

Appendix:

Data Availability and Gaps

As explained in Chapter 2, we attempted to locate data of sufficient quality and coverage to support national reporting for each of the 103 indicators included in this report. As might be expected, we found a wide variation in the availability of data. Throughout the report, we highlight those indicators for which sufficient data are not available and, in doing so, identify needs for additional monitoring. We also highlight a number of measures for which additional research is needed to define more fully the specific value to be reported. This appendix summarizes the “state of the data” for the indicators in the report.

Guidelines for Including Data

Once an indicator was chosen and relevant sources of data were identified, the first screen for inclusion was *scientific credibility*. Again, data were not used simply because they were the “best available” but, based on the professional judgment of the members of each work group, they had to meet the highest standards of the appropriate discipline. The judgments of the work groups were then extensively peer-reviewed.

The second criterion for including a data source was that it *provide information on a substantial majority of the resource or issue in question*. The practical result is that we relied on data sources that covered a majority of states or a significant fraction of coastline. For some indicators, complete coverage is available (such as is provided by remote sensing data). For others, regionally or nationally representative samples are used (such as is provided by monitoring programs employing statistical sampling techniques).

The first draft/prototype of this report, released in 1999, included many examples of data for small areas of the country, as illustrations of the types of results we had hoped to include. Feedback from readers led us to conclude that while such examples are interesting, they obscure the fact that data are not available for a significant fraction of the desired indicators.

Third, to be included in this report, data sources must be from ongoing programs—that is, there must be a reasonable chance that the *measurements will be 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 conducted by individual researchers or groups. One-time efforts are extremely valuable because they often break new ground scientifically, and they may provide baselines against which data collected later may be compared, but they do not necessarily form a solid foundation for periodic reporting.

Ideally, data sources used in this report have time trends, but the lack of trends was not a criterion for eliminating data. Where possible, we have attempted to use data from 1950 to the present, with longer historical perspectives included as needed to provide an ecological context for current reporting. These longer-term perspectives include reporting on conditions before European settlement, in the early 20th century, or for other relevant time periods. Many data sources, particularly those based on remote sensing, cover shorter time periods but will illuminate longer-term trends as time goes on and measurements are repeated.

Note as well that there were a number of cases where we were not able to determine which of several possible indicators for an important ecosystem attribute was best, and thus we could not judge whether adequate data are available. We have highlighted these cases, and we hope to work closely with the relevant scientific communities to narrow the range of possible indicators.

