5.6 What Is the Ecological Condition of Fresh Waters?

Fresh waters include wetlands, lakes and reservoirs, and streams and rivers. Wetlands are areas where saturation with water is the dominant factor determining the types of plant and animal communities. Wetlands vary widely because of differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors. Two general categories of wetlands are recognized: coastal (tidal) wetlands and inland (non-tidal) wetlands. Wetlands have been threatened by outright loss and conversion from one type to another, but programs designed to restore or enhance wetlands, such as the Wetlands Reserve Program, as well as state, local, and private initiatives on agricultural lands, have resulted in reduced losses (see Chapter 2, Purer Water).

The U.S. contains more than 3.7 million miles of streams and rivers. About 60 percent of all these stream miles are found in small, head-

Exhibit 5-24: Fresh water indicators

SAB Framework	Indicators	Category		Source
Landscape Condition		1	2	
Extent of Ecological System/Habitat Types	Wetland extent and change	■		DOI
	Extent of ponds, lakes, and reservoirs	■		DOI
Landscape Composition	Altered fresh water ecosystems		■	DOI
Landscape Structure/Pattern				
Biotic Condition				
Ecosystems and Communities	Non-native fresh water fish species		■	DOI
	Animal deaths and deformities		■	DOI
	At-risk fresh water plant communities		■	NatureServe
	Fish Index of Biotic Integrity in streams		■	EPA
	Macroinvertebrate Biotic Integrity Index for streams		■	EPA
Species and Populations	At-risk native fresh water species		■	NatureServe
Organism Condition	Contaminants in fresh water fish		■	DOI
Ecological Processes				
Energy Flow				
Material Flow				
Chemical and Physical Characteristics				
Nutrient Concentrations	Phosphorus in large rivers		■	DOI
	Lake Trophic State Index		■	EPA
Trace Organic and Inorganic Chemicals	Chemical contamination in streams		■	DOI
Other Chemical Parameters	Acid sensitivity in lakes and streams		■	EPA
Physical Parameters				
Hydrology and Geomorphology				
Surface and Ground Water Flows	Changing stream flows	■		DOI
Dynamic Structural Conditions				
Sediment and Material Transport	Sedimentation index		■	EPA
Natural Disturbance Regimes				
Frequency				
Extent				
Duration				

water streams. The U.S. also contains more than 60 million acres of lakes, ponds, and reservoirs. Natural lakes are generally located in previously glaciated areas of the Northeast and Midwest, in mountainous areas, and as sinkholes or seepage lakes in Florida. Oxbow lakes are associated with former meanders of river systems. Reservoirs predominate in the West and in the unglaciated areas of the South and Southeast. Ponds, both manmade and natural, are found throughout the U.S. (see Chapter 2).

Many of the problems facing fresh water systems are similar: low dissolved oxygen, eutrophication, acidification, toxic materials in air deposition (e.g., mercury), point and non-point discharges and sediments, siltation, hydrologic modification, temperature modification, effects of Ultraviolet-B (UV-B) radiation, invasive species, overfishing, and more recently, endocrine-disrupting chemicals (e.g., Naiman and Turner, 2000). According to the most recent 305(b) report required bi-annually under the Clean Water Act, approximately one-half of the lakes and slightly more than one-half of the streams assessed by the states do not meet the designated use assigned to them by the state in which they are located (EPA, OW, August 2002).[11]

There have been several systematic efforts over the past three decades to report on the condition of lakes and stream ecosystems with respect to some of these issues:

- The U.S. Fish and Wildlife Service (USFWS) conducted the National Fisheries Survey to determine the condition of fish communities in the nation's streams (Judy, et al., 1984). The survey used a probability design, and fish community condition was based on expert opinion, rather than collection of field data.
- The National Surface Water Survey (NSWS) used a probability design to assess the acidity of lakes and streams in all areas of the U.S. sensitive to acid deposition (NAPAP, 1991; Baker, et al., 1991; Kaufmann, et al., 1991).
- The Temporally Integrated Monitoring of Ecosystems (TIME) program has continued monitoring a representative sample of acid sensitive lakes and streams, in the Northeast and Appalachians (Stoddard, et al., 1999).
- The National Water Quality Assessment (NAWQA) network samples surface fresh water ecosystems in 50 watersheds, and makes measurements of chemistry and biota (<http://water.usgs.gov/nawqa/>).
- The Environmental Monitoring and Assessment Program (EMAP) conducted a pilot survey of streams in the mid-Atlantic states, measuring chemistry and biota (Herlihy, et al., 2000). Surveys are ongoing in the western states and have just begun in large river systems of the mid-continent.

This substantial experience has contributed progress in monitoring ecological condition in lakes and streams, but there are still few Category 1 indicators.

Exhibit 5-24 shows the fresh water indicators used in this report, grouped according to the essential ecological attributes. Nine of these indicators are discussed in the previous chapters. This section briefly summarizes those indicators, and then introduces seven new ones. There are no indicators available for national or regional reporting for ecological processes or natural disturbance regimes (The Heinz Center, 2002). Indicators presented in previous chapters include:

- The indicator *Wetland Extent and Change* (Chapter 2, Purer Water) shows that since European settlement of the conterminous U.S., more than half of the original 220 million acres of wetlands have been drained and filled. Wetland types include fresh water forested, shrub, and emergent wetlands, plus open water ponds. By 1997, total wetland acreage was estimated to be 105.5 million acres (Dahl, 2000). Of that total, nearly 95 percent or 100.2 million acres were fresh water, and about 5 percent or 5.3 million acres were intertidal marine and estuarine. Rates of annual wetland losses have been dropping from almost 500,000 acres a year three decades ago to less than 100,000 acres averaged annually since 1986. The loss rate between 1986 and 1997 was estimated to be 58,500 acres per year, an 80 percent reduction in the rate of loss from the previous decade.

