of the condition and use of ecosystems in the United States.

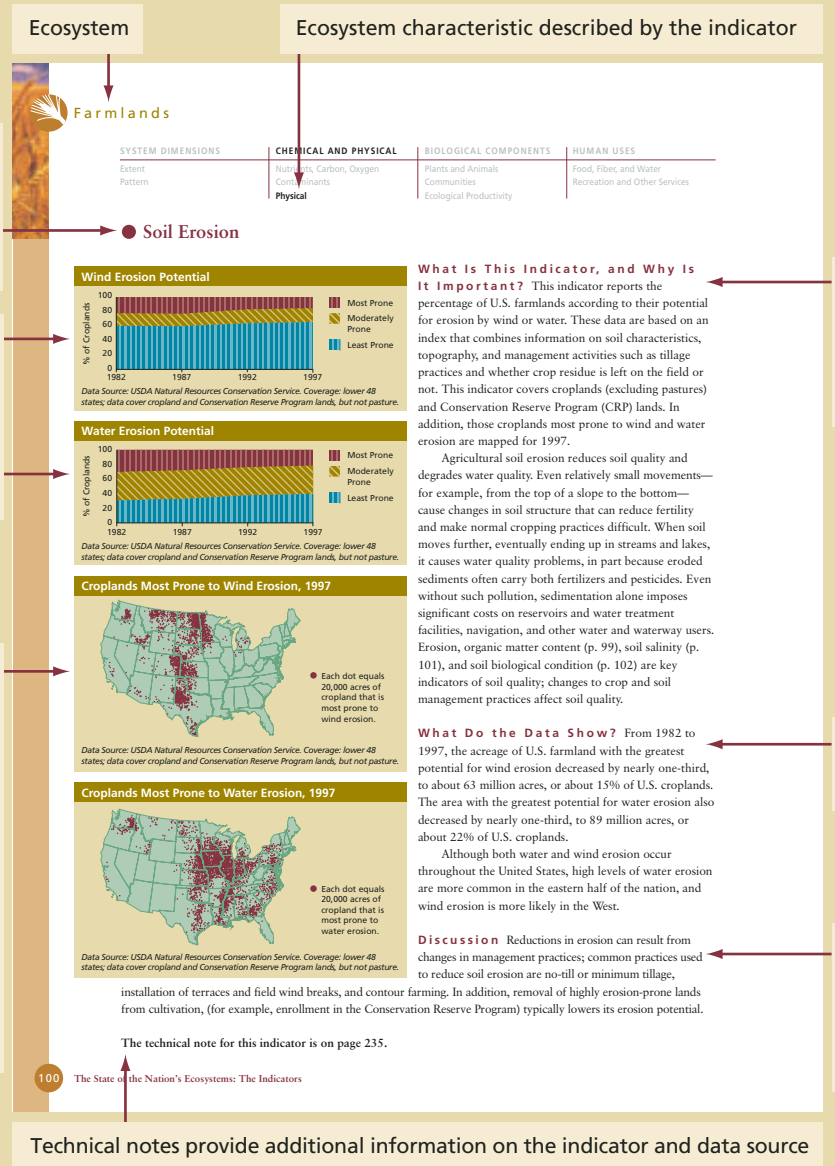
For each ecosystem type, there are 14 to 18 indicators. The significance of each is described, and, when data are available, current conditions and historic trends are reported. A typical indicator page, with explanations of each element, is shown on page 7.

The table on pages 8 and 9 presents the full array of indicators, showing both the ecosystem they apply to (columns down for each ecosystem and the core national indicators) and the major characteristic they describe (rows across for each of the ten major characteristics).

Following this table, we present brief synopses of the report's findings for the nation as a whole and for each of the major ecosystems. In describing each indicator, we also note the source of the data, usually using the relevant agency acronym; see the inside back cover for a list of these acronyms.

The State of the Nation's Ecosystems: Presenting the Indicators

Each indicator is generally presented on a single page in the full report, with additional information provided in the "Technical Notes" section. A sample indicator page is shown below.



	Core National Indicators	Coasts and Oceans	Farmlands	
SYSTEM DIMENSIONS				
Extent	◐ Ecosystem Extent	◐ Coastal Living Habitats ◐ Shoreline Types	● Total Cropland ● The Farmland Landscape	
Fragmentation and Landscape Pattern	? Fragmentation and Landscape Pattern		⊖ Fragmentation of Farmland Landscapes by Development ⊖ Shape of "Natural" Patches in the Farmland Landscape	
CHEMICAL AND PHYSICAL CONDITIONS				
Nutrients, Carbon, and Oxygen	● Movement of Nitrogen	⊖ Areas with Depleted Oxygen	● Nitrate in Farmland Streams and Groundwater ● Phosphorus in Farmland Streams ⊖ Soil Organic Matter	
Contaminants	◐ Chemical Contaminants	◐ Contamination in Bottom Sediments	● Pesticides in Farmland Streams and Groundwater	
Physical		⊖ Coastal Erosion ● Sea Surface Temperature	● Soil Erosion ⊖ Soil Salinity	
BIOLOGICAL COMPONENTS				
Plants and Animals	◐ At-Risk Native Species	⊖ At- Risk Marine Species ? Non-native Species ◐ Unusual Marine Mortalities	? Status of Animal Species in Farmland Areas ? Native Vegetation in Areas Dominated by Croplands	
Communities	? Condition of Plant and Animal Communities	? Harmful Algal Blooms ◐ Condition of Bottom-Dwelling Animals	⊖ Soil Biological Condition ? Stream Habitat Quality	
Ecological Productivity	● Plant Growth Index	◐ Chlorophyll Concentrations		
HUMAN USES				
Food, Fiber, and Water	● Production of Food and Fiber and Water Withdrawals	● Commercial Fish and Shellfish Landings ◐ Status of Commercially Important Fish Stocks ⊖ Selected Contaminants in Fish and Shellfish	● Major Crop Yields ● Agricultural Inputs and Outputs ● Monetary Value of Agricultural Production	
Recreation and Other Services	◐ Outdoor Recreation ? Natural Ecosystem Services	⊖ Recreational Water Quality	⊖ Recreation on Farmlands	