Table A.1. Indicators According to Data Availability

● Indicators with ALL Required Data	⊖ Indicators with INADEQUATE DATA FOR NATIONAL REPORTING
<p>Core National Indicators</p> <ul style="list-style-type: none"> ■ Movement of Nitrogen ■ Plant Growth Index ■ Production of Food and Fiber and Water Withdrawals <p>Coasts and Oceans</p> <ul style="list-style-type: none"> ■ Sea Surface Temperature ■ Commercial Fish and Shellfish Landings <p>Farmlands</p> <ul style="list-style-type: none"> ■ Total Cropland ■ The Farmland Landscape ■ Nitrate in Farmland Streams and Groundwater ■ Phosphorus in Farmland Streams ■ Pesticides in Farmland Streams and Groundwater ■ Soil Erosion ■ Major Crop Yields ■ Agricultural Inputs and Outputs ■ Monetary Value of Agricultural Production <p>Forests</p> <ul style="list-style-type: none"> ■ Forest Area and Ownership ■ Forest Types ■ Forest Management Categories ■ Nitrate in Forest Streams ■ Forest Disturbance: Fire, Insects, and Disease ■ Timber Harvest ■ Timber Growth and Harvest <p>Fresh Waters</p> <ul style="list-style-type: none"> ■ Changing Stream Flows ■ Water Withdrawals ■ Waterborne Human Disease Outbreaks <p>Grasslands and Shrublands</p> <ul style="list-style-type: none"> ■ Area of Grasslands and Shrublands ■ Number and Duration of Dry Periods in Streams and Rivers ■ Population Trends in Invasive Birds ■ Production of Cattle <p>Urban and Suburban Areas</p> <ul style="list-style-type: none"> ■ Area of Urban / Suburban Lands ■ Patches of Forest, Grasslands and Shrublands, and Wetlands ■ Nitrate in Urban and Suburban Streams ■ Phosphorus in Urban and Suburban Streams ■ Air Quality 	<p>Core National Indicators</p> <ul style="list-style-type: none"> ■ None <p>Coasts and Oceans</p> <ul style="list-style-type: none"> ■ Areas with Depleted Oxygen ■ Coastal Erosion ■ At-Risk Marine Species ■ Selected Contaminants in Fish and Shellfish ■ Recreational Water Quality <p>Farmlands</p> <ul style="list-style-type: none"> ■ Fragmentation of Farmland Landscapes by Development ■ Shape of “Natural” Patches in the Farmland Landscape ■ Soil Organic Matter ■ Soil Salinity ■ Soil Biological Condition ■ Recreation on Farmlands <p>Forests</p> <ul style="list-style-type: none"> ■ Non-native Plants ■ Fire Frequency ■ Forest Community Types with Significantly Reduced Area ■ Recreation in Forests <p>Fresh Waters</p> <ul style="list-style-type: none"> ■ Water Clarity ■ Status of Freshwater Animal Communities ■ Groundwater Levels ■ Freshwater Recreation Activities <p>Grasslands and Shrublands</p> <ul style="list-style-type: none"> ■ Area and Size of Grassland and Shrubland Patches ■ Nitrate in Groundwater ■ Carbon Storage ■ Depth to Shallow Groundwater ■ Non-native Plant Cover ■ Fire Frequency ■ Recreation on Grasslands and Shrublands <p>Urban and Suburban Areas</p> <ul style="list-style-type: none"> ■ Total Impervious Area ■ Species Status ■ Disruptive Species ■ Status of Animal Communities in Urban and Suburban Streams ■ Publicly Accessible Open Space per Resident
Ⓢ Indicators with PARTIAL DATA	❓ Indicators needing ADDITIONAL DEVELOPMENT
<p>Core National Indicators</p> <ul style="list-style-type: none"> ■ Ecosystem Extent ■ At-Risk Native Species ■ Chemical Contaminants ■ Outdoor Recreation <p>Coasts and Oceans</p> <ul style="list-style-type: none"> ■ Coastal Living Habitats ■ Shoreline Types ■ Contamination in Bottom Sediments ■ Unusual Marine Mortalities ■ Condition of Bottom-Dwelling Animals ■ Chlorophyll Concentration ■ Status of Commercially Important Fish Stocks <p>Farmlands</p> <ul style="list-style-type: none"> ■ None <p>Forests</p> <ul style="list-style-type: none"> ■ Forest Pattern and Fragmentation ■ Carbon Storage ■ At-Risk Native Species ■ Forest Age <p>Fresh Waters</p> <ul style="list-style-type: none"> ■ Extent of Freshwater Ecosystems ■ Altered Freshwater Ecosystems ■ Phosphorus in Lakes, Reservoirs, and Large Rivers ■ At-Risk Native Species ■ Non-Native Species ■ Animal Deaths and Deformities ■ At-Risk Freshwater Plant Communities <p>Grasslands and Shrublands</p> <ul style="list-style-type: none"> ■ Land Use ■ At-Risk Native Species <p>Urban and Suburban Areas</p> <ul style="list-style-type: none"> ■ Chemical Contamination 	<p>Core National Indicators</p> <ul style="list-style-type: none"> ■ Fragmentation and Landscape Pattern ■ Condition of Plant and Animal Communities ■ Natural Ecosystem Services <p>Coasts and Oceans</p> <ul style="list-style-type: none"> ■ Non-native Species ■ Harmful Algal Blooms <p>Farmlands</p> <ul style="list-style-type: none"> ■ Status of Animal Species in Farmland Areas ■ Native Vegetation in Areas Dominated by Croplands ■ Stream Habitat Quality <p>Forests</p> <ul style="list-style-type: none"> ■ None <p>Fresh Waters</p> <ul style="list-style-type: none"> ■ Stream Habitat Quality <p>Grasslands and Shrublands</p> <ul style="list-style-type: none"> ■ Riparian Condition <p>Urban and Suburban Areas</p> <ul style="list-style-type: none"> ■ Suburban/Rural Land Use Change ■ Stream Bank Vegetation ■ Urban Heat Island ■ Natural Ecosystem Services