  A related ecological impact has been the conversion of one wetland type to another, such as clearing trees from a forested wetland or excavating a shallow marsh to create an open water pond. Open water ponds, which have more than doubled in area since the 1950s, are not the ecological equivalent of fresh water emergent marshes. Such conversions change habitat types and community structure in watersheds and impact the animal communities that depend on them.

  Urban development accounted for an estimated 30 percent of all wetland losses. Estimates for the other loss categories included 26 percent to agriculture, 23 percent to silviculture, and 21 percent to rural development. An estimated 98 percent of all wetlands converted to other uses were fresh water wetlands (Dahl, 2000).

  Forested and emergent wetlands make up over 75 percent of all fresh water wetlands. Since the 1950s, fresh water emergent wetlands have declined by nearly 24 percent, more than any other fresh water wetland type. Fresh water forested wetlands have sustained the greatest overall losses—10.4 million acres since the 1950s.

- Physically altering a fresh water body to increase some other benefit (e.g., flood control, navigation, reduced erosion, or increased area for farming or development) also may change fish

[11] While these statistics are reported biannually, because the states use different measures and monitoring designs, the results do not provide a comparable and consistent picture of the condition of lakes and streams nationally (USGAO, 2000). See Section 2.2.1 for a discussion of recent progress on this issue.

and wildlife habitat, disrupt patterns and timing of water flows, act as barriers to animal movement, or reduce or increase natural filtering of sediment and pollutants. The indicator *Altered Fresh Water Ecosystems* (Chapter 2, Purer Water), reveals that 23 percent of the banks of both rivers and streams (riparian areas) and lakes and reservoirs have either croplands or urban development in the narrow area immediately adjacent to the stream. Data on the degree to which streams and rivers are channelized, leveed, or impounded are not available. According to Dahl (2000), 78,100 acres (31,600 hectares) of forested wetlands were converted to fresh water ponds. Conversions of forested wetlands to deep water lakes resulted from human activities by either creating new impoundments or raising the water levels on existing impoundments, thus killing the trees.

- The indicator *Contaminants in Fresh Water Fish* (Chapter 2, Purer Water) reported on contaminants in fish tissue for the entire U.S., including polychlorinated biphenyls (PCBs), organochlorine pesticides, and trace elements (The Heinz Center, 2002). The presence of contaminants can be harmful to the organisms themselves, or can affect reproduction, and they can make fish unsuitable for consumption. Half of the fish tested had at least five contaminants at detectable levels, and approximately the same number had one or more contaminants at levels that exceeded the aquatic life guidelines.

  For Mid-Atlantic Highland streams with sufficient fish tissue for analysis (44 percent of stream miles did not have sufficient quantities of fish tissue), about 4 percent of the stream miles had fish tissue mercury concentrations that exceeded wildlife criteria (EPA, ORD, Region 3, August 2000).

- For the the indicator *Phosphorus in Large Rivers* (Chapter 2, Purer Water), The Heinz Center (2002) reports that half of the rivers tested had total phosphorus concentrations of 100 ppb or higher. This concentration (100 ppb) is EPA's recommended goal for preventing excess algal growth in streams that do not flow directly into lakes. None of the rivers had concentrations below 20 ppb, a level generally held to be free of negative effects (EPA, OW, November 1986). Data were insufficient to report on lakes and reservoirs nationally.

- The indicator *Lake Trophic State Index* (Chapter 2, Purer Water) assessed the nutrient or total phosphorus (TP) concentrations in northeast lakes (Peterson, et al., 1998). Once phosphorus enters lakes, it frequently serves as the nutrient that limits the growth of nuisance blooms of phytoplankton (algae). National data on lake trophic condition are not available. However, regional patterns of lake trophic condition were assessed for a target population of 11,076 Northeast lakes sampled as part of the EPA EMAP during summers from 1991 to 1994 using the Lake Trophic State Index. It was found that 37.9 percent (±8.4 percent)[12] of the lakes were oligotrophic (TP<10 ppb), 40.1 percent (±. 9.7 percent) were mesotrophic (10<TP<30 ppb), 12.6 percent (±.7.9 percent) were eutrophic (30<TP<60 ppb), and 9.3 percent (±.6.3 percent) were hypertrophic (TP>60 ppb) (Peterson, et al., 1998).

