Chapter 8:
Indicators of the Condition and Use of 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. From the Mississippi to a seasonal desert stream, from the Great Lakes to a farm pond, and from the Everglades to a prairie pothole, the nation's fresh waters provide Americans with drinking water, food, recreational opportunities, and energy, among many other goods and services. Besides being ecosystems in their own right, freshwater systems are an essential part of every one of the other terrestrial ecosystems. Because the state of America's waters reflects and affects the health of all other ecosystems, freshwater indicators are found throughout this report.

What can we say about the condition and use of fresh waters?

Fifteen indicators describe the condition and use of freshwater ecosystems in the United States. Partial or complete data are available for ten of these indicators. Five of these have a long enough data record from which to judge trends, and one has a federally adopted goal to use in judging current conditions. For four indicators, data are not adequate for national reporting, and one indicator requires additional development before it will be possible to assess the availability of data. In addition, indicators of nutrients and chemical contamination in fresh waters are included in every indicator chapter except Coasts and Oceans.

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

System Dimensions

As in each of the other systems, tracking changes in the size of the many types of freshwater ecosystems is the most basic way of describing the condition of the nation's fresh waters. Thus our first indicator of freshwater system dimension tallies the area of lakes and wetlands and the length of streams, rivers, and riparian areas along stream banks. The second tracks the alteration of many of the elements of this complex system.

- **What is the area of lakes and wetlands, and the length of streams, rivers, and their stream bank (riparian) areas?** About half of all Colonial-era wetland acreage in the lower 48 states has been converted to agriculture, development, or other land uses. By the 1990s, about 10% of wetlands that had existed in the 1950s had been lost, with the rate of loss considerably lower after 1985. Lakes, reservoirs, and ponds cover about 21 million acres, and wetlands cover 94 million acres. The area of ponds (usually less than 20 acres) has increased by over 100% since the mid-1950s. This is believed to reflect the construction of small ponds, but the data do not distinguish natural from constructed ponds. More than three-fourths of streams and rivers have forests or other natural vegetation along their banks and riparian area. Data are not adequate for national reporting on the miles of streams of different sizes.
- **How much of the nation's lakes, wetlands, streams, and riparian areas has been significantly altered?** Freshwater systems can be altered in many ways—by damming or channelizing rivers and

streams, by excavating or impounding wetlands, or by converting the edge of a lake or river to a different land use, such as urban/suburban or agriculture. About one-fourth of streams and rivers have either farmlands or urban development in the narrow (about 100-foot-wide) area immediately adjacent to the water's edge. Data are not adequate for national reporting on alterations to lakeshores or wetlands, or on streams and rivers that have been leveed, channelized, or impounded.

Chemical and Physical Conditions

Three indicators describe the chemical and physical condition of fresh waters; these are complemented by several related measures included in other chapters (see below). Two indicators focus on water quality: the concentration of phosphorus, a vital plant nutrient that can lead to problems if present in excess, and the clarity of lake and reservoir waters. Water quantity is also important, so a third measure tracks changes in key flow characteristics of streams and rivers.

Because it is important to all ecosystems, many additional indicators of water quality are presented elsewhere in this report. These include core national indicators dealing with nitrogen and contaminants such as pesticides, PCBs, and heavy metals in streams, sediment, groundwater, and fish. There are also measures dealing with nitrogen or phosphorus or both in the farmlands, forest, grasslands and shrublands, and urban and suburban chapters and indicators dealing with contaminants in the farmlands and urban and suburban chapters.

- **How much phosphorus is there in lakes, reservoirs, and large rivers?** About half of all river sites tested had phosphorus concentrations that exceeded the Environmental Protection Agency's recommended level for preventing excess algae growth. Data are not adequate for national reporting on phosphorus in lakes. See pp. 96 and 187 for data on phosphorus in smaller streams.
- **How many streams have had major changes in the size or timing of their lowest or highest flows since the 1930s–1940s?** Changes in these key flow characteristics can disrupt the plants and animals that live in or near streams. The percentage of streams with major changes in the size of their highest or lowest flow, or in the timing of these flows, increased slightly (from 55% to 60%) from the 1970s to the 1990s. The number of streams with high flows that were well above the 1930–1949 reference period increased markedly from the 1980s to 1990s.
- **How clear are lakes in the United States?** Lakes in some regions are normally quite clear; in other places, lakes are less clear because of naturally occurring algae, sediment, and other suspended materials. Decreases in lake clarity can harm fish and aquatic plants, reduce recreational values, and increase water supply costs. Data are not adequate for national reporting on this indicator.

Biological Components

Six indicators describe the biological condition of the freshwater system. As in other systems, one tracks the native freshwater plant and animal species that are at varying levels of risk of extinction. A parallel indicator tracks the fraction of wetland and riparian (stream bank) communities—specific plant groupings—that are at risk of elimination. A third indicator tracks often unwanted non-native species, reporting now on non-native fish breeding in major watersheds but eventually including amphibians, mollusks, and plants. A fourth indicator would measure how closely fish and bottom-dwelling animal communities resemble those in relatively undisturbed lakes and streams in each region. Because abnormal environmental conditions sometimes lead to unusual animal mortality events, a fifth indicator tallies unusual mortality events among birds, fish, mammals, and amphibians (so far, data are available only for waterfowl) The final indicator will focus on measures of stream habitat quality; a companion indicator is included in the farmlands chapter.

- **How many freshwater species are at different levels of risk of extinction?** About 20% of more than 4000 native animal species that depend on streams, lakes, wetlands, or riparian areas are considered "imperiled" or "critically imperiled," and 4% may already be extinct. When "vulnerable" species are

counted, about a third of freshwater species are considered to be "at risk." Hawaii and the Southeast have a much higher percentage of at-risk freshwater species than any other region. Interpretation of these data will be greatly enhanced when information on population trends for these species becomes available.