Indicators with Full, Partial, and Insufficient Data

Throughout the report, we have classified indicators into four categories:

- Those with all data required for periodic national reporting
- ◐ Those with some, but not all, of the data needed for national reporting
- ⊖ Indicators with insufficient data for national reporting
- ⊗ Indicators that need further development

Of the 103 indicators included in this report, 58 (56%) are in the first two categories—that is, there are sufficient data to support periodic national-level reporting. Of these, 33 have all the data required and the remaining 25 have some data gaps. These gaps may be regional (i.e., data are available for part but not all of the country) or they may be topical (i.e., data are available on some but not all components of an indicator). An example of the former is the coastal shoreline types indicator (p. 70), where data are available for the Pacific and southern Atlantic coasts, but not for the middle and northern Atlantic or Gulf Coasts. Several of the at-risk species indicators (see the forest and grasslands indicators, pp. 124 and 168) provide examples of the latter. In these cases, we have reported data on the status of native animals, but not plants (such data are available but required additional analysis before they could be used). Table A.1 shows the data availability for all indicators in the report.

Data availability varies by both ecosystem type and indicator category, as shown in Figures A.1 and A.2.

Data are available for more forest indicators than for any other system: there are complete data for about half the forest indicators and some data for another quarter. Full or partial data are available for 50% or fewer of the indicators for farmlands, grasslands and shrublands and urban and suburban areas (although there are more indicators with “full data” for farmlands than for any other system) (see Box A.1). The indicator categories with the highest percentages of data available include those addressing ecosystem extent; contaminants; ecosystem productivity; and food, fiber, and water (i.e., goods provided

Box A.1. Three Systems with Large Data Gaps

Farmlands and grasslands and shrublands make up about 60% of the land area of the lower 48 states. Urban and suburban areas, which are quite small in comparison, are home to about three-quarters of all Americans. Yet, for these three ecosystems, full or partial data are available for half or fewer of the indicators.

We can report on the acreage of croplands, the food and fiber they produce, and the nutrients and contaminants that occur in farmland streams. Surprisingly, given how important soil is to farming, we cannot report nationally on soil organic matter, soil salinity, or the microscopic animal communities in cropland soils. Finally, we could not report on *any* of the indicators describing biological components in farmland areas, either because data were not available or because the indicators need additional development. (Interestingly, for farmlands, where data do exist, they are more complete than for other systems—there are more indicators with all required data than for any other system.)

Data gaps for grasslands and shrublands include information about how these areas are used, the amount of nitrate in groundwater, the amount of carbon stored in plants and soil, the depth to groundwater, the extent of non-native plants, the frequency of fires, and recreation on these lands. We can report fully on the acreage of grasslands and shrublands and the number of cattle that feed on them, on stream and river flows, on population trends for invasive birds and the number of animal species (but not plants) that are at risk of extinction.

We report data for fewer urban and suburban indicators than for any other ecosystem type—only 6 of 15 indicators. We can report on the extent of urban and suburban areas and on the undeveloped lands they contain. We can also report on nutrients and contaminants in stream water (but not on the degree of contamination in soils). All remaining indicators either have inadequate data or require additional development.

by ecosystems). Indicator categories with the poorest data availability include those addressing landscape patterns, biological communities, and services provided by ecosystems.

No data are included for 45 of the indicators in the report. For 31 of these, the desired indicator is clear, but available data are insufficient for national reporting. For the remaining 14, the indicator itself needs further development. Data gaps and problems with indicator definitions are discussed below.