- The indicator *Chemical Contamination in Streams and Ground Water* (Chapter 2, Purer Water), revealed that all the streams sampled by the NAWQA program had one or more contaminants at detectable levels throughout the year, and 85 percent had five or more (The Heinz Center, 2002).[13] Three-fourths of the streams tested had one or more contaminants that exceeded aquatic life guidelines. One-fourth of the streams exceeded the standards for four or more contaminants. Nearly all of the stream sediments tested had an average of five or more contaminants (PCBs, polycyclic aromatic hydrocarbons [PAHs], other industrial chemicals and trace elements) at detectable levels, and half had one or more contaminants that exceeded aquatic life guidelines. Half of the fish tested had at least five contaminants (PCBs, organochlorine pesticides, and trace elements) at detectable levels, and approximately the same number had one or more contaminants at levels that exceeded the aquatic life guidelines (The Heinz Center, 2002).[14]

- The indicator *Acid Sensitivity in Lakes and Streams* (Chapter 2, Purer Water) is affected by the natural buffering capacity of the soil and the rate of acid deposition from the atmosphere. The National Surface Water Survey (NSWS) (Landers, et al., 1988; Linthurst, et al., 1986; Messer, et al., 1986, 1988) determined that 4.2 percent of the NSWS lakes and 2.7 percent of NSWS streams were acidic (Acid Neutralizing Capacity <0 µeq/L) (Baker, et al., 1991). Almost 20 percent (19.1 percent) of NSWS lakes and 11.8 percent of NSWS streams were susceptible to acidic deposition (ANC < 50 µeq/L) (Baker, et al., 1991).[15] Of the acidic NSWS lakes, 75 percent were classified as acidic from acid deposition, 22 percent were organic acid dominated, and 3 percent were acidic from watershed sulfur sources. Of the acidic stream reaches, 70 percent were acidic from acid deposition, 29 percent were organic acid dominated, and 1 percent were acidic from watershed sulfur sources (Baker, et al., 1991).

  These surveys have been repeated periodically for smaller probability samples of lakes in the Northeast, the Adirondacks, and streams in the Appalachians (Stoddard, et al., 1996). More intensive monitoring also has been conducted on lakes in the Northeast, the Appalachians, and the Midwest, and on streams in the Appalachian Plateau and Blue Ridge to assess long-term acidification trends (Stoddard, et al., 1998). Based on these

[12] Concentrations in parentheses represent the 95 percent confidence interval.

[13] Nitrate, ammonium, and trace metals were not included in the occurrence analysis, because they occur naturally (Heinz(The HeinzCenterHeinz Center, 2002, p.50).

[14] Additional information on chemical contamination in all waters of the U.S. is provided in the technical notes, pp. 210-214, of the Heinz report (2002).

[15] There were regional differences in these percentages: only 0.1 percent of NSWS lakes in the West and Florida were sensitive, but 22.7 percent of Northern Appalachian streams were sensitive.

programs, EPA estimated that in three regions, one-quarter to one-third of lakes and streams previously affected by acid rain were no longer acidic, although they were still highly sensitive to future changes in deposition (EPA, ORD, January 2003). Specifically:

- Eight percent of lakes in the Adirondacks are currently acidic, down from 13 percent in the early 1990s.
- Less than 2 percent of lakes in the Upper Midwest are currently acidic, down from 3 percent in the early 1980s.
- Nine percent of the stream length in the Northern Appalachian Plateau region is currently acidic, down from 12 percent in the early 1990s.

Lakes in New England registered insignificant decreases in acidity, and streams in the Ridge and Blue Ridge regions of Virginia were unchanged. The Ridge and Blue Ridge regions are expected to show a lag time in their recovery due to the nature of their soils, and immediate responses to decreasing deposition were neither seen nor expected. The NSWS has not been repeated nationwide, so no data exist to assess trends in surface water acidification in other sensitive areas of the country.

- The indicator *Changing Stream Flows* is one of two indicators presented in Chapter 2, Purer Water that are associated with fresh water hydrology and geomorphology and relate to the ecological condition of fresh water. Changes in stream flow can result in significant effects on fish habitat and chemical concentrations in streams. According to The Heinz Center (2002), the percentage of streams and rivers with major changes in the high or low flows or timing of those flows increased slightly from the 1970s to the 1990s, but the number with high flows well above the high flows between 1930 and 1949 increased by approximately 30 percent in the 1990s. The earlier 1930 through 1949 period included some droughts, but much of it also preceded widespread dam-building and irrigation projects.
- The greatest stressor to mid-Atlantic streams, and many other streams throughout the U.S., is altered instream habitat (EPA, ORD, Region 3, August 2000). A *Sedimentation Index* (Chapter 2, Purer Water) was developed for Mid-Atlantic Highland streams to assess the quality of instream habitat for supporting aquatic communities (Kaufmann, et al., 1999). The amount of fine sediments on the bottom of each stream was compared with expectations based on each stream's ability to transport fine sediments downstream (a function of the slope, depth and complexity of the stream). When the amount of fine sediments exceeds expectations, it suggests that the supply of sediments from the watershed to the stream is greater than what the stream can naturally process. Streams with levels of fine particles at least 10 percent below the predicted value were rated to be in "good" condition relative to the sedimentation criteria. Those with levels from 10 percent below to 20 percent above the predicted value were rated "fair." Those with levels more than 20 percent above regional mean expectations were rated "poor." Based on the Sedimentation Index, about 35 percent of the stream miles had good instream habitat, 40 percent had fair instream habitat, and 25 percent of the stream miles had poor instream habitat (EPA, ORD, Region 3, August 2000).

Several indicators presented for the first time in this report are described below. They include a Category 1 indicator related to landscape condition and six Category 2 indicators relating to biotic condition. There were no indicators for ecological processes or natural disturbance regimes.