	Forests	Fresh Waters	Grasslands and Shrublands	Urban and Suburban Areas
	● Forest Area and Ownership ● Forest Types ● Forest Management Categories	◐ Extent of Freshwater Ecosystems ◐ Altered Freshwater Ecosystems	● Area of Grasslands and Shrublands ◐ Land Use	● Area of Urban/ Suburban Lands ⊖ Total Impervious Area ? Stream Bank Vegetation
	◐ Forest Pattern and Fragmentation		⊖ Area and Size of Grassland/Shrubland Patches	? Suburban/Rural Land Use Change ● Patches of Forest, Grasslands/Shrublands, and Wetlands
	● Nitrate in Forest Streams ◐ Carbon Storage	◐ Phosphorus in Lakes, Reservoirs, and Large Rivers Also see Core National, Farmlands, Forest, Grasslands/Shrublands, and Urban/Suburban Indicators	⊖ Nitrate in Groundwater ⊖ Carbon Storage	● Nitrate in Urban/ Suburban Streams ● Phosphorus in Urban/ Suburban Streams
		Also see Core National, Farmlands, and Urban/Suburban Indicators		● Air Quality ◐ Chemical Contamination
		● Changing Stream Flows ⊖ Water Clarity	● Number and Duration of Dry Periods in Streams and Rivers ⊖ Depth to Shallow Groundwater	? Urban Heat Island
	◐ At-Risk Native Species ⊖ Area Covered by Non-native Plants	◐ At-Risk Native Species ◐ Non-Native Species ◐ Animal Deaths and Deformities	◐ At-Risk Native Species ⊖ Non-native Plant Cover ● Population Trends in Invasive and Non-invasive Birds	⊖ Species Status ⊖ Disruptive Species
	◐ Forest Age ● Forest Disturbance: Fire, Insects, and Disease ⊖ Fire Frequency ⊖ Forest Community Types with Significantly Reduced Area	⊖ Status of Freshwater Animal Communities ◐ At-Risk Freshwater Plant Communities ? Stream Habitat Quality	⊖ Fire Frequency ? Riparian Condition	⊖ Status of Animal Communities in Urban/Suburban Streams
	● Timber Harvest ● Timber Growth and Harvest	● Water Withdrawals ⊖ Groundwater Levels ● Waterborne Human Disease Outbreaks	● Production of Cattle	
	⊖ Recreation in Forests	⊖ Freshwater Recreation Activities	⊖ Recreation on Grasslands and Shrublands	⊖ 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

Core National Indicators

America's ecosystems are enormous, and enormously diverse. We first present ten indicators that describe key characteristics of the entire array of America's ecosystems. They describe and track changes in key aspects of the area and configuration of ecosystems, significant chemical and physical conditions, biological components, and the goods and services that people derive from these systems.

Data are adequate for national reporting on seven of the ten core national indicators, while additional work is required to define specific measurements for the remaining three.

SYSTEM DIMENSIONS

◐ **Area, or Extent, of Major Ecosystem Types:** The area of an ecosystem is its most basic characteristic. Increases or decreases in area generally mean gains or losses of the goods and services associated with that system. **Highlights:** Forests occupy about a third of the area of the lower 48 states, as do grasslands and shrublands, while farmlands occupy about a quarter. The acreage of forests and grasslands and shrublands has declined since European settlement, as has the area of freshwater wetlands, and the acreage of urban and suburban areas has grown. Since the 1950s, the acreage of farmlands, grasslands and shrublands, forests, and freshwater wetlands has fluctuated or declined somewhat, while the area of urban and suburban lands has increased, to about 2% of U.S. land area. Data on the extent of brackish coastal waters are not available. (Data from FS, ERS, MRLC)

? **Fragmentation and Landscape Patterns:** Whether natural lands are fragmented into smaller, more isolated patches, and whether developed lands are intermingled in the natural landscape, can greatly influence how well an area provides such services as offering wildlife habitat, filtering sediments from runoff, and providing solitude. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

CHEMICAL AND PHYSICAL CONDITIONS

● **Movement of Nitrogen:** Excess nitrogen in streams and rivers can contribute to coastal water quality problems. (Nitrogen can come from wastewater treatment plants, fertilizer runoff from croplands and lawns, failing septic systems, animal manure, and industrial discharges.) **Highlights:** The amount of nitrate (a key form of nitrogen) carried by the four largest rivers in the U.S. increased markedly over the past few decades, with the amount carried by the Mississippi River—which drains more than 40% of the area of the lower 48 states—tripling since the 1950s. Watersheds in the upper Midwest and Northeast contribute the most nitrogen per square mile to rivers and streams. Additional indicators show that streams in farmland areas generally have higher nitrogen levels than those in forest or urban/suburban areas. (Data from USGS)

◐ **Chemical Contamination:** Chemical contaminants can harm people and damage ecosystems through their effects on plants and animals. **Highlights:** All or almost all (90% or more) streams, groundwater, stream and estuarine sediments, and freshwater fish sampled have at least one contaminant at detectable levels. About 15% of streams and a quarter of groundwater sites tested had at least one contaminant at a concentration that exceeded human health standards. 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. Data were not available to report on contamination of saltwater fish and on sediments in many coastal areas, or for comparing freshwater fish contamination to human health standards. (Data from USGS and EPA).

The number of contaminants found in streams, groundwater, and the like provides basic information on how widespread these compounds are. However, the presence of contamination does not necessarily mean that levels are high enough to cause problems. Comparisons with standards and guidelines can provide a useful reference for judging the significance of contamination. These comparisons must be interpreted carefully, however, because the benchmarks cited here were established for different purposes and reflect different levels of protection from harm. In addition, benchmarks have not been established for all compounds.