Trends and Other Context Information

This report does not make normative judgments about whether particular ecosystem conditions are “good” or “bad.” Rather, we aim to present the available data in as neutral a form as possible—a “just the facts” approach. However, we also seek to provide information that places current ecosystem

conditions in context, to assist the reader in understanding and making his or her own judgments about those conditions.

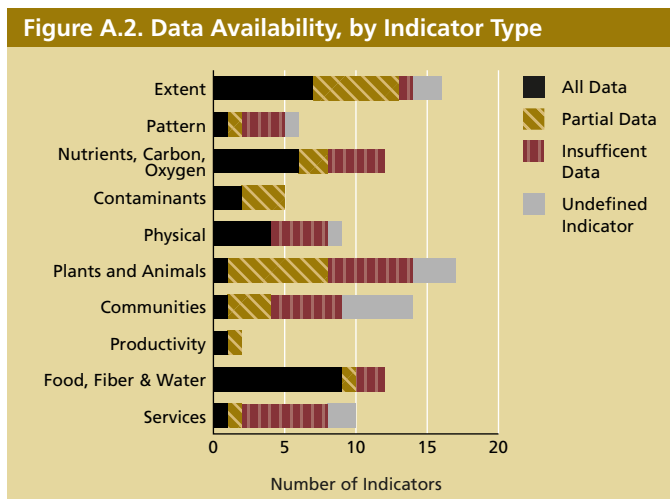
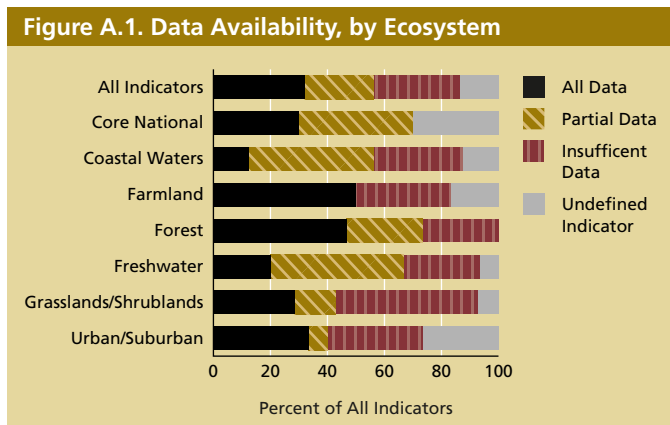
An obvious and (importantly) neutral way to place current conditions into context is to report the value of the indicator over time. Trends provide information both on the direction of change (is the value increasing or decreasing?), but also on the rate of change, which may be useful in determining whether there is reason for concern. In addition, providing information on the geographic distribution of conditions can be useful. So, for example, for some indicators we report whether one region of the country or one ecosystem type (forest, farmlands, etc.) had higher or lower values than other regions or types. A third method for placing information in context is through comparisons to relatively undisturbed “reference” conditions, and a final method is to compare current conditions to broadly accepted reference points, primarily federal limits for the allowable concentration of certain chemicals in the air or water.

As noted above, this report presents full or partial data on 58 indicators (56% of the total). Trends are presented for about half of these (31 indicators). For another 11 indicators, we have

provided comparisons against widely accepted standards or against undisturbed or other reference conditions. For the remaining 16, we have information for only one point in time, without useful reference information.

The availability of trends and other reference and comparative information differs according to ecosystem type and indicator category, as shown in Figures A.3 and A.4. For example, as noted above, there are trends for 31 indicators (30%). For urban systems, trends are available for only 7%, while trends are available for about half of the forest indicators.

The situation is even more varied when one considers the availability of trends by indicator category. Trend data are available for more than 80% of indicators describing production and use of food, fiber, and water, and for about 40% of indicators of ecosystem extent. These strong showings are largely a result of the long-standing and well-supported monitoring and reporting programs devoted to



accounting for goods of economic interest and the lands used in their production. For indicators of nutrients and related chemicals, contaminants, plant and animal species, and biological communities, trends are considerably less common—20% or less in all four cases. For contaminants and nutrients, however, regulatory standards and nonregulatory guidance levels provide a substantial increase in the amount of context information provided for these indicators.