Indicator Extent of ponds, lakes, and reservoirs - Category I

This indicator reports the area of ponds, lakes, and reservoirs in the conterminous U.S., excluding the Great Lakes. Over the long term, changes in this indicator reflect the effects of climate on water levels in existing lakes, ponds, and reservoirs, and of reservoir construction, destruction, and management.

What the Data Show

The Heinz Center (2002) reports that, excluding the Great Lakes, the conterminous U.S. contains 21 million acres of lakes, ponds, and reservoirs. The number of ponds (small water bodies usually less than 20 acres and 6 feet deep) increased by 100 percent since the 1950s (Exhibit 5-25). For unknown reasons, the rate of lake and reservoir creation declined 43 percent from the 1970s to 1980s; deep water lakes and reservoirs showed a modest but statistically unreliable increase between the 1980s and 1990s (Dahl, 2000).

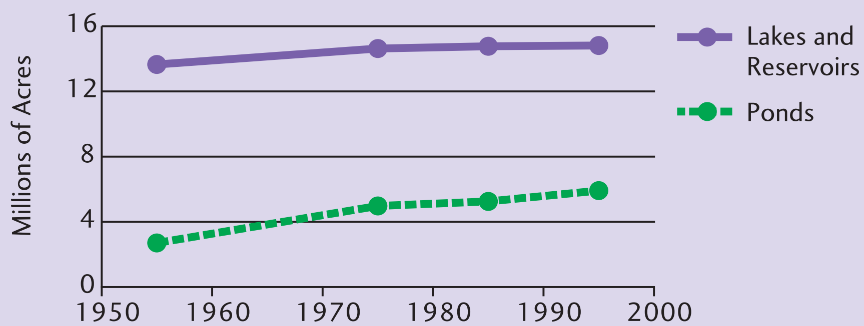
Indicator Gaps and Limitations

The USGS National Hydrography Dataset identifies a considerably larger area of lakes, reservoirs, and ponds at least 6 acres in size (26.8 million acres), and the cause of the discrepancy is unknown (The Heinz Center, 2002).

Data Source

The data source for this indicator was the National Wetlands Inventory, U.S. Fish and Wildlife Service (1970-2000). (See Appendix B, page B-43 for more information.)

Exhibit 5-25: Extent of ponds, lakes, and reservoirs, 1950s-1990s



Coverage: lower 48 states.

Note: Lake area does not include the Great Lakes, which cover about 60.2 million acres within the United States.

Source: The Heinz Center. *The State of the Nation's Ecosystems.* 2002. Data from the U.S. Fish and Wildlife Service's National Wetlands Inventory.

Indicator At-risk fresh water native species - Category 2

The U.S. was sufficiently concerned about preserving species to enact the Endangered Species Act in 1973 to provide legal protection for species that were endangered or threatened. Many of these species depend on lakes, streams, and adjoining wetlands for their continued existence. It is impossible to monitor all freshwater species, but this indicator reports on species of fish, amphibians, reptiles, aquatic mammals, butterflies, mussels, snails, crayfish, fresh water shrimp, dragonflies, damselflies, mayflies, stoneflies, and caddisflies that are at various degrees of risk of extinction (The Heinz Center, 2002).

What the Data Show

According to The Heinz Center (2002), approximately 13 percent of native fresh water species are critically imperiled, 8 percent are imperiled, 11 percent are vulnerable, and 4 percent are or might be extinct (Exhibit 5-26). Critically imperiled species are typically found at no more than five places, and may have suffered steep declines or very high risk. Vulnerable species may be found in 20 to 80 locations and show widespread declines or moderate levels of risk (Stein, 2002). Mussels and fish are particularly at risk. Hawaii and the Southeast have significantly higher percentages of at-risk species than other regions, but this condition may be partially the result of Hawaii and parts of the Southeast having a higher number of naturally rare species (The Heinz Center, 2002).

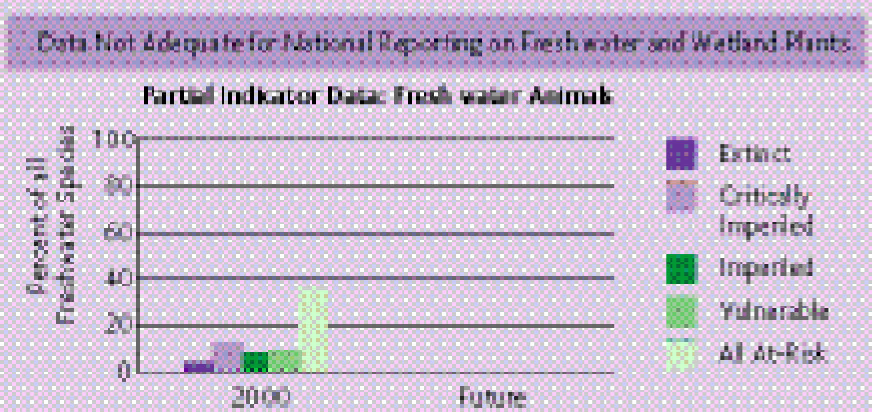
Indicator Gaps and Limitations

The data underlying this indicator are not from a site-based monitoring program, but rather from a census approach that focuses on the location and distribution of at-risk species. The data do not distinguish species that are naturally rare from species that have become rare because of human actions, making it difficult to distinguish actual trends in this indicator.