BIOLOGICAL COMPONENTS

◐ **At-Risk Native Species:** Species are valued for a variety of reasons: they provide products (including genetic material), are key elements of ecosystems, and are valued for their intrinsic worth or beauty. **Highlights:** About 19% of native animal species and 15% of native plants species with known status 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 3% of animals and 1% of plants are, or are believed to be, extinct. When species ranked as "vulnerable" are included, about one-third of all plant and animal species whose status is known are "at risk." Data are not adequate for reporting on marine species. (Data from NatureServe)

? **Condition of Plant and Animal Communities:** Whether an area is highly managed or highly altered, natural, or semi-natural, will affect the type of plants and animals found there, and the type of goods and services it provides. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

● **Plant Growth Index:** Changes in the amount of plant growth may signal important changes in overall ecosystem condition. **Highlights:** No overall trend can be seen for the 11-year period for which data are available, but there is large year-to-year variation. (Data from USGS, MRLC)

HUMAN USES

● **Production of Food and Fiber and Use of Water:** Ecosystems produce goods that meet a variety of important human needs. **Highlights:** Over the past fifty years, agricultural and forest production and freshwater withdrawals increased. Agricultural production grew the fastest, generally growing faster than U.S. population. In the late 1970s and early 1980s forest production increased to record levels, but declined in recent years. Withdrawals of fresh water increased through 1980, declined by about 10% by the mid-1980s, and have grown slowly since then. Marine fish landings grew slowly from the late 1970s through the mid-1990s, but have declined since then. (Data from ERS, FS, USGS, NMFS, Census)

◐ **Outdoor Recreation:** Recreation is a benefit that is derived from ecosystems, in much the same way that we derive products such as food, fiber, and water from these systems. **Highlights:** "Fitness activities" such as walking and biking are by far the most common recreation activity for which information is available. Nature viewing and swimming and beachgoing are next in terms of overall popularity, although it is not possible to know whether many aquatic activities are enjoyed in freshwater or saltwater settings. (Data from FS)

? **Natural Ecosystem Services:** Less-tangible services provided by natural ecosystems, such as soil building and flood protection, are important both to people and to ecosystems. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

Coasts and Oceans

The coasts and oceans of the United States extend from the narrow ribbon of shoreline that defines the water's edge out some 200 miles into the open ocean.

We have adequate data for national reporting on nine of fifteen indicators chosen to describe coasts and oceans. The remaining six either have inadequate data for national reporting or require further work to define a specific measurement.

SYSTEM DIMENSIONS

◐ **Coastal Living Habitats:** Coastal wetlands, coral reefs, seagrasses, and shellfish beds are key habitats for many species of fish, crabs, seabirds, and other animals. **Highlights:** On the Atlantic and Gulf Coasts, wetland acreage declined 8% from the mid-1950s to the mid-1990s, with losses slowing in the 1990s. Data on wetlands in other regions and on coral reefs, seagrasses, and shellfish beds are not adequate for national reporting. (Data from USFWS)

◐ **Shoreline Types:** The character of the shoreline (e.g., sand beach, mudflats, wetlands, or armored with bulkheads or riprap) affects both how people use the shore and the kind and quality of wildlife habitat. **Highlights:** Of areas with data, the South Atlantic region has the highest percentage of wetlands; in Southern California, there is nearly as much armored shoreline as either beach or steep shoreline. Data for areas other than the Pacific Northwest, Southern California, and the South Atlantic are not available. (Data from NOAA)

CHEMICAL AND PHYSICAL CONDITIONS

⊖ **Areas with Depleted Oxygen:** Most animals that live in the water depend on dissolved oxygen to survive. **Highlights:** Data are not adequate for national reporting

◐ **Contamination in Bottom Sediments:** Polluted sediments are a starting point for contamination throughout the food chain, with both ecological and human health implications. **Highlights:** About 60% of monitored estuary areas have levels of contaminants that *might* harm fish or wildlife, and 2% have levels that *probably will* harm them. Data on some estuary areas, and on sediments outside estuaries, are not adequate for national reporting. (Data from EPA)

⊖ **Coastal Erosion:** Erosion can damage coastal properties and decrease the recreational value of beaches. **Highlights:** Data are not adequate for national reporting

● **Sea Surface Temperature:** Water temperature directly affects the species of plants (such as algae and seagrasses) and animals (such as corals and fish) that live in a particular region. **Highlights:** Waters within 25 miles of the coast show neither warming nor cooling over a 14-year period. (Data from NOAA, NASA)

BIOLOGICAL COMPONENTS

⊖ **At-Risk Marine Species:** Species are valued for a variety of reasons: they provide products, they serve as key elements of ecosystems, and they are valued for their intrinsic worth or beauty. **Highlights:** Data are not adequate for national reporting.

? **Non-native Species:** Introduced species (non-natives) may harm native species. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

◐ **Unusual Marine Mortalities:** The number of marine mammals, turtles, and other animals that die in "unusual" mortality events is generally believed to reflect the integrity of an ecosystem. **Highlights:** For marine mammals, no unusual mortalities occurred in at least three of the past ten years; particularly large mortality events occurred in 1992 and 1999. Data are not adequate for national reporting on sea turtles, seabirds, fish, and shellfish. (Data from NMFS)

? **Frequency and Extent of Harmful Algal Blooms:** Some algae produce toxins that can harm people and marine life. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

◐ **Condition of Bottom-Dwelling Animals:** Worms, clams, snails, and the like are an important food source for bottom-feeding animals, and their condition is a good indicator of chemical contamination, changes in oxygen levels, and physical disruption of the bottom. **Highlights:** The bottom-dwelling animals in about half of monitored estuary area are considered to be in "undegraded" condition; those in about 20% are in "degraded" condition. Data on many estuary areas and on conditions in areas outside estuaries are not adequate for national reporting. (Data from EPA)

◐ **Chlorophyll Concentrations:** Chlorophyll is an indicator of the abundance of algae. Algae are at the base of the marine food chain, but can lead to degraded water quality if overabundant. **Highlights:** Only very short-term data are available for ocean waters (3 years); additional data are needed to establish trends. (Data from NOAA, NASA)

HUMAN USES

● **Commercial Fish and Shellfish Landings:** Fish and shellfish are an important source of food and other products. **Highlights:** Since the late 1970s, when reliable statistics became available, landings have remained at about 5 million tons per year. (Data from NMFS)

◐ **Status of Commercially Important Fish Stocks:** The condition of fish stocks provides an indication of the ability to maintain catch levels. **Highlights:** During the 1990s, about 40% of stocks with known populations were decreasing in size and 20% were increasing in size. Data are available on the status of only about 25% of commercially important fish stocks, but these represent about 75% of the weight of fish caught each year in the United States. (Data from NMFS)

⊖ **Selected Contaminants in Fish and Shellfish:** Seafood containing high levels of DDT, PCBs, and mercury is unsafe to eat. **Highlights:** Data are not adequate for national reporting

⊖ **Recreational Water Quality:** High concentrations of bacteria associated with human and animal waste indicate that swimming and other contact recreation are unsafe. **Highlights:** Data are not adequate for national reporting.