- **How many non-native species are found in watersheds throughout the United States?** Some non-native species can outcompete native species for food or habitat, and others may act as predators of native species. At least one species of non-native fish has established a breeding population in 99% of the 350 major watersheds in the United States. About 60% of major watersheds have 1–10 non-native species, and two watersheds have 41–50. Watersheds in the central United States—including those on the Gulf Coast—have, in general, the fewest established non-native fish species. Data are not adequate to report nationally on non-native species other than fish.
- **How many die-offs of waterfowl, fish, mammals, and amphibians occur? How common are amphibian deformities?** Such mortalities are typically quite visible and can lead to considerable public concern. While causes are not always known, many scientists believe that increased numbers of mortality events signal serious problems in an ecosystem. The total number of waterfowl die-offs—about 500—was about 20% less in 1995–1999 than it was in either of the two preceding five-year periods. In general, die-offs are more frequent in the Pacific Coast and Midwest regions. Data are not adequate for national reporting on die-offs of fish, amphibians, or mammals or on amphibian deformities.
- **What is the condition of communities of fish and bottom-dwelling animals in the nation's streams?** Modifying a stream—through pollution, changes to the streambed or bank, flow modification, or other means—can change the number and diversity of fish and bottom-dwelling animals. Data are not adequate for national reporting on this indicator.
- **How many wetland and riparian plant communities are at risk?** About 60% of the 1560 wetland communities whose status is known are considered to be at risk, including 12% that are critically imperiled, 24% that are imperiled, and 25% that are vulnerable. Hawaii and the Southeast have a higher percentage of at-risk wetland communities, but in all regions except the Northeast more than 50% of wetland communities are at risk. Interpreting these figures is complicated, however, because some of these wetland community types have never been widely distributed, while others once covered much larger areas and have been reduced in area by conversion to other uses. Data are not adequate to report on riparian (stream bank) communities.
- **What is the quality of the habitat in the nation's streams?** Habitat quality, which varies naturally from stream to stream, directly affects a stream's ability to support native species. This indicator requires further development.

Human Use

Four indicators describe the human uses of fresh waters, two related to water withdrawals, one on recreation, and one on waterborne disease. The first indicator tracks withdrawals by use (e.g., for irrigation, electricity generation, or municipal use) and by source (surface or groundwater). The second tracks whether groundwater levels are changing, in part as a result of withdrawals exceeding recharge. A third indicator tracks a human-focused measure of water quality—the frequency of waterborne disease outbreaks attributed to both drinking and swimming in contaminated water. The fourth tracks such recreational activities as swimming and fishing.

- **How much fresh water do people withdraw, and what do they use it for?** Groundwater and surface water withdrawals increased from 1960 to 1980, and these increases were attributed to growing demand from all major types of use. Total water withdrawals declined about 10% between 1980 and 1985, then grew slightly from 1985 to 1995. Reduced demand for irrigation, thermoelectric power generation, and self-supplied industrial use was responsible for the decline in total withdrawals between 1980 and 1985; demand for these three uses was nearly flat from 1985 to 1995.

- **Are groundwater levels changing?** Are they increasing or decreasing, and at what rate? Groundwater is a major source of water for drinking, irrigation, and other uses and it provides water to many streams, rivers, and wetlands. Deeper water levels mean higher pumping costs and reduced contributions to surface waters. Data are not adequate for national reporting on this indicator.
- **How often do people get sick from drinking or swimming in contaminated water?** The number of disease outbreaks attributable to contaminated drinking water declined markedly from 1973 to 1998. Over approximately the same period, outbreaks attributed to recreational contact increased.
- **How much recreation takes place in the nation's fresh waters?** Americans frequently take part in recreational activities in and around fresh waters; however, data are not adequate for national reporting on this indicator.

What do we mean by "fresh waters"?

Freshwater ecosystems include

- Rivers and streams, including those that flow only intermittently
- Lakes, ponds, and reservoirs, from the Great Lakes to small farm ponds
- Groundwater
- Freshwater wetlands, including forested, shrub, and emergent (marsh) wetlands
- Riparian areas: the strip of land, usually vegetated, along the edge of streams and rivers (this term can also apply to lake edges)

Obviously, there are overlaps and gradations between these areas. Wetlands often occur at the margins of streams and rivers, in what is also considered the riparian area. Some ponds are shallow and thus may also be classified as wetlands. Reservoirs created when rivers are dammed may be classified as rivers, reservoirs, or both, and groundwater often connects all these systems.

Data sources currently available may not identify the smallest ponds, streams, and wetlands. For example, the U.S. Geological Survey dataset (the National Hydrography Dataset, http://nhd.usgs.gov/) that is used to identify lakes generally records neither lakes of less than 6 acres nor very small streams. Since the number and area of these smaller features may be subject to greater change than larger bodies of water—both because they are more numerous and because they are easier to affect—it is important to improve the resolution of these datasets in the future.

Map 8.1. Regional Boundaries for the Following Indicators: At-Risk Native Freshwater Species, Animal Deaths and Deformities, and At-Risk Freshwater Plant Communities

A Note about Regions

This chapter uses a regional approach (see Map 8.1) to providing data for three indicators: At-Risk Native Freshwater Species; Animal Deaths and Deformities; and At-Risk Freshwater Plant Communities. This regional scheme was developed for this report, and is used for the national plant growth and at-risk species indicators, as well as for the at-risk species indicators for forests and grasslands and shrublands.