Data Source

The data source for this indicator was *The State of the Nation's Ecosystems,* The Heinz Center, 2002, using data from NatureServe Explorer database. (See Appendix B, page B-43, for more information.)

Exhibit 5-26: At-risk native fresh water species, by risk factor, 2000



Coverage: all 50 states.

Source: The Heinz Center. *The State of the Nation's Ecosystems.* 2002. Data from NatureServe and its Natural Heritage member programs.

Indicator | Non-native fresh water fish species - Category 2

This indicator reports on the percentage of watersheds with different numbers of non-native species with established breeding populations (The Heinz Center, 2002). Non-native species include species not native to North America and species that are native to this continent but are now found outside their historic range. Such species, once introduced from some other location, often lack predators or parasites that kept them in check in their native habitats, and expand to cause a degree of ecological and economic disruption. Some non-native species are introduced intentionally (e.g., rainbow trout).

What the Data Show

Data are currently available nationally only for fish: of 350 watersheds (6-digit HUCs) in the U.S., only five have no non-native fish (The Heinz Center, 2002). Sixty percent have 1 to 10 non-native species, and two watersheds have 41 to 50 non-native fish species (Exhibit 5-27).

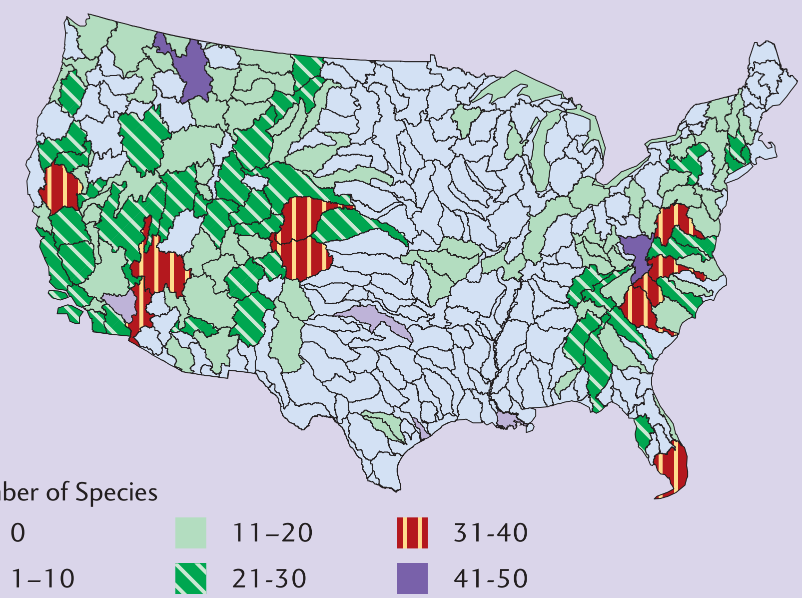
Indicator Gaps and Limitations

The data are not from a site-based monitoring program; they rely for the most part (90 percent) on the published literature and (10 percent) direct reporting by governmental and private biologists. New discoveries are not always reported (The Heinz Center, 2002).

Data Source

The data source for this indicator was The *State of the Nation's Ecosystems,* The Heinz Center, 2002, using data from the Non-indigenous Aquatic Species database. (See Appendix B, page B-44, for more information.)

Exhibit 5-27: Non-native fresh water fish species, 2000



Coverage: lower 48 states.

Source: The Heinz Center. *The State of the Nation's Ecosystems.* 2002. Data from the U.S. Geological Survey.

Indicator: Animal deaths and deformities - Category 2

Unusual mortality events (e.g., fish kills) or deformities (e.g., frog deformities) can have economic consequences, and they are also seen as evidence that something is wrong (e.g., a contaminant is present, or the organisms are under stress from some other source). Although data are collected on die-offs of mammals, fish, and amphibians, and on amphibian deformities, data are insufficient for national reporting (The Heinz Center, 2002). This indicator reports on unusual mortality events for waterfowl only.

What the Data Show

From 1995 to 1999, approximately 500 incidents of unusual waterfowl mortality were reported (The Heinz Center, 2002) (Exhibit 5-28). In slightly more than 20 percent of the incidents, more than 1,000 birds died, and in 15 of the incidents, more than 10,000 birds died. The total number of die-offs reported from 1995 to 1999 was 20 percent lower than the numbers reported in two earlier periods (1985 to 1989 and 1990 to 1994) (The Heinz Center, 2002). A larger number of events were reported in the Pacific and Midwest regions; fewer were reported in the Southwest and Southeast.

Indicator Gaps and Limitations

The data are not from a defined site-based monitoring program, but are provided by various sources such as state and federal personnel, diagnostic laboratories, wildlife refuges, and published reports, as they are discovered or reported (The Heinz Center, 2002). This makes it hard to distinguish real trends from trends in reporting.