Farmlands

We focus both on *croplands*—lands used for production of annual and perennial crops and livestock—and on the 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 others describe the entire farmland landscape.

Adequate data are available for reporting on nine of the eighteen indicators selected to describe the condition and use of farmlands in the United States.

SYSTEM DIMENSIONS

● **Total Cropland Acreage:** Land is the most basic resource in agriculture. **Highlights:** Croplands cover about a quarter of the land area of the United States. (excluding Alaska). Their area has declined somewhat since the 1950s, but official estimates vary. (Data from NRCS, ERS, NASS, MRLC)

● **The Farmland Landscape:** Noncropland areas can provide wildlife habitat, serve as streamside buffers or windbreaks, and contribute to the visual character of the landscape. **Highlights:** In all regions but the Midwest, noncropland areas make up 40–50% of the farmland landscape. In the Midwest, noncropland areas account for about 25% of the farmland landscape. (Data from MRLC, USGS)

⊖ **Fragmentation of Farmland Landscapes by Development:** Housing and other development intermingled in farmland areas may compromise the economic viability of farming. **Highlights:** Data are not adequate for national reporting.

⊖ **Shape of "Natural" Patches in the Farmland Landscape:** The size and shape of natural areas affects how well they control erosion, help recharge groundwater, provide critical habitat for wildlife, and serve other important ecological functions. **Highlights:** Data are not adequate for national reporting.

CHEMICAL AND PHYSICAL CONDITIONS

● **Nitrate in Farmland Streams and Groundwater:** Nitrate in streams can contribute to water quality problems and, in excess in drinking water, is a health threat to young children. **Highlights:** About 20% of the groundwater wells and 10% of the stream sites tested had nitrate levels that exceeded federal drinking water standards. (Data from USGS)

● **Phosphorus in Farmland Streams:** Excess phosphorus can contribute to water quality problems. **Highlights:** About three-fourths of stream sites exceeded the EPA concentration goal for avoiding excess algae growth. (Data from USGS)

● **Pesticides in Farmland Streams and Groundwater:** At sufficient levels, these compounds can contribute to both ecological and human health problems. **Highlights:** All streams had at least one pesticide at detectable levels, and 75% had an average of five or more; 40% of groundwater sites had no detectable pesticides. Four percent of monitored streams had at least one compound that exceeded human health standards or guidelines, and fewer than 1% of groundwater sites had pesticides in concentrations that exceeded human health standards. Eighty-three percent of monitored streams had at least one pesticide in concentrations that exceeded guidelines for protecting aquatic life. (Data from USGS)

⊖ **Soil Organic Matter:** Organic matter helps soil hold water, supplies nutrients, and reduces erosion. **Highlights:** Data are not adequate for national reporting.

● **Soil Erosion:** Erosion reduces soil quality and degrades water quality. **Highlights:** From 1982 to 1997, farmland with the greatest potential for wind erosion decreased by nearly a third, to about 15% of U.S. croplands. Acreage with the greatest potential for water erosion also decreased by nearly a third, to about 22% of U.S. croplands. (Data from NRCS)

⊖ **Soil Salinity:** Excess salt in the soil interferes with plant growth. **Highlights:** Data are not adequate for national reporting.

BIOLOGICAL COMPONENTS

⊖ **Soil Biological Condition:** The condition of microscopic animals that typically live in healthy soils is a good indicator of overall soil condition. **Highlights:** Data are not adequate for national reporting.

? **Status of Animal Species in Farmland Areas:** Some wildlife species that used to inhabit areas that are now cropland are no longer found in these areas, but may be found in intermingled natural areas. Other species favor the new conditions and are more common than before conversion to agriculture. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

? **Native Vegetation in Areas Dominated by Croplands:** Where croplands dominate, wildlife rely more heavily on the remaining native vegetation for their habitat needs. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

? **Stream Habitat Quality in Farmland Areas:** Stream-dwelling animals and plants require specific habitat conditions in order to survive. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

HUMAN USES

● **Major Crop Yields:** Higher per-acre yields allow the production of more food and fiber without increasing farm acreage. **Highlights:** Since 1950, per-acre yields of corn, wheat, and cotton more than doubled, with corn yield increasing almost fourfold. Of major crops, soybean yields increased the least, but still nearly doubled. (Data from NASS)

● **Agricultural Inputs and Outputs:** The amount of inputs (pesticides, fertilizers, labor, land, etc.) needed to produce a unit of farm output is an indicator of the efficiency of the farm enterprise and the level of its environmental impact. **Highlights:** U.S. agricultural output has increased steadily since 1950, while the major inputs (except pesticides) required to produce a unit of output have decreased. (Data from ERS)

● **Monetary Value of Agricultural Production:** Farming is a business, and the revenue received by farmers is important. **Highlights:** In 1999, the gross value of agricultural output (adjusted for inflation) was about 10% more than in 1950. Over this period, revenues received by farmers have not kept pace with increased agricultural productivity. Livestock sales account for about half of agricultural value. (Data from ERS, BEA)

⊖ **Recreation on Farmlands:** A great deal of recreation takes place on our nation's farmlands, and wildlife-associated recreation is an important source of income for many small agricultural communities. **Highlights:** Data are not adequate for national reporting.

Forests

The giant redwoods of the West Coast, the maples, oaks, and hickories that give New England its flaming fall foliage, the highly managed timberlands in the Southeast—these varied forest lands provide Americans with timber and other wood products, and they offer the opportunity for solitude, hunting, hiking, birdwatching, and camping.

Adequate data for national reporting are available for eleven of the fifteen indicators selected to describe the condition and use of U.S. forests.