Data Gaps and Problems in Indicator Definition

Again, of the 103 indicators included in the report, 33 have all data required for periodic national reporting, 25 have partial data available, and the remaining 45 include no data at all. Thus 70 measures (68%) are missing some or all data.

For 7 of these 70 indicators, the data required for national reporting exist (or would have been possible to obtain), but time and/or financial constraints prevented us from assembling them for this report. Three of these involve work with large data sets using geographic information systems (GIS). Another two involve categorizing 16,000 native plants into the ecosystems in which they are typically found. The remaining two would have required addition of questions to a recent recreational survey.

For another 5 of the 70 indicators, we have reason to expect that data adequate for national reporting will become available soon. These include coastal bathing water quality and additional data on shoreline habitat, forest fragmentation, and forest age structure. Table A.2 lists the 12 indicators that are either expected to become available soon or that could be made available now with additional funding.

For 41 indicators, some data are currently collected, but these data are of uncertain quality or comparability. Often the data are not comparable because different agencies or programs use different methods to collect or manage them. The fact that at least some data exist for these indicators means that it may be possible to fill data gaps relatively easily, through collation and aggregation of data from existing programs. However, detailed analyses would be required to determine the quality, coverage, and comparability of the various data sets. Such analyses were beyond the scope of this project, but should be a high priority.

Data are not collected on any significant scale for 10 indicators. For another 7 indicators, the project work groups were not able to agree on a sufficiently well defined measure to even determine whether data are available. Note that 14 of the indicators in the report are marked as needing further development (see Table A.1). However, relevant data are available for almost half of these, so once the additional research is completed to clearly define these measures, a few of these indicators may move to the “with data” category.

Figure A.5 summarizes the status of data collection for the indicators in the report.

Figure A.3. Availability of Trends and Reference Information, by Ecosystem

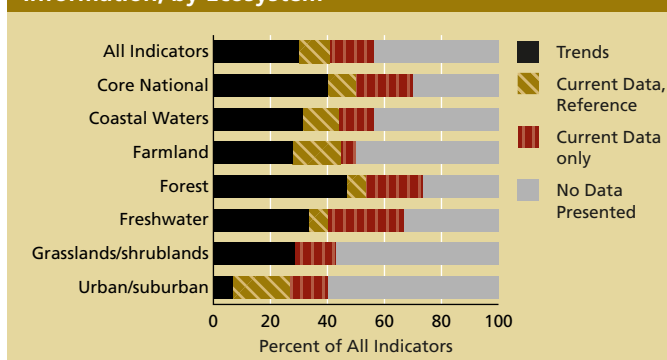
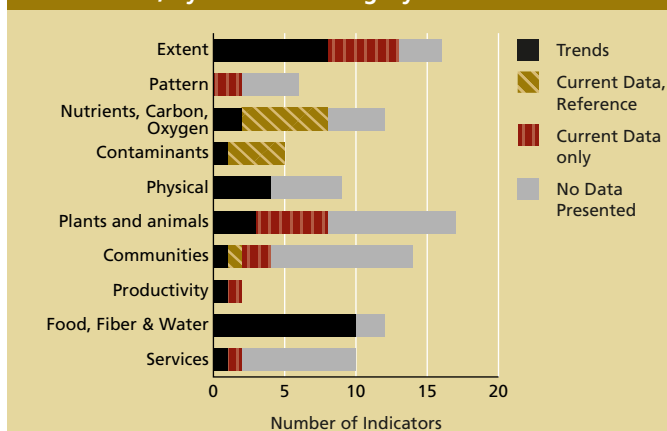


Figure A.4. Availability of Trends and Reference Information, by Indicator Category



Box A.2. Native and Non-native Species

Species are fundamental components of ecosystems, are the subject of many policy and management issues, and are of intense interest to many Americans. We include 16 measures of plant and animal species, about half of which deal with native species and half with non-native or invasive species. We report full data for one of these 16 indicators, partial data for seven, and none for the remaining eight. Only three indicators have trends.