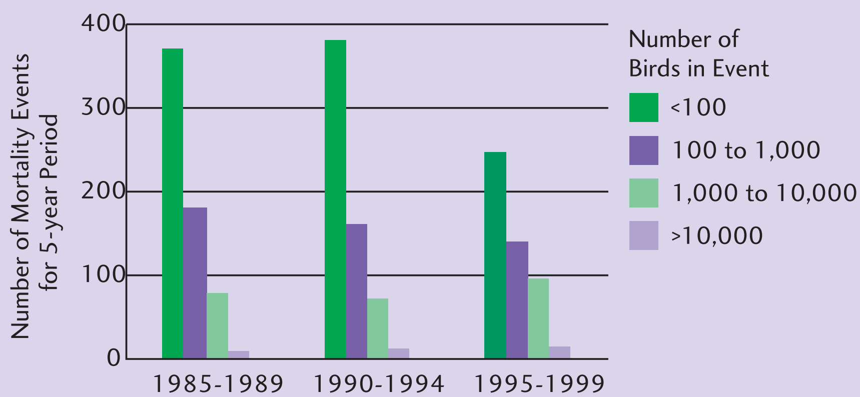
Data Source

The data source for this indicator was *The State of the Nation's Ecosystems,* The Heinz Center, 2002, using data from the National Wildlife Health Center database.
(See Appendix B, page B-44, for more information.)

Exhibit 5-28: Animal deaths and deformities, 1985-1999

Data Not Adequate for National Reporting on:
- Fish Die-offs
- Mammal Die-offs
- Amphibian Die-offs
- Amphibian Deformities

Partial Indicator Data: Waterfowl Mortality Only



Coverage: all 50 states, Puerto Rico, and the U.S. Virgin Islands

Source: The Heinz Center. *The State of the Nation's Ecosystems.* 2002. Data from the U.S. Geological Survey.

Indicator **At-risk fresh water plant communities - Category 2**

The Heinz report employs an indicator of the threat of elimination of wetland and riparian area plant communities. This indicator uses an expert assessment conducted by NatureServe (Stein, 2002) of factors such as the remaining number and condition of the community, the remaining acreage, and the severity of threats to the community type.

What the Data Show

According to this indicator, 12 percent of the 1,560 wetland communities ranked are critically imperiled, 24 percent are imperiled, and 25 percent are vulnerable (The Heinz Center, 2002) (Exhibit 5-29).

Indicator Gaps and Limitations

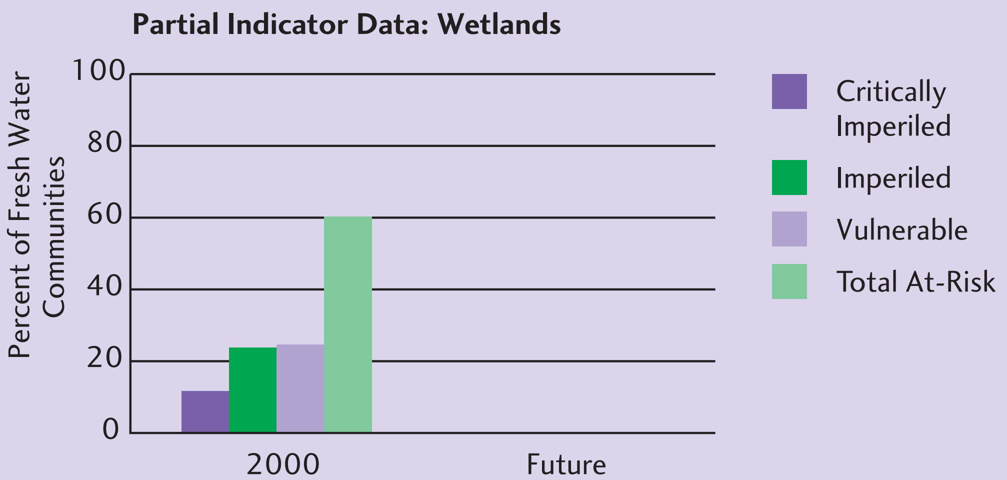
The Heinz report states that data are not adequate for national reporting (The Heinz Center, 2002). The report concludes that technical challenges in classifying riparian communities prevent national estimates for stream bank plant communities. In addition, interpreting the data is complicated because some species are naturally rare, and the total number of species for any ecosystem is unknown.

Data Source

The data source for this indicator was *The State of the Nation's Ecosystems,* The Heinz Center, 2002, using data from NatureServe Explorer database. (See Appendix B, page B-44, for more information.)

Exhibit 5-29: At-risk fresh water plant communities, 2000

Data Not Adequate for National Reporting on Riparian Communities



Coverage: excludes Alaska.

Source: The Heinz Center. *The State of the Nation's Ecosystems.* 2002. Data from NatureServe and its Natural Heritage member programs.

Indicator | Fish Index of Biotic Integrity in streams - Category 2

Fish communities integrate the effects of the physical, chemical, and biological stressors in the environment. The Heinz Center (2002) listed the status of fresh water animal communities as an indicator in need of development. Karr, et al. (1986, 1997) developed a Fish Index of Biotic Integrity (IBI) that incorporates species richness, trophic composition, reproductive composition, and abundance and individual health of fish communities in streams. This index, modified by McCormick, et al. (2001), was applied to a regional survey of streams in the mid-Atlantic states, and provides an example of an indicator that could be applied nationally.

A sample of reference sites that represented the best conditions observable today in the mid-Atlantic region (e.g., sites free of influences from mine drainage, nutrients, habitat degradation) provided a frame of reference for ranking the condition of streams overall. The IBI scores calculated for the reference sites ranged from 57 to 98. The 25th percentile of this distribution (IBI=72) was used to distinguish sites that were in good condition from those in fair condition. The first percentile value (IBI=57) separated sites in fair condition from those in poor condition. A statistical way to describe this setting of thresholds is to say that any IBI score of less than 57 in a sampled stream is 99 percent certain to be below the range of values seen in reference sites (McCormick, et al., 2001).