SYSTEM DIMENSIONS

● **Forest Area and Ownership:** Changes in forest area affect our continued enjoyment of the goods and services that forests provide, such as recreation, lumber, and watershed protection. **Highlights:** Forests cover about a third of the U.S., down from about half at the time of European settlement. In recent decades, overall acreage has been nearly stable. (Data from FS)

● **Area of Major Forest Types:** Different forest types support different plants and animals. Forest types may change because of human activity or natural succession. **Highlights:** Since total forest area changed very little from 1963 to 1997, changes in the area of specific forest types—increases in oak–hickory forest in the East, and decreases in hemlock–sitka spruce in the West, for example—represent shifts from one forest type to another. (Data from FS)

● **Forest Management Categories:** Forest areas with different levels of management (e.g., tree farms, national parks, wilderness areas) produce different goods and services. **Highlights:** In 1997, 10% of eastern forests and 4% of western forests were in intensively managed plantations. Eleven percent of western forests and 3% of eastern forests were in federally designated wilderness areas or national parks. (Data from FS)

◐ **Forest Pattern and Fragmentation:** Forests that are broken into smaller patches and interspersed with nonforest lands are called "fragmented"; such changes can affect the animals and plants that live there. One way to report on these patterns is to describe the extent to which all forested locations ("points") are surrounded by land that is also mostly forested (at least 90% forest cover). **Highlights:** About two-thirds of all points in both eastern and western forests are surrounded by mostly forest cover within a radius of about 250 feet. About a quarter of all forest points have mostly forest cover within about a 2½-mile radius. Future analyses could include consideration of smaller features (roads and clearings, for example) than was possible using currently available data. (Data from MRLC, FS)

CHEMICAL AND PHYSICAL CONDITIONS

● **Nitrate in Forest Streams:** Nitrate can contribute to water quality problems and, in excess in drinking water, is a health threat to young children. Streams in undisturbed forests generally have very low nitrate levels. **Highlights:** Ninety seven percent of forest stream sites had nitrate concentrations below 1 part per million (ppm), and more than half had concentrations of less than 0.1 ppm. All easily met the drinking water standard (10 ppm). (Data from USGS)

◐ **Carbon Storage in Forests:** Increased carbon storage by forests can offset emissions of carbon dioxide from the burning of fossil fuels, of concern because of climate change. **Highlights:** Carbon stored in trees has increased steadily in the East and remained stable in the West. Data are not adequate

to report on carbon stored in roots, forest floor litter, and soil, or on tree carbon in wilderness areas and areas with relatively slow-growing forests. (Data from FS)

BIOLOGICAL COMPONENTS

◐ **At-Risk Native Species:** Species are valued for a variety of reasons: they provide products, serve as key elements of ecosystems, and are valued for their intrinsic worth or beauty. **Highlights:** About 9% of 1,700 native animal species that depend on forests are considered critically imperiled or imperiled, and 1.5% of forest species are, or are believed to be, extinct. When "vulnerable" species are counted, a total of 20% of forest animal species with known status are considered to be at risk. Data on forest plants are not adequate for national reporting. (Data from NatureServe)

⊖ **Area Covered by Non-native Plants:** Non-native plants can crowd out native plants and may provide poorer habitat for wildlife. **Highlights:** Data are not adequate for national reporting

◐ **Forest Age:** Forests of different ages provide different goods, services, and values. **Highlights:** Sixty-five percent of surveyed forests in the East are less than 60 years old, and 90% are less than 100 years old. About 35% of surveyed western forests are more than 100 years old. Data are not available for wilderness areas and areas with relatively slow-growing forests. (Data from FS)

● **Forest Disturbance: Fire, Insects, and Disease:** These disturbances are, for the most part, natural, but can at times, be greater or less than typically encountered. **Highlights:** Since 1980, 2-7 million acres burned each year, down from a high of 52 million acres in 1930. Major insect damage affected between 8 million and 46 million acres per year from 1979 to 1999, with a clear trend toward fewer acres over that time. In recent years, about 45 million acres have been affected by two major diseases/parasites. (Data from FS)

⊖ **Fire Frequency:** Periodic fires help maintain many forest ecosystems. Both increases and decreases from presettlement fire frequency can cause changes in forest type and susceptibility to subsequent fire. **Highlights:** Data are not adequate for national reporting

⊖ **Forest Community Types with Significantly Reduced Area:** Different plant communities may provide unique ecosystem services, such as supporting rare species. **Highlights:** Data are not adequate for national reporting

HUMAN USES

● **Timber Harvest:** The production of wood products provides employment, generates economic benefits, and meets society's needs for wood, paper, and other products. **Highlights:** Nationally, timber harvest increased by about 40% from 1952 to 1996. Harvest peaked in the 1980s and has declined since then. (Data from FS)

● **Timber Growth and Harvest:** The balance between timber growth and harvest tells us whether the amount of wood potentially available for harvest is increasing or decreasing. **Highlights:** Growth exceeds harvest on both public and private timberlands in both the East and West; this has been largely true for the past 50 years. (Data from FS)

⊖ **Recreation in Forests:** Recreation is a major benefit derived from public and private forest lands. **Highlights:** Data are not adequate for national reporting.

Fresh Waters

The nation's freshwater ecosystems are amazingly diverse, yet together they form an interconnected whole. They include streams and rivers, lakes and ponds, reservoirs, freshwater wetlands, groundwater, and riparian areas—the narrow strips of land along the edge of many of these bodies of water. Because the state of America's waters reflects and affects all other ecosystems, freshwater-related indicators are also found in the chapters on forests, farmlands, grasslands and shrublands, and urban and suburban areas.

Adequate data are available to report on ten of the fifteen indicators selected to describe the condition and use of freshwater ecosystems in the United States.