Native species indicators focus on risks of extinction and on unusual mortalities and deformities. Partial data are available for several indicators dealing with the risk of extinction of U.S. plants and animals. However, we could not report on species in farmlands, urban and suburban areas, or coastal waters. For forests, freshwater, and grasslands and shrublands, we are able to report on the status of animal species that depend on these ecosystem types, but not on plants, because the required analyses of the habitats of all 16,000 U.S. plants have not been completed. The only indicators for which trend data are available are those dealing with unusual mortality. However, these indicators are limited because there are data available for only a few groups of species.

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

All six ecosystems have indicators that would—if data were available—track key aspects of non-native species, invasive or disruptive species, or both. However, despite the strong attention this subject is receiving in both scientific and management circles, we can report on only two indicators—the number of non-native fish species established in U.S. fresh waters, and population trends in invasive birds in grasslands and shrublands. All other indicators dealing with non-native or invasive species have data that are inadequate for national reporting, require additional development, or both.

Non-native species indicators also vary greatly in their focus. Some focus on plants—the fraction of land area covered by non-native species. Others focus on animals—the number of species in an area, or population trends in those species. Our recommended coastal indicator would integrate both the area covered and the number of non-native species in an area. While these different approaches reflect differences of opinion about what is most important to track, integrated national reporting—across multiple ecosystems—will be made easier if these differences are resolved in the future.

Resources for Filling Data Gaps

Filling the data gaps identified in this report will require a combination of ground-based surveys and information acquired from remote sensing platforms (satellites). Though many hope that remote sensing will form the backbone of future monitoring programs, a preliminary examination reveals that on-the-ground surveys are the method of choice for filling many—and possibly most—of the data gaps.

There are striking differences between the types of monitoring resources likely to be required to fill gaps, depending upon the nature of the indicator. All indicators of chemical conditions (both nutrients and other compounds, and chemical contaminants) and those that track the production and use of food, fiber, and water will probably continue to require on-the-ground data collection, as will a majority of the indicators of species and biological community condition. Measures of landscape pattern (fragmentation

Table A.2. Status of Data Collection for Selected Indicators with Partial or Insufficient Data

SYSTEM	INDICATOR	PAGE
Data available, but time, financial, or other constraints limited access		
Core National	Recreation	60
Farmlands	Fragmentation of Farmland Landscapes by Development	93
Farmlands	Shape of "Natural" Patches	94
Forests	At-Risk Native Species	124
Freshwater	Freshwater Recreational Activities	153
Grassland/shrubland	Area and Size of Grassland and Shrubland Patches	163
Grassland/shrubland	At-Risk Native Species	168
Data expected to be available soon (1–3 years)		
Coastal Waters	Shoreline Types	70
Coastal Waters	Recreational Water Quality	84
Forests	Forest Pattern and Fragmentation	120
Forests	Area Covered by Non-native Plants	125
Forests	Forest Age	126

and related attributes) and measures of extent will likely continue to rely heavily upon remote sensing information. These conclusions are tentative, however, because we have not conducted detailed assessments nor consulted widely about the potential for new and innovative approaches to using remote sensing data to monitor ecosystem attributes that previously required on-the-ground data collection.

In the previous section, we pointed out that for many of the indicators listed as having data insufficient for national reporting, at least some data are available today. The implication for filling the data gaps identified in this project are mixed. On one hand, the fact that data are collected for many measures is heartening, because it means that new monitoring programs may not be needed. However, the disaggregated nature of current monitoring efforts means that simply identifying the nature and scope of the problem will be a painstaking effort. For example, it is a significant undertaking to determine whether data collected by monitoring programs operated by states, federal agencies, research organizations, and others are sufficiently comparable to be collated into a single data set and whether this data set would be appropriate for making regional and national statements. We hope to examine these data sets in detail during the next phase of our research.

Figure A.5. Status of Data Collection