What the Data Show

Fish were collected at probability sites that represent about 90,000 miles of streams in the mid-Atlantic. The fish IBI indicated that 27 percent of the streams were in good condition and 14 percent were in poor condition in the Mid-Atlantic Highlands (see Exhibit 5-30). About 38 percent of the streams were scored in fair condition. No fish were caught in about 21 percent of the streams. The estimates of stream condition have a confidence interval of about ±.8 percent (McCormick, et al., 2001).

Indicator Gaps and Limitations

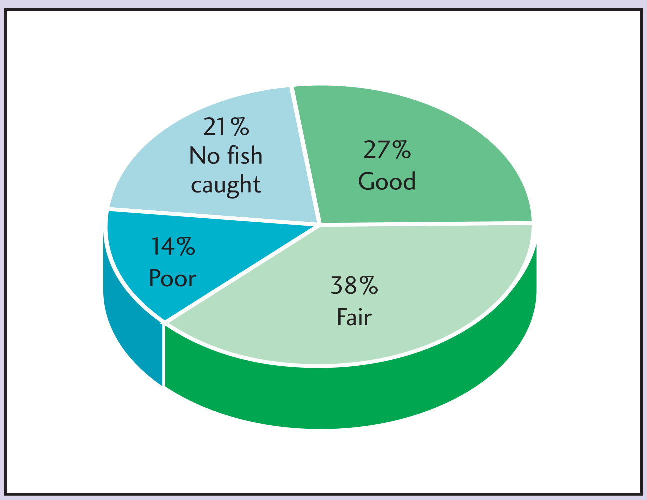
The limitations of this indicator include the following:

- Condition cannot be assessed in streams where no fish were caught. Poor condition cannot be inferred from no fish caught, because some streams were likely too small to support a fishery. Data were insufficient to indicate if the stream had poor quality or simply no fish (EPA, ORD, Region 3, August 2000).
- The data are available only for a limited geographic region, and no repeated sampling is available to estimate trends.

Data Source

The data source for this indicator was the Mid-Atlantic Highlands Streams Assessment, Environmental Protection Agency, August 2000, using data from the Mid-Atlantic Integrated Assessment. (See Appendix B, page B-45, for more information.)

Exhibit 5-30: Fish Index of Biotic Integrity (IBI) indicators used to assess stream condition in the Mid-Atlantic Highlands, 1993-1996



Coverage: Mid-Atlantic Highlands

Note: No fish caught does not indicate poor condition. Some streams naturally do not have fish.

Source: McCormick, F. H. et al. *Development of an Index of Biotic Integrity for the Mid-Atlantic Highlands Region.* 2001.

Indicator Macroinvertebrate Biotic Integrity Index for streams - Category 2

Like fish, macroinvertebrate communities integrate physical, chemical, and biological stressors, but because many of them are more sedentary than fish and occupy different ecological niches, they provide a complementary picture of ecological condition.

A Macroinvertebrate Biotic Integrity Index (MBII) was developed for mid-Atlantic streams by Klemm, et al. (2002, 2003). The MBII incorporates taxa richness, assemblage composition, pollution tolerance (includes all maroinvertebrates, not just insects), and functional feeding groups (Klemm, et al., 2002). Similar to the approach used to separate the Fish IBI scores (McCormick, et al., 2001), the 25th percentile of the reference site MBII scores was used to distinguish sites in good condition from those in fair condition. The first percentile was used to separate sites in fair condition from those in poor condition (McCormick, et al., 2001).

What the Data Show

The MBII scores indicated that 17 percent of the streams in the mid-Atlantic were in good condition, 57 percent were in fair condition, and 26 percent were in poor condition (Exhibit 5-31).

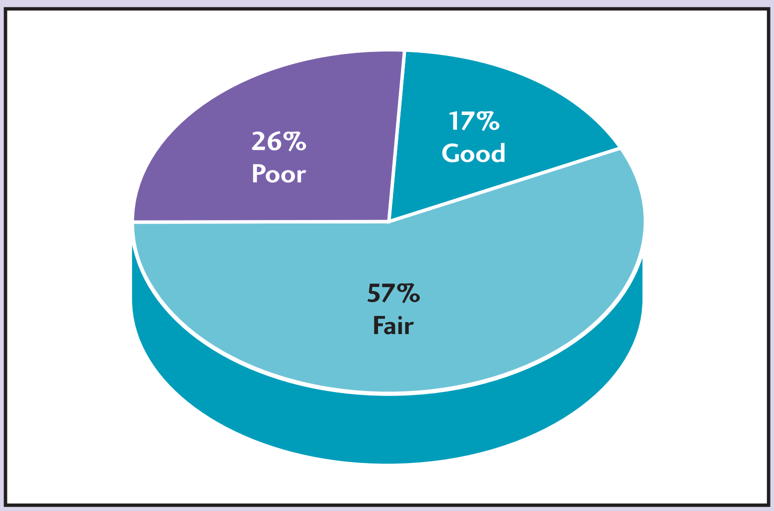
Indicator Gaps and Limitations

The data are available only for a limited geographic region, and no repeated sampling is available to estimate trends.