SYSTEM DIMENSIONS

◐ **Extent of Freshwater Ecosystems:** Changes in wetland and lake area and in the length of streams, rivers, and stream bank (riparian) areas indicate corresponding changes in habitat and other goods and services. **Highlights:** Wetlands cover about 94 million acres, about half as much as during Colonial times and about 10% less than in the 1950s. Lakes, reservoirs, and ponds (excluding the Great Lakes) cover about 21 million acres; the area of small ponds has more than doubled since the 1950s. About three-fourths of streams and rivers have forest or other natural vegetation along their banks. It is not possible to report on the miles of streams of different sizes. (Data from USFWS, MRLC, USGS, EPA)

◐ **Altered Freshwater Ecosystems:** Physically altering a body of fresh water (by building levees or dams, channelizing, and the like) can affect the plants and animals that depend on it, as well as the goods and services people receive from it. **Highlights:** About 23% of streams and rivers have urban development or agriculture along their edges. Data on other stream alterations and wetland or lake alterations are not available. (Data from MRLC, USGS, EPA)

CHEMICAL AND PHYSICAL CONDITIONS

◐ **Phosphorus in Lakes, Reservoirs, and Large Rivers:** Increased phosphorus concentrations can cause water quality problems by overstimulating algae growth. **Highlights:** About half of all river sites tested exceeded the EPA goal for avoiding excess algae growth. Data are not adequate to report on lakes and reservoirs. (Data from USGS)

● **Changing Stream Flows:** Several key characteristics of how a stream flows—the volume of its high and low flows and when these extreme flows occur—help determine what plants and animals live there. **Highlights:** The percentage of streams or rivers whose flows were quite different from a 1930–1949 reference period rose slightly from the 1970s to the 1990s, and the number with high flows well above the reference period rose markedly from the 1980s to the 1990s. (Data from USGS)

⊖ **Water Clarity in Lakes:** Decreases in lake water clarity can reduce recreational and aesthetic values, harm aquatic life, and increase water supply costs. **Highlights:** Data are not adequate for national reporting.

BIOLOGICAL COMPONENTS

◐ **At-Risk Native Species:** Species are valued for a variety of reasons: they provide products, serve as key elements of ecosystems, and are valued for their intrinsic worth or beauty. **Highlights:** About 20% of native freshwater species are "critically imperiled" or "imperiled," and 4% are, or are believed to be,

extinct. When vulnerable species are counted, about a third of freshwater animal species are considered "at risk." Data are not adequate for national reporting on the status of freshwater and wetland plants. (Data from NatureServe)

◐ **Non-native Species:** Non-native species, some of which were introduced as game fish, can outcompete or otherwise harm native animals, and a few have caused significant economic loss. **Highlights:** Sixty percent of U.S. watersheds have between one and ten non-native fish species; less than 2% have no non-native fish species. Data on non-native species other than fish are not adequate for national reporting. (Data from USGS)

◐ **Animal Deaths and Deformities:** The number of waterfowl, fish, mammals, and amphibians that die in "unusual" mortality events, and the number of amphibian deformities, are generally believed to reflect the integrity of an ecosystem. **Highlights:** Data are available only for waterfowl mortalities: there were 500 incidents in 1995–1999, about 20% fewer than in the two previous five-year periods. (Data from USGS)

⊖ **Status of Freshwater Animal Communities:** The kinds and numbers of fish and bottom-dwelling animals in a lake or stream are the biological "neighborhood" within which individual species live, and their condition reflects a broad array of influences on the system, including chemical contamination, changes in oxygen levels, and physical disruption. **Highlights:** Data are not adequate for national reporting

◐ **At-Risk Freshwater Plant Communities:** Different wetland and stream bank plant communities (groups of species that occur in similar environmental conditions) may provide unique ecosystem services, such as supporting rare species or storing large amounts of carbon. **Highlights:** Data are available only for wetland communities, about 36% of which are "critically imperiled" or "imperiled" and 25% are "vulnerable." (Data from NatureServe)

? **Stream Habitat Quality:** Stream-dwelling animals and plants require specific habitat conditions to survive and reproduce. **Highlights:** Data are not adequate for national reporting

HUMAN USES

● **Water Withdrawals:** People require fresh water for drinking, irrigation, electricity generation, and industrial and other uses. **Highlights:** Water withdrawals increased from 1960 to 1980, driven by increasing demand from all major sectors. Withdrawals declined about 10% between 1980 and 1985, then grew slightly. (Data from USGS)

⊖ **Changes in Groundwater Levels:** Groundwater is used extensively for municipal water supplies, irrigation, and in rural homes. It is also a major source of water for many rivers, streams, and wetlands. **Highlights:** Data are not adequate for national reporting.

● **Waterborne Human Disease Outbreaks:** The number of disease outbreaks from drinking or swimming in contaminated water is a direct measure of the fitness of the nation's waters for these uses. **Highlights:** Disease outbreaks from contaminated drinking water declined from 21 in 1973 to 7 in 1998, while outbreaks from recreational contact increased from 4 in 1978 to 12 in 1998. (Data from CDC)

⊖ **Freshwater Recreation Activities:** Americans enjoy many types of recreation in and around water, including swimming, fishing, and sailing. **Highlights:** Data are not adequate for national reporting.

Grasslands and Shrublands

America's grasslands and shrublands—often called rangelands—are extensive and diverse, ranging from the coastal meadows of the Southeast, to the prairies, shrubland, and deserts of the West, to the tundra of Alaska.

Data are adequate for national reporting on six of the fourteen indicators of grassland /shrubland condition. The remaining eight either have inadequate data or require further work to define a specific measurement.

SYSTEM DIMENSIONS

● **Area of Grasslands and Shrublands:** The area of an ecosystem is its most basic characteristic—increases or decreases mean gains or losses of all the goods and services associated with that system. **Highlights:** There are 861 million acres of grasslands and shrublands (including pastures) in the lower 48 states, or about 45% of the total land area. From 1982 to 1997, 11 million acres of nonfederal grasslands and shrublands were converted to other uses. (Data from MRLC, NRCS)

◐ **Land Use:** Different land uses (livestock grazing; oil, gas, and mineral development; rural residences; intensive recreation; "protected areas"; and the Conservation Reserve Program) change the landscape in unique ways and produce different goods and services. **Highlights:** Data on land use are available only for the Conservation Reserve Program, which pays farmers to remove sensitive lands from production. About 30 million acres of grassland or shrubland acreage have been enrolled since 1994. (Data from FSA)

⊖ **Area and Size of Grassland and Shrubland Patches:** Changes in the size of grassland and shrubland "patches," and how they are intermingled with other land cover, can affect vulnerability to fire and wildlife habitat quality. **Highlights:** Data are not adequate for national reporting