Data Source

The data source for this indicator was *Development and Evaluation of a Macroinvertebrate Biotic Integrity Index (MBII) for Regionally Assessing Mid-Atlantic Highlands Streams.* 2003, Klemm, et al., using data from the Mid-Atlantic Integrated Assessment. (See Appendix B, page B-45, for more information.)

Exhibit 5-31:
Macroinvertebrate Biotic Integrity Index (MBII), Mid-Atlantic Highlands, 1993-1996



Coverage: Mid-Atlantic Highlands

Source: Klemm, D.J., et al. *Development and Evaluation of a Macroinvertebrate Biotic Integrity Index (MBII) for Regionally Assessing Mid-Atlantic Highlands Streams.* 2003.

Summary: The Ecological Condition of Fresh Waters

Fresh water systems are under pressure from point and non-point pollution, atmospheric deposition, altered habitat, and invasive species. A review of Exhibit 5-24, however, indicates that there are virtually no Category 1 indicators or monitoring programs that provide a national picture of the ecological condition of fresh waters. No national condition data are available on ecological processes, not are there any nationally or regionally reported indicators of natural disturbance regimes.

Landscape condition

The National Wetlands Inventory provides unbiased statistical estimates of the extent of wetlands, ponds, lakes, and reservoirs in the conterminous U.S. at decadal scales since the 1970s. There is no similar effort for the extent of streams (losses can occur because of mining, damming, water withdrawal, or climate change). Chapter 2, Purer Water, estimates that the U.S. has more than 3.7 million miles of streams and rivers (EPA, OW, June 2000a, 2000b). About 60 percent of all these stream miles are found in small, headwater streams. The Heinz Center reports, however, that because there is no agreed-upon system to classify streams (e.g., by discharge, drainage area, or stream order), there are no national data sets for reporting on stream size.

Biotic condition

At this time, no national condition data are available on lake, wetland, or stream biota. The USGS National Water Quality Assessment (NAWQA) program has collected data on the biota in rivers and streams in the network, but no analysis has been performed on the data at a national level (USGS, 2002; <http://water.usgs.gov/nawqa/>). Surveys of stream benthos and fish communities have been conducted for the mid-Atlantic region that provide unbiased estimates of the condition of 90 percent of the streams in the region. Both surveys showed only 17 percent (±8 percent) of the streams to be in good condition, but there is no indication of whether they are the same streams or of the likely cause(s) of impairment. No fish were caught in 16 percent of the streams, so their condition could not be judged based on this criterion. Similar regional studies have been conducted in the western states, but the data have not yet been reported. There are no nationally or regionally representative data on the aquatic communities of lakes. Based on NatureServe data, 36 percent of aquatic biota in several categories are either extinct or at some risk of extinction, but because this database relies on voluntary reporting, future trends might not be discernable with statistical reliability. NAWQA collected contaminant data from fish tissue in 223 streams, and almost half showed concentrations that exceeded aquatic life guidelines for at least one contaminant. However, these data have not been related to the condition of the fish communities in the corresponding streams, so ecological condition cannot be determined. There are no specific plans to re-sample in any of these programs, and so there is no assurance that trend data will be available in the future.

Chemical and physical characteristics

Better data are available for chemical and physical characteristics of streams, less for lakes, and none for wetlands. The NAWQA program reports data on total phosphorus concentrations in more than 140 large rivers nationwide, but there are no corresponding national data on either lake or reservoir concentrations (where algal blooms are likely to develop), nor on the corresponding biological communities. Reliable regional estimates have been made of total phosphorus concentrations in 11,076 lakes in the Northeast states. These estimates showed with a high degree of confidence that fewer than 22 percent of the lakes were estimated to be eutrophic or hypertrophic. While a relationship exists between total phosphorus concentrations and algal biomass or productivity (Carlson, 1977), lake-to-lake variation is considerable, so none of these data truly express the known ecological condition of these lakes or rivers with respect to eutrophication. Nitrate is not often a limiting nutrient in fresh waters, so it provides little ecological information on fresh waters themselves (although it does provide useful information on the watershed, as discussed in the sections on forests and farmlands).

The NAWQA program reports on contaminants in stream waters from 109 streams, and sediments from 558 stream sites across the U.S. At least half of the streams had concentrations that exceeded wildlife criteria, but there are as yet no analyses relating these to the condition of fish or invertebrate communities in the streams naturally. Incorporation of water quality data monitored by the states could improve the coverage, if care is given to representative sampling and comparable methods and indicators.

A national survey in the 1980s provided estimates of the sensitivity of all lakes and all streams in the eastern U.S. to acidic deposition (Landers, et al., 1988; Kaufmann, et al., 1991). Periodic resurveys and intensive sampling of representative lakes and streams have allowed EPA to conclude that, because of reductions in sulfate emissions under its acid rain regulations, one-quarter to one-third of lakes and streams in three regions affected by acid rain are no longer acidic (EPA, ORD, Region 3, August 2000). Corresponding biological community data exist only for streams in the Mid-Atlantic Highlands.

Hydrology and geomorphology

There are nationally reported data on only one hydrologic/geomorphological indicator: changing stream flow. This indicator is reported on all rivers and streams for which the record of data is adequate, and it shows that high flows have increased during the past decade. There are no corresponding data to indicate why, however, nor are there data on any accompanying change in the fish communities, so ecological condition cannot be assessed with any reliability.