CHEMICAL AND PHYSICAL CONDITIONS

⊖ **Nitrate in Groundwater:** Elevated nitrate, in water used for drinking, can be a health threat to children and is a sign that inputs from human sources have increased or that plants in an area are under stress. **Highlights:** Data are not adequate for national reporting

⊖ **Carbon Storage in Grasslands and Shrublands:** Increased carbon storage in ecosystems can offset emissions of carbon dioxide from the burning of fossil fuels, of concern because of climate change. Carbon in soils, in the form of organic matter, helps soil hold water and reduces erosion. **Highlights:** Data are not adequate for national reporting

● **Number and Duration of Dry Periods in Streams and Rivers:** Changes in stream flow—especially more frequent or longer periods of zero flow—can affect fish and wildlife, as well as human uses such as irrigation. **Highlights:** The percentage of streams that had at least one day with zero flow was noticeably lower in the 1970s, 1980s, and 1990s, than in the 1950s and 1960s, and the number of streams and rivers with shorter than average zero-flow periods was higher. (Data from USGS)

⊖ **Depth to Shallow Groundwater:** When shallow groundwater levels drop, wetland and streamside (or riparian) plant communities decline, springs and streams dry up, and lake levels drop. **Highlights:** Data are not adequate for national reporting

BIOLOGICAL COMPONENTS

◐ **At-Risk Native Species:** Species are valued for a variety of reasons: they provide products; serve as key elements of ecosystems; and are valued for their intrinsic worth or beauty. **Highlights:** About 10% of native grassland/shrubland animal species are "critically imperiled" or "imperiled." When vulnerable species are counted, about 17% of grassland/shrubland animal species are considered "at risk." Data on grassland/shrubland plants are not adequate for national reporting. (Data from NatureServe)

⊖ **Non-native Plant Cover:** Many non-native plants may be disruptive to ecosystems, crowding out native plants and increasing fire frequency; others can stabilize eroding soils, be useful in grazing, and act as a barrier to fire. **Highlights:** Data are not adequate for national reporting

● **Population Trends in Invasive and Noninvasive Birds:** Some species of birds can rapidly increase in number (invade) and disrupt established native bird populations. **Highlights:** For most of the past 35 years, across much of the West, populations of invasive and native, noninvasive bird species followed similar population trends. (Data from USGS)

⊖ **Fire Frequency Index:** Periodic fires help maintain many grassland and shrubland ecosystems. Changes in fire frequency may cause conversion of grasslands to shrubs or allow the invasion of non-native species. **Highlights:** Data are not adequate for national reporting.

? **Riparian Condition:** Riparian areas (stream banks) serve as habitat for many animal species and provide services such as trapping sediment, modifying flood flows, and increasing groundwater recharge. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

HUMAN USES

● **Production of Cattle:** The number of cattle grazing on grasslands and shrublands is an indicator of the overall use of these lands for livestock grazing, which is important economically and socially in many areas of the country. **Highlights:** Cattle on grasslands and shrublands declined from about 100 million in 1994 to 93 million in 2001. Comparable long-term figures are not available. (Data from NASS)

⊖ **Recreation on Grasslands and Shrublands:** Recreation is an important human use of grasslands and shrublands. **Highlights:** Data are not adequate for national reporting.

Urban and Suburban Areas

Most Americans live within urban and suburban areas, and the condition of their "natural" areas is a factor in our daily quality of life.

Data are adequate for national reporting on six of the fifteen indicators of urban and suburban ecosystem condition. The remaining nine either have inadequate data or require further work to define a specific measurement.

SYSTEM DIMENSIONS

● **Area of Urban and Suburban Lands:** About 75% of all Americans live on land that is urban or suburban in character. Most of this is used for buildings, houses, roads, and lawns; some remaining undeveloped areas provide the services of "natural" ecosystems. **Highlights:** In 1992, about 32 million acres in the lower 48 states, or about 1.7% of total land area, were urban or suburban. About 20% of this land was undeveloped. (Data from MRLC, USGS)

? **Suburban/Rural Land Use Change:** Both wildlife and people can be affected by land use patterns at the boundary between suburban and rural areas **Highlights:** Additional work is needed to define a specific measurement for this indicator.

● **Size of Forest, Grassland and Shrubland, and Wetland Areas:** Smaller patches of natural habitat often provide lower-quality habitat for plants and animals and less solitude and fewer recreational opportunities for people. **Highlights:** About half of all natural lands in urban and suburban areas are smaller than 10 acres, with less than 5% of the total found in patches of 1,000 acres or more. (Data from MRLC, USGS)

⊖ **Total Impervious Area:** The area covered by buildings, concrete, and other impervious surfaces is a direct measure of the degree of urbanization and strongly affects both water quality in urban and suburban areas and replenishment of groundwater. **Highlights:** Data are not adequate for national reporting

? **Stream Bank Vegetation:** The amount of vegetation along a stream bank has an important influence on both water quality and the kinds of fish and other animals that live in and along the stream. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

CHEMICAL AND PHYSICAL CONDITIONS

● **Nitrate in Urban and Suburban Streams:** Nitrate in streams can contribute to water quality problems, and excess nitrate in drinking water is a health threat for young children. Sources include sewage treatment plants, animal wastes, and fertilizers. **Highlights:** All sampled streams in urban and suburban areas had nitrate concentrations lower than the federal drinking water standard. (Data from USGS)

● **Phosphorus in Urban and Suburban Streams:** Excess phosphorus in streams can contribute to water quality problems. **Highlights:** About two-thirds of sampled urban/suburban streams exceeded the EPA concentration goal for avoiding excess algae growth. (Data from USGS)

● **Air Quality (High Ozone Levels):** Elevated levels of ground-level ozone, which are found in both urban/suburban and rural areas, are harmful to human health. **Highlights:** In the 1990s, about 50% of monitoring stations in urban and suburban areas had high ozone levels on 4 or more days, which generally triggers air quality violations. (Data from EPA)

◐ **Chemical Contamination:** In sufficient quantities, artificial compounds and heavy metals can harm people, fish, and other wildlife. **Highlights:** About 85% of urban/suburban stream sites had at least five detectable contaminants throughout the year. About 5% of sites had at least one contaminant that exceeded human health standards or guidelines, and all sites had at least one contaminant that exceeded guidelines for protection of aquatic life. Data are not currently available to report in a consistent manner on chemical contamination in urban and suburban soils. (Data from USGS)

? **Urban Heat Island:** Densely developed areas can be hotter than their surrounding region, and these higher temperatures can affect both human and ecosystem health. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

BIOLOGICAL COMPONENTS

⊖ **Species Status:** Some wildlife species that used to inhabit areas that are now urban or suburban are no longer found in these areas, but they may still be found in nearby less-developed areas. Other species favor the new conditions and are more common than before urbanization. **Highlights:** Data are not adequate for national reporting

⊖ **Disruptive Species:** Some species of plants and animals, such as white-tailed deer and Scotch broom, are so abundant in urban and suburban areas that they disrupt other species and cause problems for people. **Highlights:** Data are not adequate for national reporting.

⊖ **Status of Animal Communities in Urban and Suburban Streams:** The condition of fish and bottom-dwelling animals is a direct reflection of the degree of disturbance in an area's streams (water quality or quantity changes, alteration of stream banks, and so on). **Highlights:** Data are not adequate for national reporting.

HUMAN USES

⊖ **Publicly Accessible Open Space per Resident:** Open space is important for recreation and other reasons, and the amount available per person often determines how intensely such places will be used and how crowded they will be. **Highlights:** Data are not adequate for national reporting.

? **Natural Ecosystem Services:** "Natural" areas in cities and towns provide valuable "ecosystem services." For example, forested areas reduce stormwater runoff and trees cool streets and buildings, reducing energy consumption. **Highlights:** Additional work is needed to define a specific measurement for this indicator.

The State of the Nation's Ecosystems: An Important National Resource

Our nation now has the opportunity to greatly improve the amount, quality, and accessibility of information for making decisions about how we use, protect, and manage our ecosystems. *The State of the Nation's Ecosystems* is the first step in creating a system of periodic reports that are high-quality, unbiased, scientifically grounded, and accessible to nonspecialists. Over the past three-quarters of a century, the United States created a set of indicators of the condition of the U.S. economy. Such a system for our lands, waters, and living resources is long overdue.

We hope that readers of this Summary and Highlights document will explore the full content of *The State of the Nation's Ecosystems,* either in the print version available from Cambridge University Press (see the back cover for ordering information), or online at www.heinzctr.org/ecosystems. The Heinz Center welcomes comments, criticisms, and suggestions for refinement as it works toward the development of the second report in this series, scheduled for completion in five years.

Sources of Data: Acronym List

In addition to the brief highlights of each indicator, this summary report includes a brief reference to the agency or agencies whose data are used in the indicator. In the interests of space, these agency names were abbreviated; they are included in their entirety in the full report.

BEA	Bureau of Economic Analysis
Census	U.S. Census Bureau
CDC	Centers for Disease Control and Prevention
EPA	Environmental Protection Agency
ERS	Economic Research Service, USDA
FS	Forest Service, USDA
FSA	Farm Service Agency, USDA
MRLC	Multi-Resolution Land Characteristics Consortium
NASA	National Aeronautics and Space Administration
NASS	National Agricultural Statistics Service, USDA
NMFS	National Marine Fisheries Service, National Oceanic and Atmospheric Administration
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service, USDA
USFWS	U.S. Fish and Wildlife Service, Department of the Interior
USGS	U.S. Geological Survey, Department of the Interior

Pre-publication praise for The State of the Nation's Ecosystems:

"This authoritative report is what both the public and policymakers most need. Factual, comprehensive, balanced, and written in minimally technical language, it documents point by point what is known about America's ecosystems, what is not yet known (but should be), and the many reasons why the information is important to the nation's environmental future."

—Edward O. Wilson, *University Research Professor Emeritus, Harvard University*

"Reliable, high-quality information about the state of our environment forms a foundation for our ability to make sound public policy, and for Americans to assess our progress and chart our course of action in the years ahead. *The State of the Nation's Ecosystems* is an outstanding contribution to this effort, providing valuable information for both policymakers and concerned citizens who want to know what we've accomplished and what we still need to do."

—James L. Connaughton, *Chairman, White House Council on Environmental Quality*

"Simply put, if we are to succeed in creating sustainable societies, we need to understand how the natural ecosystems on which they depend are faring. *The State of the Nation's Ecosystems* is an excellent model for identifying what decision makers and the public need to know about the condition of ecosystems and their benefits to society. This book takes a clear-eyed approach to evaluating whether that information is available, and, in doing so, highlights what we know and what we don't know. This report is required reading for business, environmental, and policy leaders. Regular updates are a must."

—Timothy Wirth, *President, The United Nations Foundation, former U.S. Senator and former Undersecretary of State for Global Affairs*

"Americans of all political stripes overwhelmingly support laws and policies that protect our environment. Yet, inexplicably, we don't now have a regular, credible means of assessing our progress. Are our lakes and rivers cleaner? Are native wildlife disappearing? Are wildfires consuming more of our forests and grasslands? *The State of the Nation's Ecosystems* meets this need by taking the pulse of our nation's environment. It provides policymakers and citizens with a set of unbiased indicators on the condition of nature and the resources we are working hard to protect."

—William K. Reilly, *President and CEO of Aqua International Partners, Chairman of the Board and former President of World Wildlife Fund, and former Administrator of the Environmental Protection Agency*

"Solid data on environmental trends are surprisingly scarce, and The Heinz Center deserves everyone's gratitude for its serious and systematic effort to discover what we know and don't know about the condition of U.S. ecosystems. *The State of the Nation's Ecosystems* won't end every argument, and will probably start some new ones, but it will be an important baseline to consult as we decide where to go from here."

—Steven Hayward, *F. K. Weyerhaeuser Fellow, American Enterprise Institute*

The State of the Nation's Ecosystems: Measuring the Lands, Waters, and Living Resources of the United States (the full report on which this short version is based) is published by Cambridge University Press. The full report may be purchased from the publisher, Cambridge University Press; telephone toll-free 1-800-872-7423 in the United States and Canada, or order online at http://us.cambridge.org.
The report is also available in full on the World Wide Web at www.heinzctr.org/ecosystems.